

POLITECHNIKA ŚLĄSKA

SILESIAN UNIVERSITY OF TECHNOLOGY

ZESZYTY NAUKOWE

SCIENTIFIC PAPERS

ORGANIZACJA I ZARZĄDZANIE

Zeszyt Naukowy nr 250

ORGANIZATION AND MANAGEMENT

Scientific Paper no. 250

Nowe trendy w zarządzaniu

New trends in management

Pod redakcją

Radosława WOLNIAKA

Edited by

Radosław WOLNIAK

GLIWICE 2026

Kolegium redakcyjne

REDAKTOR NACZELNY – Dr hab. inż. Małgorzata KRÓL, prof. PŚ
REDAKTOR DZIAŁU – Prof. dr hab. inż. Radosław WOLNIAK

**Wydano za zgodą
Rektora Politechniki Śląskiej**

**ISSN 1641-3466
ISSN 2720-751X**

© Copyright by
Wydawnictwo Politechniki Śląskiej
Gliwice 2026

**WYDAWNICTWO POLITECHNIKI ŚLĄSKIEJ
ul. Akademicka 5, 44-100 Gliwice
tel. (32) 237-13-81, faks (32) 237-15-02
www.wydawnictwopolitechniki.pl**

**Sprzedaż i Marketing
tel. (32) 237-18-48
wydawnictwo_mark@polsl.pl**

CONTENTS

Foreword	7
1. Katarzyna AUGUSTYN, Lidia LUTY – Socio-economic development of Poland against the background of European Union countries	9
2. Katarzyna BRENDZEL – Cooperation with the business environment as a factor shaping the university image.....	25
3. Jan BRZÓSKA, Sławomir OLKO – Innovation strategies and business models of material processing sector enterprises in the Silesian voivodeship	41
4. Maja CHAMIER-GLISZCZYŃSKA, Adam WASILEWSKI – Forms of activity within a farm – legal and practical aspects in Poland	63
5. Karolina CZERWIŃSKA, Andrzej PACANA – Model for eliminating motion waste in a manufacturing company using KPIs	81
6. Łukasz DOMŻAŁ-DRZEWICKI – Organizational capabilities in the field of cybersecurity for important entities under the NIS2 directive. An analysis of selected management challenges. The Polish perspective.....	95
7. Irena DUDZIK-LEWICKA – Sustainable development and ESG factors in the SME sector: challenges and perspectives for leader	115
8. Michał FERTSCH, Łukasz HADAŚ – Readiness for adaptation in the context of artificial intelligence implementation in production planning.....	133
9. Marcin GERYK – Synthetic knowledge as systemic capital in the governance of generative artificial intelligence.....	143
10. Adam GUMIŃSKI, Adam BOSOWSKI, Marzena PISARSKA – The relationship between employees' mental resilience and job insecurity in the hard coal mining industry in Poland	169
11. Patrycja KABIESZ, Grażyna PŁAZA, Adam R. SZROMEK, Tayyaba JAMIL – The safety culture in textile industry companies in Poland	187
12. Filip KEIPER, Joanna FURMAN, Sylwia KRUCZYŃSKA – The A3 report as a problem-solving tool in a manufacturing enterprise – case study.....	205
13. Agata KIELESIŃSKA – Psychological aspects of market strategies in e-commerce.	223
14. Beata KOLNY – Consumers towards corporate ESG activities	237
15. Agnieszka KOWALSKA-STYCZEŃ, Przemysław SIELSKI – Urban transport as a key element of smart city development: a comparative analysis of Warsaw and London	249
16. Paweł KRÓLAS – Provider – client collaboration: implementation of quality management frameworks versus AI-based models.....	267
17. Marzena KUCZYŃSKA-CHAŁADA, Michał MIKINA – Improvement of the warehousing using RFID technology in a manufacturing enterprise – a literature review.....	285

18. Aleksandra KUZIOR, Dariusz KRAWCZYK – The level of social awareness of sustainable development in the management of image and product activities	299
19. Janusz M. LICHTARSKI, Anna WITEK-CRABB – Corporate values and paradoxical approach in strategic management.....	311
20. Jacek LIS – The role of strategic allies in shaping an innovative educational offer of a non-public university	325
21. Sylvia ŁĘGOWIK-ŚWIĄCIK – Integration of information resources in interorganizational collaboration strategies	345
22. Aneta MADYDA – The role of communication in the management of a services company in the Silesian region	361
23. Marcin MAJEWSKI, Aleksandra SZTUK – The potential of small towns to foster business development and local entrepreneurial ecosystems.....	379
24. Artur MATŁACH – The future of the cord model: recommendations for its development in Polish higher education institutions	401
25. Rafał MIŚKO – An overview and comparison of selected MBA programs in Poland ..	421
26. Katarzyna OLEJNICZAK-SZUSTER – Work life balance – the importance of balance in the academic live of students.....	435
27. Pamela OMIOTEK – Conceptual approach to information waste in lean management	447
28. Zbigniew ORBIK, Bogdan PLISZKA – Artificial intelligence and its impact on economic transformation in India	457
29. Agnieszka PIEKARA, Małgorzata KRZYWONOS, Stanisław POPEK, Magdalena ANKIEL, Michał KUCIA, Paulina ŻMIJOWSKA, Michał HALAGARDA, Bogdan PACHOLEK, Bartłomiej JEFMAŃSKI, Sylwia SADY – Consumer perception of sustainability communication on fermented probiotic milk packaging: a focus group study.....	477
30. Monika ROGALSKA, Liliana HAWRYSZ – Quality implications of virtual reality assisted distraction protocols in pediatric dental care: a systematic review	509
31. Danuta ROJEK – Inter-organizational cooperation in the innovative activities of industrial enterprises in Poland – in the context of open innovation.....	529
32. Paweł SIEMASZKIEWICZ – Succession in small family organic farms in Poland – conditions and barriers	549
33. Sebastian SKOLIK – Cultural diversity of cooperation forms in virtual communities of practice. The case of wikimedia projects	571
34. Jan STACHOWICZ, Bartosz SYLWESTRZAK – Development of modern leaders as a fundamental function of the leadership training system in the army.....	591
35. Tomasz WAŁEK – The prosumer-centered approach to energy microgrids in Poland	607
36. Elżbieta WAŻNA, Irena MALINOWSKA, Marta PIETRZYKOWSKA – The impact of audit on the effectiveness of business management	617

37. Angelika WODECKA-HYJEK, Hubert OBORA, Michał TECZKE – Digital competences as a determinant of information process performance in municipal administration.....	633
38. Paweł ZABILSKI – Greenwashing as a governance challenge: the EVIDENCE model for environmental claims.....	655

FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Presented papers contain result of researches conducted by various universities. The number consists of 38 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: sustainable development; public management; innovativeness; production management; the implementation of Artificial Intelligence in management; knowledge management; human resource management; safety management; e-commerce; ESG; smart city; logistics; strategic management; services management; quality management; open innovation; cultural diversity; prosumers; and greenwashing.

Radosław Wolniak

SOCIO-ECONOMIC DEVELOPMENT OF POLAND AGAINST THE BACKGROUND OF EUROPEAN UNION COUNTRIES

Katarzyna AUGUSTYN^{1*}, Lidia LUTY²

¹ Department of Statistics and Social Policy, University of Agriculture in Krakow;
katarzyna.augustyn@urk.edu.pl, ORCID: 0009-0009-8611-8846

² Department of Statistics and Social Policy, University of Agriculture in Krakow, lidia.luty@urk.edu.pl,
ORCID: 0000-0001-8250-8331

* Correspondence author

Purpose: The main purpose of this article is to assess the level of socio-economic development in Poland, with particular emphasis on its position relative to other EU Member States between 2014 and 2023.

Methodology: The study was based on a review of the relevant literature and an analysis of socio-economic data from the following databases: Eurostat, the Happy Planet Index and the World Bank. Due to the complex nature of socio-economic development, tools from Multidimensional Statistical Analysis (MSA) were employed, specifically the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). A synthetic socio-economic development index (SEDI) was constructed on the basis of selected indicators. The analysis covered the years 2014–2023, which enabled an assessment of the dynamics of the phenomenon both in Poland and in other EU countries.

Findings: The analysis revealed an improvement in Poland's socio-economic development between 2014 and 2023; however, overall, Poland still ranks towards the bottom of the list of Member States. The constructed socio-economic development index enabled the presentation of Poland's position relative to other EU Member States. At the same time, it was found that significant disparities in socio-economic development persist between the countries of Northern and Western Europe and those of Central and Eastern Europe.

Practical implications: A practical application of the research could be to draw the attention of public authorities to the monitoring of development processes and the identification of areas requiring support. The proposed synthetic approach could also be used in comparative analyses of development levels at an international level.

Originality: This article presents the construction of a synthetic socio-economic development index (SEDI) and the application of multidimensional statistical analysis to assess Poland's position relative to other EU countries. The study also provides an empirical assessment of the extent of spatial diversity in socio-economic development within the EU.

Keywords: socio-economic development, Poland, European Union, Multidimensional Statistical Analysis, spatial diversity.

Category of the paper: research paper.

1. Introduction

Socio-economic development is the broadest concept relating to the development trends of a given territorial unit, and maximising it is the primary goal of all the world's economies. This concept is complex in nature; therefore, interpreting it correctly requires an analysis of its individual components. Economic development is a long-term process of internal social and economic transformation that fosters the emergence of a society striving to improve its material circumstances. It involves creating conditions favourable to investment in physical, human and intellectual capital, which ensures its continuous accumulation and the country's further development (Nasiłowski, 2004). Social development is a process of expanding human opportunities and choices, which leads to an improvement in the quality of life, increased prosperity and greater access to the resources necessary for a dignified existence (UNDP, 1990).

Overall, socio-economic development encompasses the totality of changes affecting society and the economy (Schumpeter, 1960). On a global scale, significant differences in the level of socio-economic development are evident, influenced by a range of factors. Factors of regional development include: human, social, material and financial capital, as well as innovation (Churski, Perdał, 2008). The causes of development are also classified according to their origin: political, economic, social, natural, legal and reputational (Parysek, 2021). Churski et al. (2018) also identify megatrends in the contemporary economic landscape that influence classic factors such as: transformation, economic integration, globalisation and post modernisation.

In recent years, the European Union has faced a number of challenges, such as the COVID-19 pandemic, crises resulting from the high cost of living, climate change and the digital transformation. In light of these difficulties, the European Union has stepped up its efforts to protect citizens and local communities. The organisation supports the creation of new and better jobs, skills development, equality, social protection and social inclusion (European Commission, 2024). The countries belonging to the European Union are mainly perceived as highly developed economies; however, there are differences in the level of socio-economic development within the community (World Bank, 2024). These disparities stem, among other things, from unequal access to resources and certain valued assets, i.e. social inequalities (Podemski, 2009). Wójcik-Żołądek (2013) identifies three areas of social inequality: economic, which includes income, wages and living conditions; social, covering social recognition, education, lifestyle and access to culture; and political, concerning influence and power. The relatively similar level of socio-economic development among European Union countries should lead to a similar level of inequality, or at least indicate a certain correlation between these phenomena.

The purpose of this article is to assess the level of socio-economic development in Poland, with particular emphasis on its position relative to other EU Member States. The article draws on socio-economic data from the years 2014-2023.

The article adopts a research hypothesis (H1) according to which selected methods of Multivariate Statistical Analysis constitute an appropriate tool for verifying and assessing the level of socio-economic development in Poland compared to other EU countries. A second hypothesis (H2) has also been formulated, which assumes that there is significant spatial diversity in the level of socio-economic development among EU Member States.

2. Literature Review

The concept of socio-economic development emerged after the Second World War, and research into measuring the development of global economies has been ongoing ever since. Issues relating to the level of socio-economic development in European Union countries have been addressed by many researchers and continue to attract considerable interest. Research into the impact of social inequalities on this level of development has also been ongoing for decades. Authors use a variety of methods to assess the level of development, some of which are considered useful, whilst others are deemed completely unacceptable. Stec (2008) compares the level of socio-economic development of EU countries between 2003 and 2006 using the following methods: Z. Hellwig's method, standardised sums and ranks, and Spearman's correlation coefficients.

The set of socio-economic indicators used in the study comprises 23 quantitative characteristics relating to various aspects of development, ranging from the macroeconomic situation, demographics and the labour market to the development of industry, construction, agriculture, research and development, and socio-technical infrastructure. Sweden, Finland and Denmark occupy the top spots in the socio-economic development rankings, whilst Romania and Bulgaria are at the bottom, with Latvia or Greece also featuring near the bottom depending on the methodology. A study by Soava, Meheditu and Sterpu (2020) analyses the impact of income inequality on economic growth and the relationship between poverty and economic development in European Union countries between 2005 and 2016. The study utilised the Gini coefficient, the at-risk-of-poverty threshold and the median equivalent net income. The analysis supports Kuznets' hypothesis, according to which income inequality initially rises with economic development but begins to decline once a certain level of development is reached. Belas et al. (2020) assess the progress of economies across three levels of development, taking into account indicators of economic growth intensity, stability and rate. The study was conducted using the MDD (Minimum Detectable Difference) method and compared EU countries based on GDP per capita. The analyses carried out show that, between 2008 and 2017, only Luxembourg and Switzerland were classified at the first level of development, with a further 16 countries placed at the second level and a similar number at the third. Migąła-Warchoń (2021), in her research on the socio-economic development of EU countries

between 2008 and 2018, focuses on five areas that influence residents' standard of living: the economy and finance, science and technology, health, education, and living conditions. The author employs multidimensional ordinal analysis to create a composite socio-economic development index, which enabled the classification of EU countries and the analysis of the phenomenon of social convergence. A second-order non-linear model was used to model the changes. The research shows that the division between old and new EU countries, and between the wealthier North and the poorer South, persists. The low level of socio-economic efficiency of EU countries in 2018 stems from marked income inequalities, which vary from country to country, as confirmed by an analysis of the socio-economic efficiency of countries using the DEA (Data Envelopment Analysis) method. Myszczyszyn and Bąk (2025) use the TOPSIS method to assess the socio-economic development of European countries, creating an aggregate variable based on 11 indicators. The research findings confirm that this method allows countries to be ranked even when the values of the analysed characteristics are difficult to determine unambiguously. The inclusion of a large number of economic indicators allowed for a more comprehensive assessment of the development of the countries under study. The resulting ranking confirms significant differences between Western European and Nordic countries, and the countries of the former Eastern Bloc. Kasprzyk and Wojnar (2023) used the TOPSIS method to compare socio-economic development and quality of life in Poland against other EU countries. The authors constructed two composite variables based on 13 indicators. The first assessed the level of economic development, whilst the second assessed the quality of life in EU countries. Between 2005 and 2021, Poland significantly improved its position in the EU country rankings, rising by nine places in terms of economic development and by ten places in terms of quality of life. In other studies, EU countries were analysed on the basis of data relating to indicators (employment rates, average net income equivalent, GDP per capita in PPS (Purchasing Power Standard), and the percentage of people at risk of poverty and social exclusion). The research shows that only four EU countries achieve a satisfactory level of socio-economic efficiency (the Czech Republic, Luxembourg, Switzerland and Norway). Furthermore, countries in Northern and Western Europe achieve greater efficiency than those in Southern Europe (Stalković, Marjanović, Stalković, 2021). Kostov and Moraliyska (2022) confirm in their research that income inequality in the EU between 2010 and 2021 had a negative impact on GDP levels across the Union. And differences in the level of social inequality, particularly income inequality, undermine the economic performance of Member States. The Gini coefficient and the S80/S20 ratio (covering the richest 20% and the poorest 20%) were used as indicators of inequality. The greatest income disparities among EU Member States, with a Gini coefficient above 35, were recorded in Bulgaria, Lithuania and Latvia, whilst the most even distribution of income was found in the Czech Republic, Slovenia and Slovakia. Research by Popescu (2022) confirms that there is a significant and moderately strong positive linear relationship between the Gini coefficient and the S80/S20 ratio, allowing for their parallel use in assessing the level of inequality. Milek and Nowak (2024) analyse socio-

economic inequalities in Europe between 2010 and 2022, with particular emphasis on the level of social development and income distribution. The study employed a descriptive method, utilising the HDI, the Gini coefficient, the Lorenz curve and Ward's method. The study covered 32 European countries, including all EU member states as well as the United Kingdom, Switzerland, Norway, Liechtenstein and Iceland. The findings show that, despite general progress in social development across Europe, discrepancies between countries are deepening, with nearly 47% of the countries surveyed classified as having a low or very low level of social development. Furthermore, groups of countries with similar characteristics, such as Estonia, the Czech Republic, Poland, Hungary and other Central European countries, exhibit similar levels of GDP per capita.

3. Materials and Methods

The level of socio-economic development of EU countries was assessed using the Multidimensional Statistical Analysis tool, specifically the TOPSIS method (The Technique for Order of Preference by Similarity to Ideal Solution) (Hwang, Yoon, 1981). First, features describing the phenomena under study were selected and assigned a character (S – stimulant, D – destimulant) (Table 1).

Table 1.
Diagnostic variables for assessing socio-economic development.

Variable	Full name [character*]
W_1	Gross Domestic Product per capita (GDP per capita) (tys. euro) [S]
W_2	Gini index (0-100) [D]
W_3	At risk of poverty rate (60% of median income) (%) [D]
W_4	Income quintile share ratio (S80/S20**) [D]
W_5	Happy Planet Index (HPI) (0-100) [S]

*S: Stimulant, D: Destimulant.

**S80/S20: the ratio of the total income earned by the richest 20% to the income of the poorest 20%.

Source: Own study based on Eurostat. available online: <https://ec.europa.eu/eurostat>, 29 January 2026; World Bank. available online: <https://www.worldbank.org>, 29 January 2026; Happy Planet Index. available online: <https://happyplanetindex.org>, 29 January 2026.

Their selection was based on a review of the literature, data availability and statistical analysis. The statistical data used in this study were sourced from Eurostat, the Happy Planet Index and the World Bank databases. The study covers the period 2014-2023.

GDP per capita is an indicator based on the System of National Accounts. It represents the total value of goods and services produced by a given economy at a given time, per capita. It is calculated by dividing GDP—which includes consumption, government and investment expenditure, as well as net exports—by the population of the country in question (Urban, Urbanek, 2015). The GDP used to calculate GDP per capita is employed by economists as the

primary indicator of the health and prosperity of the national economy (Telberth, Cobb, Slettery, 2007). The most commonly used measure of income inequality in society is the Gini coefficient. It was introduced by Corrado Gini and first described in the journal "Metron" (Lisowski, 2023), and is based on the distribution of income within society. The higher its value, the greater the inequality in household income in a given country (Stawicka, 2012). The at-risk-of-poverty rate defines the percentage of people whose equalized disposable income, after taking social transfers into account, is below 60% of the national median. It measures a relatively low level of income in a given society, rather than poverty in absolute terms (Eurostat, 2026). Income disparities in society can also be compared using the S80/S20 ratio, also known as the quintile ratio. It is calculated by comparing the income of the richest 20% of the population with that of the poorest 20%. This indicator is expressed as the ratio of the sum of the incomes of the first and last quintile groups. In practice, it indicates how many times more income is held by the wealthiest 20% of the population compared to the poorest 20% (Eurostat, 2026). The Happy Planet Index (HPI) is a measure of sustainable well-being that assesses countries based on their ability to provide their inhabitants with a long and happy life whilst making the most of limited environmental resources. It was introduced in 2006 by the New Economics Foundation (NEF) and is scored on a scale of 0 to 100. The worst possible score indicates low life expectancy, low satisfaction and a high carbon footprint, whilst the ideal score represents a long and happy life with minimal environmental impact (Simms et al., 2006).

The values of the selected indicators (W_1 – W_5) formed the basis for the construction of a synthetic measure of socio-economic development.

The synthetic indicator of socio-economic development for each country was calculated using the formula (Hwang, Young, 1981).

$$SEDI_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (1)$$

where:

$SEDI_i$ - a country's socio-economic development indicator i ($i=1,...,n$);

n – number of countries; d_i^- , d_i^+ these are the distances within the country i from the pattern and anti-pattern determined by the formula:

$$d_i^- = \sqrt{\sum_{j=1}^m (z_{ij} - z_j^-)^2} \quad \text{and} \quad d_i^+ = \sqrt{\sum_{j=1}^m (z_{ij} - z_j^+)^2} \quad (2)$$

when:

$$z_j^- := \begin{cases} \min_i \{z_{ij}\}, & W_j \in S \\ \max_i \{z_{ij}\}, & W_j \in D \end{cases}, \quad z_j^+ := \begin{cases} \max_i \{z_{ij}\}, & W_j \in S \\ \min_i \{z_{ij}\}, & W_j \in D \end{cases}, \quad z_{ij} = \frac{w_{ij}}{\sqrt{\sum_{i=1}^n w_{ij}^2}} \quad (3)$$

So that: w_{ij} , z_{ij} - actual and normalised value W_j for country i ($i=1,...,n, j=1,2,...,m$);

m – number of indicators.

4. Results

All variables in the sample group of objects meet the basic criteria for selecting variables to describe a complex phenomenon; they are not quasi-constant variables (Kukuła, Luty, 2015, 2017). Table 2 presents the basic characteristics of the socio-economic indicators analysed for EU countries in 2014 and 2023.

Table 2.

Key characteristics of selected indicators used to assess the socio-economic development of EU countries in 2014 and 2023.

Specification	2014						2023					
	Q_1	Q_2	Q_3	M	SD	CV	Q_1	Q_2	Q_3	M	SD	CV
W_1	12.40	20.17	38.30	26.59	18.54	0.70	16.90	25.74	40.78	31.62	20.49	0.65
W_2	28.40	31.90	35.60	31.78	3.67	0.12	28.50	30.10	33.40	30.59	3.57	0.12
W_3	14.40	15.90	19.40	16.44	3.62	0.22	13.00	15.40	19.30	16.25	3.56	0.22
W_4	4.05	4.90	6.23	5.02	1.15	0.23	3.87	4.63	5.37	4.71	0.92	0.19
W_5	35.80	40.20	44.70	39.66	6.56	0.17	39.30	46.80	49.80	44.95	6.73	0.15

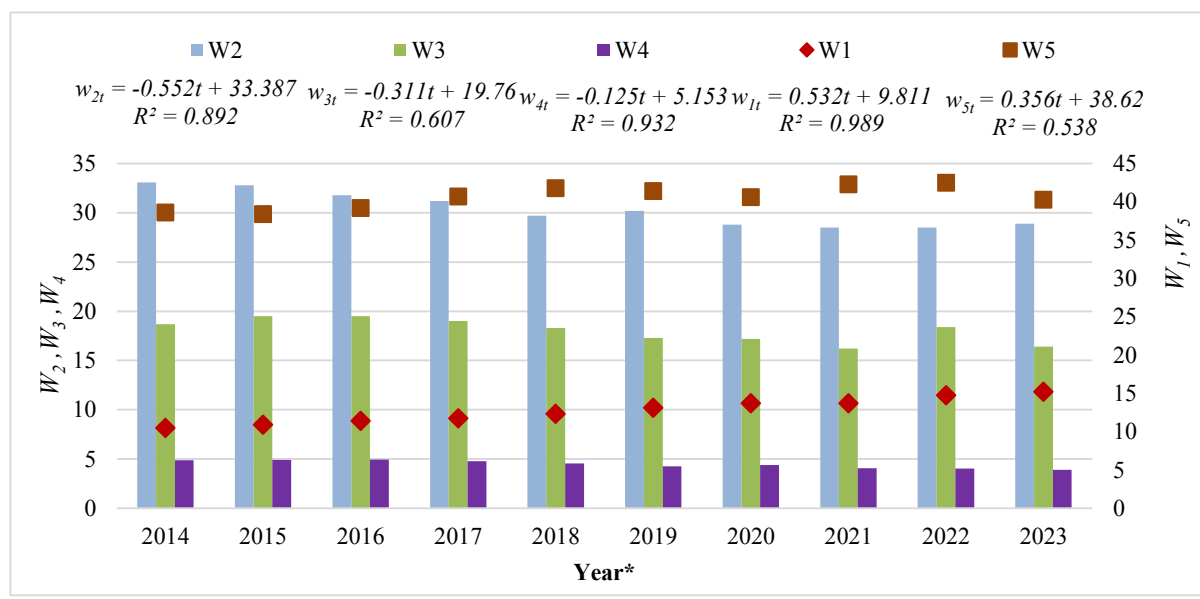
* 2012 and 2021 respectively.

Q_1 , Q_2 , Q_3 : the first, second and third quartiles, respectively; M : arithmetic mean; SD : standard deviation; CV : coefficient of variation.

Source: Own study based on Eurostat. available online: <https://ec.europa.eu/eurostat>, 29 January 2026; World Bank. available online: <https://www.worldbank.org>, 29 January 2026; Happy Planet Index. available online: <https://happyplanetindex.org>, 29 January 2026.

For the indicators: Gross Domestic Product per capita (W_1) and Happy Planet Index (W_5), an increase in all position measures (Q_1 , Q_2 , Q_3 , M) was recorded in 2023 compared to 2014. The simultaneous increase in the standard deviation of the indicators indicates greater absolute variation between countries, whilst the decrease in the coefficient of variation points to a reduction in relative variation. For the Gini coefficient (W_2), Q_2 , Q_3 and M decreased, whilst Q_1 increased slightly. The standard deviation also decreased, and the coefficient of variation remained at the same level, indicating a stable degree of variation in this indicator. The measures of central tendency for two indicators also decreased: Gross Domestic Product per capita (W_3) and Income quintile share ratio (W_4), whilst the reduction in the standard deviation and coefficient of variation indicates a reduction in both absolute and relative variation between Member States.

During the period under review, an increase in the GDP per capita indicator in Poland was recorded, from €10,900 to €15,290, which confirms the positive incline of the linear trend equation (Figure 1).



*years 2012 – 2021 for indicator W₅

Figure 1. Values of diagnostic variables used to assess the level of socio-economic development in Poland for the period 2014-2023, with linear trends ($t = 1, 2, \dots, 10$).

Source: Own study based on Eurostat. available online: <https://ec.europa.eu/eurostat>, 29 January 2026; World Bank. available online: <https://www.worldbank.org>, 29 January 2026; Happy Planet Index. available online: <https://happyplanetindex.org>, 29 January 2026.

Furthermore, the very high value of the coefficient of determination (0.989) indicates that the trend line fits the data almost perfectly, which points to stable growth. At the same time, income inequality indicators show a downward trend: the Gini coefficient fell from 32.8 in 2014 to 28.5 in 2023, and the S80/S20 ratio decreased by 0.85. High R^2 values indicate that the model provides a good fit and explains 89.2% and 93.2% of the variance in the dependent variable, respectively. The at-risk-of-poverty rate also showed a downward trend (a decrease of 3 percentage points), though its R^2 value (0.607) suggests an unstable direction of change. The HPI index showed a slight upward trend from 38.6 in 2012 to 40.3 in 2021; however, the relatively low value of the coefficient of determination (0.538) indicates irregular changes. The overall trend in the HPI index values between 2012 and 2021 highlights a clear instability in the level of well-being in relation to environmental impact.

An assessment of Poland's position in terms of GDP per capita shows that it lies well below the EU average, which stood at €26,590 in 2014 and €31,620 in 2023 (Figure 2). At the same time, the very wide gap between the minimum and maximum values indicates significant disparities in the economic development of Member States.

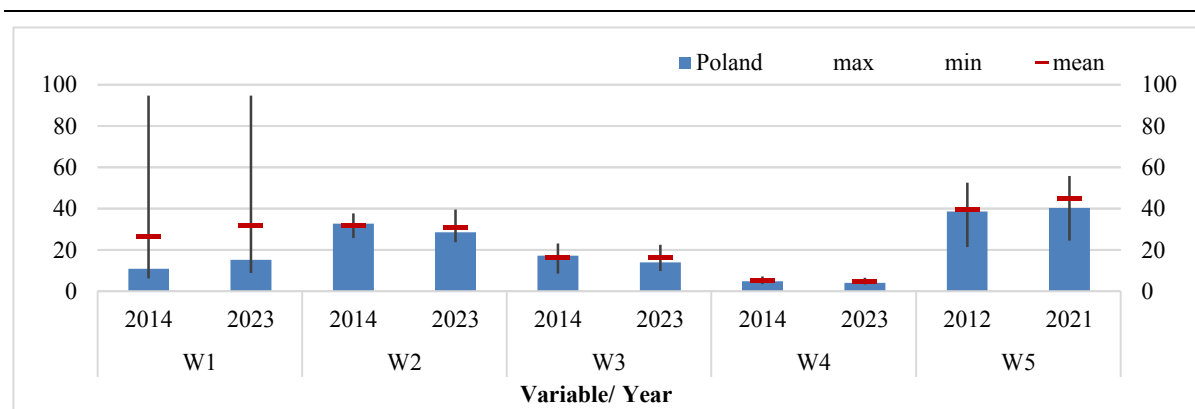


Figure 2. Values of selected numerical characteristics of diagnostic variables for assessing the level of socio-economic development of EU countries.

Source: Own study based on Eurostat. available online: <https://ec.europa.eu/eurostat>, 29 January 2026; World Bank. available online: <https://www.worldbank.org>, 29 January 2026; Happy Planet Index. available online: <https://happyplanetindex.org>, 29 January 2026.

In 2014, Poland's Gini coefficient was slightly higher than the EU average, which stood at 31.78, whereas in 2023 it fell below the EU average of 30.59. Differences in the level of income inequality across the EU are not significant. This is confirmed by the limited range between the minimum and maximum values of the S80/S20 income inequality ratio in the EU. The values of this ratio for Poland in selected years were very close to the EU average, which stood at 5.02 in 2014 and 4.71 in 2023. In terms of the risk of poverty, Poland in 2014 was slightly above the EU average of 16.44%, and after a decade the value of the indicator fell below this average, which stood at 16.25%. The HPI value for Poland in both years under review was lower than the EU average, which stood at 39.66 in 2014 and 44.95 in 2023, indicating a relatively lower level of effectiveness in terms of sustainable development.

In 2023, GDP per capita in Poland rose by 40% compared to 2014. Although this growth rate indicates significant economic progress, income levels in Poland lag considerably behind those of the EU leaders (Table 3). Poland's per capita income is similar to that of Hungary and Croatia, for which the W_1 indicator stood at €14,760 and €15,370 respectively in 2023, representing an increase of €3,690 and €4,770 compared to 2014. However, this level is significantly higher than in the countries at the bottom of the ranking: Romania, where it stood at €7800 in 2014 and €11,120 in 2023, and Bulgaria, where it was €6260 in 2014 and €8830 in 2023. In both the first and last years of the survey, the leading positions in terms of GDP per capita were held by Luxembourg, Denmark and Ireland, for which GDP per capita in 2023 stood at €94,830, €53,230 and €84,560, and in 2014: €94,820, €47,240 and €47,010 respectively. Lithuania and Bulgaria had the highest levels of inequality, with W_2 standing at 36.0 and 39.5 respectively in 2023. In the case of Lithuania, it fell by 1.7 compared to the base year, whilst in the case of Bulgaria it rose by 2.1, indicating an increase in inequality over the decade. In 2023, Poland had higher income inequality (W_2) than Finland (27.4), Belgium (26.8), the Netherlands (25.9), the Czech Republic (25.7), Slovenia (24.7) and Slovakia (23.8).

The improvement in the situation of Polish society is also reflected in the decline in W_3 from 17.0% in 2014 to 14.0% in 2023.

Table 3.

Rankings of EU countries based on selected indicators used to assess socio-economic development in 2023 and 2014, with Poland's position highlighted

Variable/ year		Ranking*
W_1	2014	LU, DK, IE, SE, NL, AT, FI, DE, BE, FR, IT, ES, MT, CY, SL, PT, GR, EE, CZ, SK, LT, LV, HU, PL , HR, RO, BG
	2023	LU, IE, DK, SE, NL, AT, FI, BE, DE, FR, IT, MT, CY, ES, SL, PT, GR, CZ, EE, SK, LT, HR, PL , HU, LV, RO, BG
W_2	2014	LT, BG, ES, RO, GR, CY, PT, LV, IT, EE, PL , FR, HR, IE, LU, HU, DE, AT, MT, NL, DK, SE, BE, FI, SK, CZ, SL
	2023	BG, LT, IT, LV, PT, LU, ES, GR, MT, CY, FR, AT, EE, HR, DK, RO, DE, SE, IE, HU, PL , FI, BE, NL, CZ, SL, SK
W_3	2014	RO, ES, GR, BG, EE, LV, PT, HR, IT, LT, PL , IE, DE, LU, MT, SE, BE, HU, SL, CY, AT, FR, FI, SK, DK, NL, CZ
	2023	EE, LV, RO, BG, LT, ES, HR, GR, IT, LU, PT, MT, SE, FR, AT, CY, DE, SK, PL , HU, NL, SL, BE, FI, IE, DK, CZ
W_4	2014	RO, BG, ES, EE, LV, GR, PT, LT, IT, CY, DE, HR, PL , IE, LU, HU, FR, SE, AT, DK, MT, SK, NL, BE, SL, FI, CZ
	2023	BG, LT, LV, RO, PT, ES, EE, MT, GR, IT, HR, LU, SE, FR, DE, HU, AT, CY, DK, PL , NL, IE, FI, SK, CZ, BE, SL
W_5	2012	SE, FR, ES, NL, DK, HR, AT, IE, IT, FI, DE, CZ, PT, SL, RO, PL , SK, LT, GR, CY, MT, BE, LV, HU, BG, EE, LU
	2021	SE, DK, ES, FR, PT, NL, FI, IT, RO, GR, SL, HR, IE, CZ, DE, AT, HU, LT, SK, PL , MT, LV, BE, EE, BG, CY, LU

*: in descending order.

AT: Austria, BE: Belgium, BG: Bulgaria, CY: Cyprus, CZ: Czechia, DE: Germany, DK: Denmark, EE: Estonia, ES: Spain, FI: Finland, FR: France, GR: Greece, HR: Croatia, HU: Hungary, IE: Ireland, IT: Italy, LT: Lithuania, LU: Luxembourg, LV: Latvia, MT: Malta, NL: Netherlands, PL: Poland, PT: Portugal, RO: Romania, SE: Sweden, SL: Slovenia, SK: Slovakia.

Source: Own study based on Eurostat. available online: <https://ec.europa.eu/eurostat>, 29 January 2026; World Bank. available online: <https://www.worldbank.org>, 29 January 2026; Happy Planet Index. available online: <https://happyplanetindex.org>, 29 January 2026.

In 2023, Poland had a lower at-risk-of-poverty rate than Malta (16.6%), Sweden (16.1%), France (15.4%), Austria (14.9%), Cyprus (14.9%), Germany (14.4%) and Slovakia (14.3%), which in 2014 were ranked higher than Poland. In terms of the W_4 index, Poland also improved its position in the ranking; the index stood at 4.91 in 2014 and fell to a level in 2023 closer to that of Germany (4.44) and the Netherlands (3.87). However, it still remains significantly below the level of countries with the most equal income distribution: the Czech Republic (3.50), Belgium (3.39) and Slovenia (3.34). With regard to the HPI (W_5), Poland recorded an increase from 38.6 in 2012 to 40.3 in 2021. However, this result still differs significantly from those of the leaders: Sweden (55.9), Denmark (53.0) and Spain (53.0). In 2023, Poland's HPI reached a level similar to that of the economies of Lithuania (41.0), Slovakia (41.0) and Malta (39.3).

In accordance with the described TOPSIS method, EU countries were ranked according to the *SEDI* index (Figure 3).

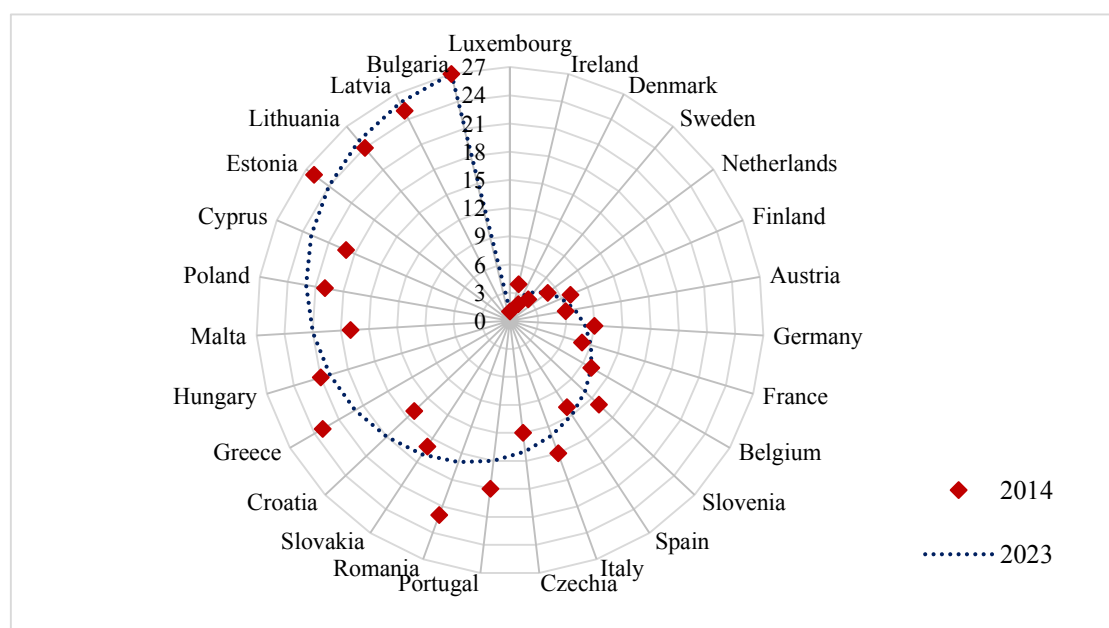


Figure 3. Rankings of EU countries by Socio-Economic Development Index (*SEDI*) score in 2023, with their 2014 rankings based on this index.

Source: Own study based on Eurostat. Available online: <https://ec.europa.eu/eurostat> (accessed on 29.01.2026); World Bank. Available online: <https://www.worldbank.org> (accessed on 29.01.2026); Happy Planet Index. Available online: <https://happyplanetindex.org> (accessed on 29.01.2026).

In 2023, Luxembourg and Ireland achieved the highest level of socio-economic development, establishing a clear lead over the other countries (Table 4). Denmark, Sweden and the Netherlands also achieved high positions in the ranking. Among the leaders, particular attention should be paid to Ireland, which has significantly improved its position compared to 2014. This improvement was primarily driven by an increase in GDP per capita of nearly 80%, which represents the highest growth rate in the EU, alongside a moderate decline in W_2 and W_4 , and minor changes in W_3 . In 2023, the middle of the ranking was occupied by: Slovenia, Spain, Italy, the Czech Republic, Portugal, Romania and Slovakia. Compared to 2014, the level of socio-economic development in these countries increased, driven by rises in the values of indicators W_1 and W_5 , and decreases in the values of W_2 , W_3 and W_4 . In 2023, despite a marked improvement in the socio-economic situation compared to the base year, Poland was placed in the lower part of the ranking. Positive changes in the Polish economy are confirmed by the indices of the analysed indicators.

During the period under study, GDP per capita increased by 40.3% and the HPI by 4.4%. At the same time, income inequality decreased (with the Gini coefficient falling by 13.1% and the S80/S20 ratio by 17.3%), and the risk of poverty was reduced by 19.1%. In 2023, only Cyprus, Estonia, Lithuania, Latvia and Bulgaria ranked lower than Poland. These economies also recorded positive changes in the analysed indicators compared to 2014, but the scale of these changes was insufficient to strengthen their position in the ranking.

Table 4.

Index values for 2023 and 2014, and indices of the output diagnostic variables used to assess the level of socio-economic development for EU countries

Country (i)	<i>SEDI_i</i>		Indices				
	2023	2014	$\frac{w_{1,2023}}{w_{1,2014}}$	$\frac{w_{2,2023}}{w_{2,2014}}$	$\frac{w_{3,2023}}{w_{3,2014}}$	$\frac{w_{4,2023}}{w_{4,2014}}$	$\frac{w_{5,2023}}{w_{5,2012}}$
Luxembourg	0.797	0.824	1.000	1.077	1.182	1.084	1.144
Ireland	0.785	0.271	1.799	0.909	0.764	0.788	1.109
Denmark	0.362	0.290	1.127	1.053	0.992	1.007	1.142
Sweden	0.327	0.288	1.082	1.032	1.006	1.140	1.063
Netherlands	0.298	0.247	1.131	0.906	1.250	1.010	1.065
Finland	0.259	0.213	1.065	1.022	1.034	1.044	1.200
Austria	0.238	0.222	1.060	1.023	1.035	1.036	1.013
Germany	0.231	0.196	1.064	0.955	0.894	0.867	1.101
France	0.228	0.202	1.074	0.985	1.124	1.084	1.077
Belgium	0.226	0.180	1.107	0.954	0.821	0.890	1.093
Slovenia	0.195	0.139	1.274	0.961	0.876	0.903	1.197
Spain	0.193	0.158	1.144	0.925	0.990	0.808	1.097
Italy	0.187	0.138	1.129	0.988	0.979	0.912	1.178
Czechia	0.186	0.152	1.180	0.992	1.140	0.977	1.133
Portugal	0.175	0.109	1.192	0.952	0.909	0.899	1.250
Romania	0.163	0.088	1.426	0.828	0.922	0.805	1.260
Slovakia	0.161	0.130	1.232	0.912	1.117	0.924	1.088
Croatia	0.159	0.139	1.450	0.938	0.990	1.000	1.043
Greece	0.155	0.079	1.160	0.933	0.818	0.817	1.316
Hungary	0.149	0.097	1.333	0.939	0.920	1.023	1.265
Malta	0.144	0.117	1.400	1.138	1.051	1.309	1.098
Poland	0.141	0.103	1.403	0.869	0.809	0.827	1.044
Cyprus	0.140	0.103	1.425	0.893	0.974	0.788	0.997
Estonia	0.109	0.061	1.161	0.887	1.210	0.829	1.307
Lithuania	0.100	0.079	1.363	0.955	1.000	1.036	1.111
Latvia	0.093	0.070	1.276	0.969	1.160	0.957	1.147
Bulgaria	0.070	0.045	1.411	1.056	0.981	0.971	1.218

Source: Own study based on Eurostat. Available online: <https://ec.europa.eu/eurostat> (accessed on 29.01.2026); World Bank. Available online: <https://www.worldbank.org> (accessed on 29.01.2026); Happy Planet Index. Available online: <https://happyplanetindex.org> (accessed on 29.01.2026).

5. Summary

The socio-economic development studies conducted assess the diagnostic reliability of the research models used. The complex nature of the phenomenon under analysis required the use of tools capable of taking multiple variables into account simultaneously, which justified the choice of Multi-Dimensional Statistical Analysis and the TOPSIS method.

The research confirmed hypothesis H1, according to which the selected models of multidimensional statistical analysis constitute an appropriate tool for assessing the level of Poland's socio-economic development in comparison with other EU countries. The application of this method enabled a synthetic approach to complex socio-economic processes and the

construction of the synthetic SEDI index, which allowed the ranking position of individual countries to be determined. Furthermore, the hypothesis is supported by research by other authors (Muszczyszyn, Bąk, 2025), who in their conclusions also highlight the usefulness of the TOPSIS method in assessing the level of socio-economic development of countries. It should be emphasised, however, that the mere fact of applying specific research methods does not imply their universality in every comparative analysis, and synthesis involves a certain simplification of the data. Further research could incorporate additional diagnostic variables or alternative methods of data normalisation. Migdał-Warchoń (2021) proposes assessing the socio-economic efficiency of EU countries using the DEA method. In contrast, Belas et al. (2020) use the MDD method in their development analyses, which aims to verify statistically significant differences in the level of GDP per capita across EU countries. These methods were also found to be useful in the analyses conducted and could form the basis for further research aimed at assessing the situation of the Polish economy in comparison with EU countries.

An analysis of selected indicators revealed a marked improvement in Poland's situation during the period under review. There was a significant increase in GDP per capita, a decrease in income inequality and a reduction in the risk of poverty. At the same time, the HPI index showed greater variation, indicating that developments in the area of sustainable development were less straightforward. Despite improving its position in the rankings for individual indicators, Poland still remains below the EU average in terms of socio-economic development. In summary, Poland ranks in the lower part of the table, which indicates a persistent development gap compared to the leaders of European integration. Poland's position in 2023 differs significantly from that of Luxembourg or Ireland, which are at the top of the ranking. Kasprzyk and Wojnar (2023) present different conclusions; the authors point to a significant improvement in Poland's position relative to EU countries between 2005 and 2021. The synthetic variables constructed by the authors place Poland in a relatively higher position than the results obtained in this study. Differences in the results may be a consequence of the use of different diagnostic indicators or a different methodology.

The results also confirmed Hypothesis H2, which assumes the existence of significant spatial diversity in the socio-economic development of EU Member States. There are clear and persistent differences between the economies of Northern and Western Europe and those of Central and Eastern Europe, a finding which is confirmed by the research of other authors (Migdał-Warchoń, 2021; Stalković, J., Marjanović, Stalković, N., 2021). The range between the minimum and maximum values of the analysed indicators, as well as the distribution of their values, point to the persistent nature of these inequalities. This implication is consistent with the findings of Miłek and Nowak (2024), who highlight the fact that differences in Europe's social development are widening. The results obtained therefore confirm that the process of economic convergence within the EU is gradual and non-uniform.

Acknowledgements

Funded by a grant from the Ministry of Science and Higher Education to the Hugo Kołłątaj University of Agriculture in Kraków for the year 2026.

References

1. Belas, J., Klietnik, T., Smrcka, L., Remeikienė, R. (2020). *Quantitative assessment of dynamics of economic development in the countries of the European Union*. Technological and Economic Development of Economy, pp. 933-946.
2. Churski, P., Perdał, R. (2008). Czynniki rozwoju społeczno-gospodarczego w układzie regionalnym Unii Europejskiej. In: S. Dołzbłasz, A. Raczyk (eds.). *Europa bez granic – nowa jakość przestrzeni. Przekształcanie regionalnych struktur funkcjonalno-przestrzennych* (pp. 21-32). Wrocław: Instytut Geografii i Rozwoju Regionalnego Uniwersytetu Wrocławskiego.
3. Churski, P., Perdał, R., Konecka-Szydłowska, B., Herodowicz, T. (2018). Redefinicja czynników rozwoju regionalnego w świetle megatrendów społeczno-gospodarczych. *Studia Regionalne i Lokalne*, 3(73), pp. 70-98.
4. Eurostat. *Glossary: At-risk-of-poverty rate*. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At-risk-of-poverty_rate, 29.01.2026.
5. Eurostat. *Income quintile share ratio S80/S20 for disposable income by sex and age*. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Income_quintile_share_ratio, 29.01.2026.
6. Eurostat. *DATABASE*. Retrieved from: <https://ec.europa.eu/eurostat>, 29.01.2026.
7. Happy Planet Index. *DATABASED*. Retrieved from: <https://happyplanetindex.org/countries>, 29.01.2026.
8. Hwang, C.L., Young, K. (1981). *Multiple Attribute Decision Making: Methods and Applications A State-of-the-Art Survey* (Lecture Notes in Economics and Mathematical Systems). Springer.
9. Kasprzyk, B., Wojnar, J. (2023). Dynamiczna analiza porównawcza rozwoju społeczno-gospodarczego i jakości życia w Polsce na tle krajów UE. *Nierówności Społeczne a Wzrost Gospodarczy*, no. 74(2/2023), pp. 33-52.
10. Komisja Europejska, Dyrekcja Generalna ds. Komunikacji Społecznej (2024). UE w 2023 r.: sprawozdanie ogólne z działalności Unii Europejskiej, Urząd Publikacji Unii Europejskiej. Retrieved from: <https://data.europa.eu/doi/10.2775/498494>, 04.12.2025.

11. Kostov, L., Moraliyska, M. (2022). *Impact of income inequality on economic growth in the European Union in the period 2010-2021*. Economic and Social Development: Book of Proceedings, pp. 251-260.
12. Kukuła, K., Luty, L. (2015). Propozycja procedury wspomagającej wybór metody porządkowania liniowego (Proposition of procedures supporting the choice of the method of linear ordering). *Przegląd Statystyczny*, LXII(2), pp. 219-231.
13. Kukuła, K., Luty, L. (2017). Jeszcze o procedurze wyboru metody porządkowania liniowego (Still about the procedure of choosing the method of linear ordering). *Przegląd Statystyczny*. LXIV(2), pp. 163-176.
14. Lisowski, G. (2023). *Nierówności społeczne i ekonomiczne wybrane miary*. Warszawa: Scholar.
15. Migąła-Warchoł, A. (2021). Spatial-time analysis of EU countries for 2008-2018. In: *Modeling of socio-economic development in European Union countries* (pp. 65-90). Rzeszów: University of Technology.
16. Miłek, D., Nowak, P. (2024). Inequalities in the social development of European countries. *Scientific Papers of Silesian University of Technology. Organization & Management [Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie]*, 204, pp. 417-438.
17. Myszczyżyn, J., Bąk, I. (2025). Wykorzystanie metody TOPSIS w badaniu poziomu rozwoju społeczno-gospodarczego krajów Europy. *Zeszyty Naukowe Akademii Górnośląskiej*, No. 34(10/2025), pp. 229-236.
18. Nasiłowski, M. (2004). *System rynkowy. Podstawy mikro i makroekonomii*. Warszawa: Key Tekst.
19. Parysek, J.J. (2021). Rozwój społeczno-gospodarczy oraz czynniki i uwarunkowania rozwoju. *Studia komitetu przestrzennego zagospodarowania kraju PAN*, 183, pp. 37-56.
20. Podemski, K. (2009). Nierówności ekonomiczne w europejskich krajach postkomunistycznych z globalnej perspektywy – wybrane zagadnienia In: *Spór o społeczne znaczenie społecznych nierówności* (pp. 45-66). Poznań: UAM.
21. Popescu, A. (2022). Income inequality in the countries of the European Union. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 22, Iss. 3*, pp. 547-560.
22. Schumpeter, J.J. (1960). *Teoria rozwoju gospodarczego*. Warszawa: PWN.
23. Simms, A., Marks, N., Abdallah, S., Thompson, S. (2006). *The (un) Happy Planet Index: An index of human well-being and enviromental impact*. London: New Economics Foundation.
24. Soava, G., Mehedintu, A., Sterpu, M. (2020). Relation between income inequality, economic growth and poverty threshold: new evidences from EU countries panels. *Technological and Economic Development of Economy*, 26(2), pp. 290-310.

25. Stalković, J., Marjanović, I., Stojković, N. (2021). DEA assessment of socio-economic development of European countries. *Management: Journal of Sustainable Business and Management Solutions in Emerging Economies*.
26. Stawicka, M.K. (2012). Ekonomiczne rozwarstwienie społeczeństwa Unii Europejskiej po światowym kryzysie gospodarczym-problematyka rozkładu dochodów. *Nierówności społeczne a wzrost gospodarczy*, 24, pp. 125-135.
27. Stec, M. (2008). Ranking poziomu rozwoju krajów Unii Europejskiej. *Gospodarka Narodowa. The Polish Journal of Economics*, 225(7-8), pp. 99-118.
28. Telberth, J., Cobb, C., Slettery, N. (2007). The genuine progress indicator 2006. *Redefining Progress*, 26. Oakland, CA, pp. 1-7.
29. UNDP (1990). *Human Development Report 1990*. Oxford University Press.
30. Urban, D., Urbanek, P. (2015). Elementy makro- i mikroekonomii In: *Ekonomia finansowa i prawo gospodarcze, Podręcznik dla sędziów i prokuratorów*. Uniwersytet Łódzki, Wydział Zarządzania, Krajowa Szkoła Sądownictwa i Prokuratury, pp. 9-21.
31. World Bank (2024). *The World Bank in the European Union*. Retrieved from: <https://www.worldbank.org>, 04.12.2025.
32. World Bank. *DATABASE*. Retrieved from: <https://www.worldbank.org>, 29.01.2026.
33. Wójcik-Żołądek, M. (2013). Nierówności społeczne w Polsce. *Infos zagadnienia społeczno-gospodarcze*, 20, pp. 1-4.

COOPERATION WITH THE BUSINESS ENVIRONMENT AS A FACTOR SHAPING THE UNIVERSITY IMAGE

Katarzyna BRENDZEL

Czestochowa University of Technology; katarzyna.brendzel@pcz.pl, ORCID: 0000-0003-1654-7046

Purpose: The aim of this article is to identify and systematize the mechanisms through which collaboration between universities and the business environment shapes the institutional image. The author attempts to answer the question of which forms of relations with the economic environment most effectively build academic brand equity.

Design/methodology/approach: The article is a literature review. It employs the method of critical analysis of literature in the fields of university management, educational marketing, and the concept of the entrepreneurial university. The analysis covers publications indexed in Scopus, Web of Science, and BazEkon databases from 2014 to 2024, allowing for the capture of current dynamics in university image changes in the era of Economy 4.0. An exception was made for fundamental theoretical works which, due to their paradigmatic nature, constitute an essential reference point for contemporary research on the entrepreneurial university. This approach enabled the confrontation of classical theoretical assumptions with the latest scientific considerations regarding prestige transfer and academic brand building.

Findings: The study demonstrates that a university's image is shaped by the synergy of three perspectives: resource-based, relational, and institutional. A key mechanism for reputation building is the transfer of prestige. The analysis confirmed the existence of a positive feedback loop: an established reputation facilitates the acquisition of strategic investors, creating a self-reinforcing mechanism for market prestige growth. It is through direct interactions between the worlds of science and business that a real transfer of brand value occurs. This emphasizes that a university's image is not merely the result of signed agreements, but a derivative of the quality of developed relationships and trust.

Originality/value: The author proposes a model illustrating the impact of science-business collaboration on the university's image. The model assumes that collaboration with business does not automatically translate into a positive image; rather, the quality of the relationship is crucial, with the transfer of brand value being its most significant outcome.

Keywords: university image, entrepreneurial university, academic brand equity.

Category of the paper: research paper.

1. Introduction

The evolution of the role of higher education has led to a shift from the classical Humboldtian university model towards institutions deeply embedded in the socio-economic environment. A key element of this transformation is the so-called "third mission" of the university, which involves the active transfer of knowledge and technology to the economy (Compagnucci, Spigarelli, 2020). In an era of increasing competition in the educational market, collaboration with business has ceased to be the sole domain of technical sciences, becoming a strategic tool for building the identity and competitive advantage of every modern higher education institution.

Despite the growing number of studies on the economic aspects of science-business relations, there is still a need to systematize knowledge regarding the impact of these links on the academic brand. A university's image is an intangible asset that directly influences candidates' decisions, student loyalty, and the institution's credibility in the eyes of investors and ranking agencies. The research problem of this article is to determine the nature and mechanisms of the impact of industry relations on the perception of the university by its key stakeholders. Accordingly, the following research questions have been formulated:

RQ1: Which forms of university-business collaboration are most frequently identified in the literature as key determinants of building a modern university image?

RQ2: How do prestige transfer mechanisms and the attributes of the entrepreneurial university affect academic brand equity?

RQ3: Does the literature analysis confirm the existence of a positive feedback loop between a university's established reputation and its ability to acquire strategic business partners?

The aim of this article is to systematize current theoretical findings and to develop a conceptual model that illustrates the impact of science and business collaboration on the university's image. The analysis of the university's image in the context of business collaboration was conducted based on three perspectives: resource-based, relational, and institutional. This approach allowed for a multi-dimensional treatment of the phenomenon under discussion.

2. Research Methodology

This study is a systematic literature review. The literature selection process was conducted systematically, covering publications indexed in key bibliographic databases: Scopus, Web of Science, and BazEkon. The choice of these databases was dictated by the need to include both

the global scientific discourse and the specific characteristics of the Polish higher education system. The use of these databases allowed for the selection of exclusively peer-reviewed scientific literature of high substantive standards.

The search process utilized keywords such as: university-industry collaboration, university image, entrepreneurial university, brand equity in higher education, and their Polish equivalents. The primary timeframe of the analysis covers the years 2014-2024, which allows for capturing the latest trends related to Economy 4.0 and the digital transformation of universities (Table 1). A conscious exception to this criterion was the inclusion of fundamental paradigmatic works (including those by B. Clark and H. Etzkowitz), which provide the essential theoretical foundation for contemporary higher education management models.

Table 1.
Criteria for the selection and screening of the literature kryteria doboru i selekcji literatury przedmiotu

Criterion	Description/Parameters
Databases	Scopus, Web of Science, BazEkon
Timeframe	2014-2024 (excluding fundamental theoretical works)
Language of publication	Polish, English
Keywords	university-industry collaboration, university image, entrepreneurial university, academic brand equity
Type of source	Scientific articles, monographs
Inclusion criteria	Direct correlation with the impact of external relations on the university's reputation or image
Exclusion criteria	Technical publications focusing solely on technology transfer without reference to branding or image aspects

Source: Own elaboration.

The literature selection process was conducted based on a multi-stage record verification procedure. An initial analysis of the selected bibliographic databases (Scopus, Web of Science, BazEkon) identified 264 publications meeting the keyword criteria. In the subsequent step, duplicates and texts that—despite the presence of keywords—focused solely on the technical aspects of technology transfer, without reference to image management or brand equity, were eliminated.

Through a critical analysis of titles and abstracts, a group of articles with the highest substantive potential was selected. The final selection, based on full-text analysis, citation indices, and journal prestige, resulted in the inclusion of 54 key items for in-depth analysis and citation. This selection process ensured the appropriate quality of the evidence and enabled the synthesis of the most representative views within the researched subject area.

3. From the "Ivory Tower" to the Entrepreneurial University: The Evolution of the Higher Education Model

The foundation of contemporary considerations regarding the relationship between science and the economy is the evolution of the university's role within the innovation system. The traditional division into teaching and research functions has become blurred in favor of the so-called "third mission," which imposes an obligation on higher education institutions (HEIs) to participate actively in socio-economic development (Etzkowitz, 2008; Abreu et al., 2016; Urdari et al., 2017). In this context, collaboration with business ceases to be merely a mechanism for knowledge transfer and becomes a key element of the strategy for building the university's identity and competitive advantage (Secundo et al., 2017). Consequently, the university's image is no longer constructed in isolation but within a dynamic interplay between business and the state (Kwiek, 2015; Benneworth et al., 2016; Aragonés-Beltrán et al., 2017; De La Torre et al., 2017; Mariani et al., 2018).

The application of the Triple Helix paradigm in image analysis reveals that the reputation of a modern university is not an autonomous value but a relational one. As indicated by Etzkowitz and Leydesdorff (2000); Etzkowitz (2003); Di Berardino, Corsi (2018), the university becomes an active link in an innovation system based on close interdependence between science, industry, and administration. In a marketing context, this signifies a transition from building a tradition-based image toward an image based on utility and market interdependence. The traditional linear model of "science – implementation" has been replaced by a spiral model (Bojar, Machnik-Słomka, 2014). The university moves away from the role of a passive knowledge provider and undertakes activities traditionally assigned to business, such as founding spin-off companies, thereby becoming an active economic partner (Mora et al., 2015). Such hybridization builds the image of the university as a responsive and flexible institution. The university is no longer perceived as an isolated "ivory tower" (Czakoń, 2019; Nakwa, Zawdie, 2016; Kapetanidou, Lee, 2017) and becomes an "innovation hub," which enhances its prestige as a socially useful institution (Puślecki, 2017). The university begins to be seen as a capital generator. Collaboration with business under state regulatory supervision creates a synergy effect, fostering the reputation of an "engaged university" (Bryła, 2013). This image is particularly potent in relations with local governments and communities, which can translate into brand stability. The knowledge flow between universities and firms further builds expert credibility.

The Triple Helix model is complemented in the literature by the concept of the entrepreneurial university, which has garnered significant interest from scholars and policymakers (e.g., Etzkowitz, Leydesdorff, 2000). The term "entrepreneurial university" was first used by Etzkowitz (1983), while the transition from a research university to an entrepreneurial one originated in the USA in the late 19th century (Etzkowitz, 2004;

Riviezzo, Napolitano, 2010). The Massachusetts Institute of Technology and Stanford University are early archetypes, being the first institutions to expand their traditional missions of teaching and research and pioneers in incorporating applied research of commercial significance into their programs. Furthermore, they began transferring knowledge to the non-academic environment and providing support for industry (Etzkowitz, 2003; Goethner, Wyrwich, 2019). Clark (1998) made a major contribution to popularizing the entrepreneurial university concept. According to his approach, the modern HEI is characterized by a proactive stance toward the market environment, manifested through the development of technology transfer centers and business incubators. The image of such an institution evolves toward an "agentic entity," capable of knowledge commercialization and innovation creation, which, in the eyes of stakeholders, signifies modernity and high pedagogical quality (Makarona, Kavoura, 2019). While the literature offers various ways of defining the entrepreneurial university (Clark, 2001; Abreu et al., 2016), all point toward the development of entrepreneurship in higher education. This direction of transformation raises numerous social, cultural, and managerial challenges, including the necessity of employing marketing strategies encompassing image and brand awareness, segmentation, targeting, and promotional strategies (Sułkowski, Seliga, 2016).

In this context, the classical Triple Helix is insufficient and requires supplementation with a fourth element: society and the media (Bojar, 2014; Morawska-Jancelewicz, 2016; Carayannis et al., 2015; Carayannis, Rakhmatullin, 2014). The essence of the Quadruple Helix model is its influence on shaping a knowledge-based society. The links between the three helices – university, government, and industry – generate new knowledge, technologies, products, and services that meet societal needs. Moving further, one must also account for the natural environment and sustainable development, leading to the Quintuple Helix model. In this framework, the functioning and outcomes of a university must be viewed through a broad socio-economic lens. Consequently, universities cannot ignore their own image; it must reflect their commitment to solving global problems, becoming a strategic element in managing a modern scientific unit.

Nevertheless, the Triple Helix perspective remains the starting point for considerations on the contemporary role of the university, providing an understanding of the structural framework of science-business collaboration. This model is evolving toward the university as a catalyst for innovation rather than just a partner for business environment institutions. Thus, the university's image is built through its capacity for hybridization – the merging of academic and economic goals without losing its identity. However, a full diagnosis of the impact of relations with the economic environment and public administration on the image of an HEI requires a more detailed categorization. The literature of the last decade reveals an evolution in the perception of this impact, which is worth analyzing through three dominant perspectives: resource-based, relational, and institutional.

While the helix model describes macrosocial dynamics, the resource-based perspective focuses on the image benefits derived from possessing unique market competencies. The relational perspective shifts the focus of analysis to the psychological mechanism of prestige transfer between partners, while the institutional perspective embeds the university's reputation in the context of societal expectations and the fulfillment of the "third mission". Such a multidimensional approach allows for the precise mapping of factors that, within the Triple/Quadruple Helix model, tangibly translate into an increase in academic brand equity.

4. The Multidimensionality of University Image in Relations with Business

Within the resource-based perspective (Resource-Based View – RBV), a university's image is analyzed through the lens of unique resources that the institution acquires through its relationships with the business environment. According to this perspective, a higher education institution's competitive advantage is based on possessing resources that are rare, valuable, and difficult to imitate (Barney, 1991). Collaboration with business becomes a strategic mechanism for acquiring such assets, which directly translates into the perception of the university as a modern center for teaching and research (Nowacka, 2016). The literature emphasizes that the first pillar of image in this context is modern infrastructure. Sponsored laboratories, technology centers created jointly with industry, or the funding of specialized research equipment provide tangible evidence of the university's professionalism. In the eyes of prospective students and external partners, possessing advanced technological facilities builds an image of the university as a "wealthy" and stable institution that genuinely invests in the quality of education and research (Talar, 2019; Geryk, 2009).

The second pillar of the resource-based perspective is competency capital, identified with the unique know-how of business practitioners (Sujchaphong, 2015; Fazlagić, 2013). Integrating experts from the economy into didactic processes and conducting joint research projects enhance the university's credibility as an innovation leader. Within this perspective, the institutional image evolves from a theoretical academic center toward an advanced knowledge transfer platform, where the university's ability to solve real market problems becomes a reputational "resource" (Lafuente Ruiz de Sabando, 2017; Bryła, 2013). Consequently, the institution positions itself as an entity of high utility, which serves as a key quality signal for a wide range of stakeholders.

Within the relational perspective, a university's image is not defined by what the institution possesses, but rather by the network of connections in which it participates (Jaskólska, 2018). According to this view, an organization's reputation is a relational value, resulting from the quality and status of the partners (Wójcik, 2021; Gołata, Sojkin, 2020) with whom the university collaborates. In educational marketing literature, the key mechanism at play here is

prestige spillover. Through official partnerships with recognized business brands, the university "borrows" the attributes of these brands—such as professionalism, innovativeness, or market success (Piotrowska-Piątek, 2016)—which directly strengthens its own brand equity.

Relational analysis places particular emphasis on signalling theory. Joint projects with market leaders, certified educational paths under the patronage of well-known corporations, or the presence of practitioners on university boards serve as a clear signal of the institution's high quality to the environment (Osica, Niedzicki, 2019). Through the mechanism of academic co-branding, the university builds an image as an "elite partner," which reduces the uncertainty of prospective and current students regarding the value of the degree offered. In this view, image becomes a derivative of relational capital (Jaskólska, 2018), and the university's status in the academic hierarchy is closely linked to its ability to build lasting and credible strategic alliances with business.

The contemporary evolution of the institutional perspective extends beyond the classical model of science-business relations, leaning towards the previously mentioned Quadruple Helix concept. This model complements the existing structure with a fourth pillar: civil society and the media (Bryła, 2013). From an image-building perspective, this implies that the legitimization of university activities no longer occurs solely at the level of market efficiency but, above all, at the level of social acceptance and media visibility (DiMaggio, Powell, 1983). The introduction of the fourth helix significantly strengthens the institutional mechanism, transforming the university's image from a "closed laboratory" into an "open institution". Here, the media act as a catalyst—it is through digital and social communication channels that the successes of business collaboration are transmitted to the general public. In this view, the university's image becomes a public good, and its prestige depends on the ability to communicate its real-world impact on the quality of life of inhabitants or regional development (Sulkowski, 2016). Applying the Quadruple Helix perspective thus helps explain why universities increasingly engage in University Social Responsibility (USR) projects. Collaboration with business, presented in the media as an action for the common good (e.g., ecological innovations, educational programs for local communities), builds the most durable foundation for institutional reputation, making the university an indispensable entity enjoying social trust.

The literature emphasizes that a lack of visible links with business is currently perceived as an anachronism, which negatively affects the prestige of the institution. The institutional perspective indicates that a university's image as a "useful" entity is constructed by meeting external evaluation criteria, such as high positions in rankings (e.g., *Perspektywy*), where industry collaboration serves as a key performance indicator. In this context, the image is based on the attribution of modernity—a university engaged in relations with the economy is perceived as a responsible organization that tangibly impacts regional and national development (Geodecki, Hausner, 2023). Consequently, academic brand equity becomes a function of the

institution's ability to act as a proactive socio-economic actor (Jessop, 2018), which ultimately confirms its status as an indispensable institution within the innovation ecosystem.

The presented theoretical perspectives—resource-based, relational, and institutional—are not mutually exclusive but rather form a complementary picture of image-shaping mechanisms (Peszko, 2012). While resources build the foundation of professionalism and relations provide prestige, the institutional perspective grants social justification to the university's actions (Iwankiewicz-Rak, Shulgina, 2012). The synthesis of these interdependencies and their impact on the final academic brand equity is presented in the model below (Fig. 1). It illustrates the dynamic nature of reputation building, where image effects become the fuel for subsequent cycles of collaboration.

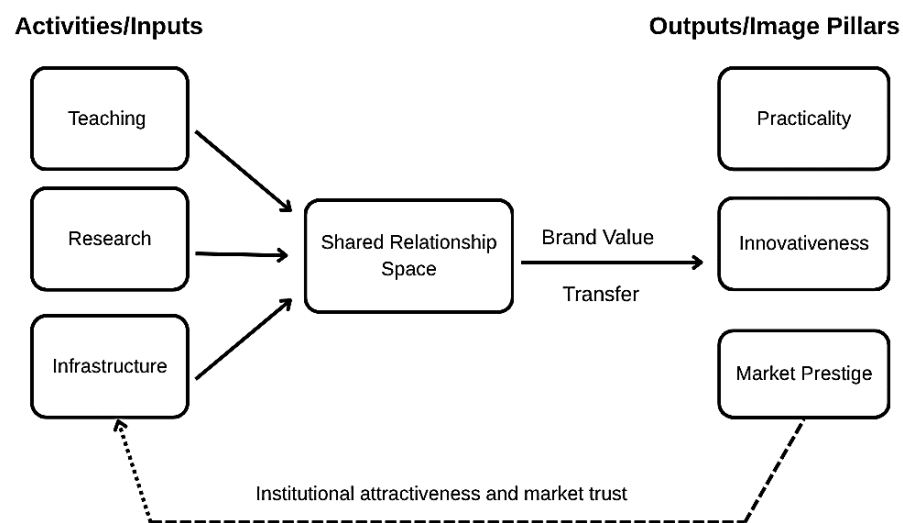


Figure 1. A model of university image building through synergy with business.

Source: Own elaboration.

A key assumption of the presented model is the recognition that formal collaboration (whether didactic or research-oriented) does not automatically translate into image. The central point of the framework is the "shared relationship space," which acts as a catalyst—it is precisely there, through direct interactions between the worlds of science and business, that a real transfer of brand value occurs. This emphasizes that a university's image is not merely the result of signed agreements, but a derivative of the quality of developed relationships and trust.

The model distinguishes three main components:

- Activities – focus on the substantive foundations of collaboration in the spheres of teaching (e.g., internships, commissioned courses), research (joint R&D projects), and infrastructure (laboratories, technology transfer centers).
- Brand Value Transfer – a link symbolizing the process in which the prestige and innovative attributes of the business partner are attributed to the university's brand.
- Reputational Effects (Image Pillars) – the target image dimensions, which include practicality, innovativeness, and market prestige.

The model is completed by a feedback loop. It illustrates that the developed market prestige becomes capital that facilitates the initiation of new activities in subsequent cycles. The essence of this mechanism consists of:

- Selection (Prestige Magnet): A high reputation ensures that enterprises themselves seek collaboration. In this arrangement, the university ceases to be a "supplicant" and becomes a partner selectively choosing market leaders for joint projects.
- Risk Reduction: A strong image of a modern and efficiently managed unit lowers so-called business transactional uncertainty. Companies are more willing to invest in research and development (R&D) at universities that enjoy social trust and a reputation as professional partners.
- Strengthening Relational Capital: Satisfied business partners become natural "ambassadors" for the university. Their positive recommendations attract not only further projects but also new students, which directly feeds back into the teaching area.

Through such a loop, the model acquires a circular character, where reputational success becomes the fuel for the university's further substantive development. Collaboration with business is not a one-time benefit, but a strategic flywheel for the institution.

5. Relationship Marketing as a Tool for Strategic Academic Brand Management

The modern university moves beyond traditional transactional marketing (focused on "selling" a degree program) toward relationship marketing. In this strategic approach, the objective is not a one-time contract, but the construction of lasting bonds with the business environment, which translate into the stability of the academic brand.

In the academic context, relationship marketing is typically defined through the lens of strategy and values. In his model, Ch. Grönroos (1984) demonstrated that service quality is an essential and integral part of marketing strategy. This concept allows for the inclusion of factors determining customer-perceived quality, such as: professionalism and mastery, attitude and behavior, accessibility and flexibility, reliability and trustworthiness, a recovery system, as well as reputation and integrity. In this context, a university's relationship marketing is the process of identifying, establishing, maintaining, and strengthening relations with stakeholders (students, business, the social environment), so that the goals of all parties are achieved through mutual exchange and the fulfillment of promises (Jonas, 2016). This concept posits that marketing, understood as relationship management, should be an activity integrated with the entire organization and its network of contacts. Consequently, the key resource of a university brand is not its product offering, but its network of connections, which generates unique value for market partners (Gummesson, 2002).

Modern university brand management is no longer merely about promoting infrastructure or educational offerings, but about cultivating a "shared relationship space". Trust between the scientist and the entrepreneur becomes the guarantor of brand authenticity (Bryła, 2013). Relationship marketing allows for the integration of business into the university's internal processes. When a company co-creates a degree program, it becomes part of the academic brand, which radically enhances its market prestige.

To bridge the gap between these conceptual frameworks and managerial practice, it is essential to implement concrete mechanisms for monitoring relationship quality. In this context, the following metrics are proposed: the Stakeholder Engagement Index (SEI), which measures the depth of joint R&D interactions; the Partner Retention Rate, reflecting the stability of business cooperation; and Knowledge Transfer Efficiency, calculated as the ratio of joint intellectual property outputs to collaborative agreements. Furthermore, systematic survey research among key stakeholders and in-depth interviews (IDI) with business partners prove to be highly helpful in this process. These tools allow for a qualitative assessment of trust and the identification of subtle factors shaping the university's image that often elude quantitative metrics alone.

The key management tool here is the feedback mechanism. Business partners cease to be mere external entities and become brand advocates for the university, representing the most effective and cost-efficient form of building credibility in the eyes of prospective students and the social environment (Wańkowski, 2015). The implementation of relationship marketing thus allows the university to transition from a "market-responsive" model to a "market-co-creating" model. This also signifies a departure from the "advertising-recruitment" scheme. The university builds brand value through long-term interactions with stakeholders (students, companies, alumni). Consequently, the way the university manages its resources, relationships, and institutional status to create a coherent image becomes crucial. Building a network of connections with recognized business partners acts as a "quality certificate" for the university, increasing its credibility in the educational market. As a result, the academic brand gains a unique characteristic—it becomes resilient to temporary economic fluctuations, as its strength is rooted in a network of stable economic ties.

6. Discussion and Summary

The analysis of the literature from the last decade confirms that the image of a modern university is inextricably linked to its activity within the economic environment. However, the results of this review suggest the existence of significant tensions between the "entrepreneurial university" paradigm and traditional academic values. The scholarly discourse increasingly addresses concerns regarding so-called "academic capitalism", which may lead to

the instrumentalization of science and the potential loss of the university's image as an independent arbiter of truth.

It is worth noting that while the resource-based and relational perspectives emphasize the image benefits derived from market efficiency, the institutional perspective imposes an obligation on the university to maintain a balance between commercialization and public service. A key challenge for relationship marketing strategies remains managing the brand such that the transfer of prestige from business partners does not overshadow the institution's research autonomy. This analysis indicates that the strongest and most stable images are built by those entities capable of hybridizing their goals—presenting themselves as modern "innovation hubs" while upholding high standards of academic ethos.

The conducted systematic literature review has allowed for the formulation of answers to the research questions and the development of a model for science-business collaboration. It has been demonstrated that a university's image is shaped by the synergy of three perspectives: resource-based, relational, and institutional. The key mechanism for reputation building is the transfer of prestige. The analysis confirmed the existence of a positive feedback loop, where an established reputation facilitates the acquisition of strategic investors, creating a self-reinforcing mechanism for market prestige growth. This article organizes knowledge on the intangible consequences of science-business collaboration, providing a theoretical foundation for further analysis. In the next stage of this research, an attempt will be made to empirically verify the developed model. Planned studies will focus on analyzing the correlation strength between specific forms of collaboration and perceived academic brand equity in the eyes of students and business representatives. Future research should also focus on verifying the proposed model in specific sectors, such as humanistic universities, where the mechanisms of brand value transfer may take different forms than in the technical sciences.

References

1. Abreu, M., Demirel, P., Grinevich, V., Karatas-Özkan, M. (2016). Entrepreneurial practices in research-intensive and teaching-led universities. *Small Business Economics*, No. 47(3), pp. 695-717.
2. Aragones-Beltran, P., Poveda-Bautista, R., Jiménez-Sáez, F. (2017). An in-depth analysis of a TTO's objectives alignment within the university strategy: an ANP-based approach. *Journal of Engineering and Technology Management*, No. 44, pp. 19-43.
3. Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, No. 17, pp. 99-120.

4. Benneworth, P., Pinheiro, R., Sánchez-Barrioluengo, M. (2016). One size does not fit all! New perspectives on the university in the social knowledge economy. *Sci. Public Policy*, No. 43(6), pp. 731-735.
5. Bojar, M., Machnik-Słomka, J. (2014). Model potrójnej i poczwórnej helisy w budowaniu współpracy sieciowej dla rozwoju innowacyjnych projektów regionalnych. *Zeszyty naukowe Politechniki Śląskiej Organizacja i Zarządzanie*, No. 76, pp. 99-111.
6. Bryła, P., Jurczyk, T., Domański, T. (2013). Korzyści współpracy uczelni wyższych z otoczeniem gospodarczym – próba typologii. *Marketing I Rynek*, No. 4, pp. 14-19.
7. Carayannis, E.G., Grigoroudis, E., Pirounakis, D. (2015). Quadruple Innovation Helix and Smart Specialization Knowledge Production and National Competitiveness. *Tech Monitor*, Jul-Sep, pp. 20-28.
8. Carayannis, E.G., Rakhmatullin, R. (2014). The Quadruple/Quintuple Innovation Helixes and Smart Specialisation Strategies for Sustainable and Inclusive Growth in Europe and Beyond. *Journal of the Knowledge Economy*, Vol. 4, No. 4, pp. 221-239.
9. Clark, B. (1998). The entrepreneurial university: demand and response. *Tertiary Education Management*, No. 4(1), pp. 5-16.
10. Clark, B. (2001). The entrepreneurial university: new foundations for collegiality, autonomy, and achievement. *Higher Education Management*, No. 13(2), pp. 17-23.
11. Compagnucci, L., Spigarelli, F. (2020). The Third Mission of the university: A systematic literature review on potentials and constraints. *Technological Forecasting & Social Change*, No. 161, pp. 1-30. doi.org/10.1016/j.techfore.2020.120284
12. Czakon, W. (2019). Grand Challenges: A Way Out of the Ivory Tower for Management Academic Discipline (Wielkie wyzwania: droga wyjścia z „wieży z kości słoniowej” zarządzania jako dyscypliny akademickiej). *Problemy Zarządzania*, No. 17(84). University of Warsaw, Faculty of Management, pp. 9-23.
13. De La Torre, E.M., Agasisti, T., Perez-Esparrells, C. (2017). The relevance of knowledge transfer for universities’ efficiency scores: an empirical approximation on the Spanish public higher education system. *Research. Evaluation*, No. 26(3), pp. 211-229.
14. Di Berardino, D., Corsi, C. (2018). A quality evaluation approach to disclosing their mission activities and intellectual capital in Italian universities. *Intellectual Capital*, No. 19(1), pp. 178-201.
15. DiMaggio, P.J., Powell, W.W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, No. 48, 147-160. <https://doi.org/10.2307/2095101>
16. Etzkowitz, H. (2003). Research groups as ‘quasi-firms’: the invention of the entrepreneurial university. *Research Policy*, No. 32, pp. 109-121.
17. Etzkowitz, H. (2004). The evolution of the entrepreneurial university. *International Journal of Technology and Globalization*, No. 1, pp. 64-77.

18. Etzkowitz, H. (2008). *The Triple Helix. University-Industry-Government*. New York: Routledge.
19. Etzkowitz, H., Leydesdorff L. (2000). The dynamics of innovation: From national systems and 'Mode 2' to a triple helix of university – industry – government relations. *Research Policy*, No. 29(2), pp. 109-123.
20. Fazlagić, J. (2013). Struktura kapitału intelektualnego jako kontekst dla tworzenia strategii szkół wyższych. *E-mentor*, No. 2(49). Retrived from: <http://www.e-mentor.edu.pl/artukul/index/numer/49/id/1000>.
21. Geodecki, T., Hausner, J. (2023). *Współpraca uczelni z biznesem. Polska na tle wybranych krajów Unii Europejskiej*. Kraków: Fundacja Gospodarki i Administracji Publicznej.
22. Geryk, Ż. (2009). Wizerunek uczelni jako element strategii marketingowej. In: M. Geryk (Eds.), *Strategia zarządzania uczelniami niepublicznymi w kontekście społecznej odpowiedzialności* (pp. 35-54). Warszawa, Gdańsk: Wyższa Szkoła Zarządzania w Gdańsku & Wyższa Szkoła Infrastruktury i Zarządzania w Warszawie.
23. Goethner, M., Wyrwich, M. (2019). Cross-faculty proximity and academic entrepreneurship: the role of business schools. *The Journal of Technology Transfer*, No. 45, pp. 1016-1062. doi.org/10.1007/s10961-019-09725-0
24. Gołata, K., Sojkin, B. 2020, Determinanty budowania wizerunku i reputacji wyższej uczelni wobec jej interesariuszy. *Marketing Instytucji Naukowych i badawczych*, No. 1, pp. 29-58.
25. Grönroos, Ch. (1984). Grönroos Ch., A Service Quality Model and Its Marketing Implications. *European Journal of Marketing*, No. 4, pp. 12-24.
26. Gummesson, E. (2002). Practical Value of Adequate Marketing Management Theory. *European Journal of Marketing*, No. 36(3), pp. 325-349.
27. Iwankiewicz-Rak, B., Shulgina, L. (2012). Misja – marka – wizerunek uczelni- relacje wzajemne. *Zeszyty Naukowe Wyższej szkoły Bankowej w Poznaniu*, No. 44, pp. 31-42.
28. Jaskólska, J. (2018). Kształtowanie wizerunku uczelni w otoczeniu międzynarodowym. *Marketing i Rynek*, No. 12, pp. 199-212.
29. Jessop, B. (2018). Rodzaje kapitalizmu akademickiego i uniwersytetów przedsiębiorczych. O przeszłych badaniach i trzech eksperymentach myślowych. *Nauka i Szkolnictwo Wyższe*, 1(51), pp. 17-44. doi: 10.14746/nisw.2018.1.1
30. Jonas, A. (2016). Logika usługowa a kształtowanie jakości usług. *Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, No. 255, pp. 58-70.
31. Kapetaniou, Ch., Lee, S.H. (2017). A framework for assessing the performance of universities: The case of Cyprus. *Technological Forecasting and Social Change*, No. 123, pp. 169-180.
32. Krzyżak, M. (2014). Istota i potrzeba budowania wizerunku uczelni. *Zeszyty Naukowe Wyższa Szkoła Wojsk Lądowych im. Tadeusza Kościuszki we Wrocławiu*, No. @, pp. 119-126.

33. Kwiek, M. (2015). *Uniwersytet w dobie przemian, Instytucje i kadra akademicka w warunkach rosnącej konkurencji*. Warszawa: PWN.
34. Lafuente Ruiz de Sabando, A., Forcada, J., Zorrilla, P. (2017). The marketing orientation as a university management philosophy: a framework to guide its application. *Cuadernos de Gestión, No. 18*, pp. 37-58. doi: 10.5295/cdg.150576al
35. Makarona, E., Kavoura, A. (2019). Restrukturyzacja wieży z kości słoniowej: przedsiębiorczość akademicka jako nowe wyzwanie wspierające wzrost gospodarczy. *Zeszyty Naukowe Małopolskiej Szkoły Ekonomicznej w Tarnowie, No. 2*, pp. 15-26. <https://doi.org/10.25944/znmwse.2019.02.1526>
36. Marczevska, M. (2016). Podejście zasobowe do organizacji. In: K. Klineciewicz (Eds.), *Zarządzanie, organizacje i organizowanie – przegląd perspektyw teoretycznych*. Warszawa: Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego.
37. Mariani, G., Carlesi, A., Scarfo, A.A. (2018). Academic spinoffs as a value driver for intellectual capital: the case of the University of Pisa. *Journal of Intellectual Capital, No. 19*, pp. 202-226. <https://doi.org/10.1108/JIC-03-2017-0050>
38. Mora, J.G., Ferreira, C., Vidal, J., Vieira, M.J. (2015). Higher education in Albania: developing third mission activities. *Tertiary Education and Management, No. 21*, pp. 29-40.
39. Morawska-Jancelewicz, J. (2016). Model poczwórnej helisy jako narzędzie wdrażania strategii inteligentnych specjalizacji. *Studia i Prace WNEIZ US, no. 46*, pp. 107-116.
40. Nakwa, K., Zawdie, G. (2016). The ‘third mission’ and ‘triple helix mission’ of universities as evolutionary processes in the development of the network of knowledge production: Reflections on SME experiences in Thailand. *Science and Public Policy, No. 43*, pp. 622-629. <https://doi.org/10.1093/scipol/scw030>
41. Nowacka, M. (2016). Kreowanie wizerunku szkoły wyższej wśród wybranych grup docelowych. *Prace Naukowe Akademii im. Jana Długosza w Częstochowie, No. 2*, pp. 85-100.
42. Osica N., Niedzicki, W. (2019). *Sztuka promocji nauki. Praktyczny przewodnik dla naukowców*. Warszawa: Ośrodek Przetwarzania Informacji — Państwowy Instytut Badawczy.
43. Peszko, K. (2012). Kształtowanie wizerunku i tożsamości szkół wyższych jako działanie budujące przewagę konkurencyjną. *Problemy Zarządzania, Finansów i Marketingu, No. 24*, pp. 409-419.
44. Piotrowska-Piątek A. (2016), Analiza interesariuszy zewnętrznych szkół wyższych — identyfikacja i ocena ich znaczenia przez szkoły wyższe. *Zarządzanie Publiczne, No. 2(36)*, pp. 85-93.
45. Puślecki, Z.W. (2017). Model potrójnej helisy (triple helix) we wzroście efektów innowacyjnych i konkurencyjności. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, No. 475*, pp. 238-257. doi: 10.15611/pn.2017.475.21

46. Riviezzo, A., Napolitano, M.R. (2010). Italian Universities and the Third Mission: A Longitudinal Analysis of Organizational and Educational Evolution towards the 'Entrepreneurial University'. *Industry and Higher Education*, No. 24, pp. 227-236.
47. Secundo, G., Perez, S.E., Martinaitis, Z. (2017). An Intellectual Capital framework to measure universities' third mission activities. *Technological Forecasting and Social Change*, No. 123, pp. 229-239. <https://doi.org/10.1016/j.techfore.2016.12.013>
48. Sułkowski Ł. (2016). *Kultura akademicka – koniec utopii?* Warszawa: PWN.
49. Sułkowski, Ł., Seliga, R. (2016). Przedsiębiorczy uniwersytet – zastosowanie zarządzania strategicznego. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, No. 444, pp. 478-489.
50. Talar, D. (2019). Wykorzystanie podejścia zasobowego w budowaniu wizerunku uczelni publicznej - analiza Uniwersytetu Ekonomicznego we Wrocławiu z perspektywy kluczowych zasobów oraz ich spójności ze strategią i misją uczelni. *Prace Naukowe Uniwersytetu Ekonomicznego*, No. 11, pp. 293-307.
51. Urdari, C., Farcas, T.V., Tiron-Tudor, A. (2017). Assessing the legitimacy of HEIs' contributions to society. *Sustainability Accounting, Management and Policy Journal*, No. 8, pp. 191-215. <https://doi.org/10.1108/SAMPJ-12-2015-0108>
52. Vorley, T., Nelles, J. (2009). Building Entrepreneurial Architectures: A Conceptual Interpretation of the Third Mission. *Policy Futures in Education*, No. 7, pp. 284-296.
53. Waśkowski, Z. (2015). Wykorzystanie koncepcji marketingu relacyjnego w procesie budowania więzi uczelni z interesariuszami zewnętrznymi. *Marketing Instytucji Naukowych i Badawczych*, No. 1, pp. 33-46.
54. Wójcik, K. (2021). Wizerunek i reputacja organizacji – komunikacyjny i zarządczy potencjał. *Studia Medioznawcze*, No. 4, pp. 1061-1076.

INNOVATION STRATEGIES AND BUSINESS MODELS OF MATERIAL PROCESSING SECTOR ENTERPRISES IN THE SILESIAN VOIVODESHIP

Jan BRZÓSKA^{1*}, Sławomir OLKO²

¹ Silesian University of Technology; jan.brzoska@polsl.pl, ORCID: 0000-0002-0753-6444

² Silesian University of Technology; slawomir.olko@polsl.pl, ORCID: 0000-0001-5284-6284

*Correspondence author

Purpose: The aim of this study was to identify the specific characteristics of innovation strategies and business models of selected material production and processing companies in the Silesian Voivodeship in the context of the innovations they have implemented.

Design/methodology/approach: The diagnostic survey method, employing research questionnaires and multiple case studies, made it possible to assess the importance of various types of innovations in introducing changes to the strategies and business models of the analyzed enterprises in order to enhance their competitiveness, operational efficiency, and business resilience.

Findings: Companies in the materials production and processing sector adapt their innovation strategies to market requirements by offering a specific combination of values to the customer. The results of the research indicate that companies very often apply product and process innovations.

Research limitations/implications: The most significant limitations of the study relate to its sectoral and regional focus, as well as the fact that it was conducted on a relatively small sample size. Research in the field of innovation management is relevant and timely due to the fact that the production and processing of metallic and non-metallic materials remains an important industry in Poland, supplying its products to many sectors of the economy.

Practical implications: The results of the research can be used in the Regional Knowledge Management System to stimulate innovation as part of the Regional Innovation Strategy implementation.

Originality/value: The article highlights the importance of innovation in the materials production and processing sector, which is not typically identified as innovative. It presents the nature of innovation strategies and business models in this sector.

Keywords: innovation strategy, business model, material sector.

Category of the paper: research paper.

1. Introduction

Intensifying global competition, particularly from East Asian countries, dynamics of changing customer needs, and adherence to the principles of sustainable economy constitute the primary reasons for changes in the strategies and business models of enterprises operating in the metallic and nonmetallic materials processing sector. These changes are largely oriented toward the use of various types of innovations, i.e., process, product, marketing, organizational, social, and environmental innovations, enhancing competitiveness through the implementation of economic and market objectives and values as well as social and environmental goals. The Polish market for metallic, plastic, and ceramic products is fully open, i.e., competitive and, apart from broadly defined environmental regulations (which, within the EU, is self-evident), is not subject to additional regulatory instruments. Competition is therefore global, with large industrial corporations, including foreign companies, acting as dominant players. Alongside them operate small and medium-sized enterprises focused on deep materials processing, innovative, often niche, products (e.g., manufacturing of composites and decorative ceramic products) as well as specialized services. The sector under study is represented by enterprises classified within four divisions of the Polish Classification of Economic Activities (NACE): 22, 23, 24, and 25.

Such a situation constitutes the antecedence for the studies undertaken within the project “Network of Regional Specialized Observatories in the Entrepreneurial Discovery Process in the Silesian Voivodeship”, code SO RIS w PPO – II (hereinafter referred to as the Project). The Project involved a study conducted among enterprises operating in the technological sector of materials production and processing. The study addressed issues related to innovation management and business models, the implementation of innovations and strategies, organizational structures, development of human resources, and the impact of innovation on enterprise performance. The study findings are intended to enable the development of instruments supporting the implementation of innovations and reducing the risks associated with them in small and medium-sized enterprises in the Silesian Voivodeship. This article presents the results of a portion of the study, including innovation strategies and business models. The objective of the study was to identify the specific features of innovation strategies and business models adopted by enterprises engaged in materials production and processing in the Silesian Voivodeship. The study conducted among entrepreneurs enabled an assessment of the impact of different types of innovations on changes in strategies and business models. The object of the study was a selected study sample of small and medium-sized enterprises operating in the metallic and non-metallic materials processing sector in the Silesian Voivodeship.

The subject of the study was innovation management in companies, and in particular their innovation strategies and business models. These constitute fundamental elements and instruments of strategic management in modern organizations. The literature on the subject (Zott, Amit, 2013; Knop, Brzóska, 2016; Wirtz et al., 2016; Ritter, Lettl, 2018; Shepherd et al., 2023), the importance of the business model as a key instrument for generating value for the customer and for increasing and maintaining a company's competitiveness is emphasized. In the relationship between strategies, business models, and innovation, one can observe the creation of strategic synergy (Aagaard, 2024), as well as opportunities to develop social and technical architectures and business processes capable of creating new value for both the customer and the company (Prahalad, Krishnan, 2009), which form the foundation of competitiveness and business resilience. Innovation is a key driver of the implementation of new strategies and business models in many companies (Saebi et al., 2017). The rationale for undertaking the presented research was the ever-growing importance of innovative strategies and business models resulting from the dynamics of the environment, but as noted by Aagaard (2024) and Kubiński et al. (2023), this is primarily due to the requirements of a sustainable economy (development) and the rapid growth of the digital economy and the innovation ecosystem. In line with this trend in innovation research, it is worth noting the relatively narrow scope of quantitative studies in Poland concerning innovation management in SMEs operating in specific economic sectors. The present study aims, in part, to fill this gap by presenting the innovativeness of enterprises as reflected in the various types of innovations they have implemented, their impact on strategy and business models, as well as the measurement of the benefits and effects derived from these innovations.

2. Innovation Strategies and Business Models – theoretical approach

In management studies, strategy refers to a long-term plan of action and encompasses all organization's areas. An innovation strategy may be regarded as a functional strategy, as innovation management can be regarded as a key organizational function, similar to marketing, production, human resource management, and finance. Innovations also constitute key elements of organization's strategy; therefore, an innovation strategy of an organization should be perceived not only as a functional strategy but also as a competitive one (Hannah et al., 2019). Pires and Ferreira (2025) argue that innovation strategies comprise a range of organizational strategic decisions related to knowledge acquisition sources (in-house development versus external acquisition), the degree of collaboration with other organizations, the extent (incremental or radical), and the type (technological and non-technological) of innovation, as well as funding sources and mechanisms for protecting IP. Based on a systematic literature review, the authors argue that the key decisions in innovation strategy concern the

degree of innovation openness (open, closed, or hybrid) as well as the degree and types of innovations. The latter area refers to the diversity of innovation degrees and types of innovations that may define the essence of an innovation strategy. One of the dichotomies in innovation management described by F. Trompenaars (2010) is the presence of the “hare” and the “tortoise” strategies in organizations. The “hare” strategy involves rapid pursuit of end results, bypassing intermediate issues and projects perceived as non-essential and requiring collaboration with external partners possessing superior competencies. The “tortoise” strategy is based on the systematic accumulation of knowledge necessary to build a core competitive advantage and investing in additional projects providing a foundation for the organization’s activity in the future. As a result, the “hare” strategy provides greater dynamics of effects at the beginning of a project, to gradually diminish along with project development. The “tortoise” strategy is characterized by lower dynamics of effects at the beginning of a project, yet, as time progresses, the accumulated knowledge proves valuable in solving emerging problems. Paradoxically, despite their different trajectories, both strategies ultimately lead organizations to the same place - the same strategic position over time. The “tortoise” strategy must rely on long-term relationships with suppliers in the process of new product development. In terms of relationships with the external environment, the dichotomy between the “hare” and the “tortoise” strategies corresponds to the key strategic make-or-buy dilemma. Perron et al. (2005), based on their empirical research conducted in the United Kingdom, found that long-term relationships with suppliers do not appear to play a significant role in the development of radical innovations.

Another important dichotomy in innovation management strategy concerns the openness or closed nature of innovation processes. The traditional model of innovation management is closed and requires entrepreneurs to maintain confidentiality of their solutions and use available forms of intellectual property protection. According to P. Trott, the open innovation model emerged in the early twenty-first century, emphasizing collaboration at every stage of the innovation process – from idea generation (co-ideation), through co-design, to use by prosumers, who are both a source of product-related feedback and new ideas (Trott, 2018). The most prominent author describing open innovations is H. Chesbrough. Two additional areas of innovation, increasingly important to innovation strategies and deserving particular attention are digitalization and so-called green or eco-innovations. Digitalization supports innovation across virtually all industrial sectors and constitutes a significant component of innovation strategies within public organizations (Guenduez et al., 2025). This subject has become sufficiently significant that, in some organizations, one can speak of a distinct digitalization strategy, constituting a component of organization’s innovation strategy. In turn, eco- or green innovations, although increasingly present in organization managerial practice, may conflict with the expectations of certain stakeholders (Dong et al., 2026). Over the past decade, the relationships between innovations and business models has been a very important area of both theory and practice in strategic management. These relationships

may be analyzed in terms of two aspects. The first one regards the business model as an original management concept constituting an organizational innovation in its own right, sometimes even taking the form of a breakthrough innovation (Hammel, 2003). Examples include business models using digital economy instruments, startup-type models, and sustainable business models (Jabłoński, Jabłoński, 2023; Brzóska, Szmaj, 2017; Szumniak-Samolej, 2022). In advanced sectors of the economy, increasing importance is also attributed to Economy 4.0-based business models (Brzóska, Knop, 2020; Brzóska, Szmaj, 2017; Grabowska, 2025). The second aspect of the relationship between innovations and business models concerns the use of various types of innovations for building model structures and, particularly, creating and delivering value to customers. These two approaches to business models are linked by a fundamental element, an attribute and, at the same time, an outcome of business model implementation, namely, the increasingly multidimensional, i.e., economic, social, and environmental value (Schaltegger et al., 2016). Such value is intended to satisfy customer needs or enable the solution of customer's problems and, at its most advanced level, to create prosumer relationships (supplier-customer value exchange). This value is also expected to enable the growth of enterprise value (Teece, 2010; Brzóska, Szmaj, 2020), primarily through the retention of a portion of the value creating economic value added (EVA), but also through pro-environmental and pro-social activities. Studies on business models have produced numerous definitions and concepts (e.g., Chesbrough, 2010; Teece, 2010; Amit, Zott, 2017; Osterwalder, Pigneur, 2008; Newth, 2012; Gołębiowski et al., 2008). A business model may be regarded as a configuration of social and technical architecture, along with resilient and flexible processes and projects creating values for the customer and the enterprise. In the context of the research area of this article, particularly important are concepts concerning the creation of value and the importance of innovations in business modeling. The creation of unique, multidimensional value and competitive advantage as well as efficiency is closely linked to innovations, with an innovative business model serving as their primary vehicle. Such a model is understood as a process aimed at reducing costs, optimizing processes, accessing new markets, or improving financial performance (Foss, Saebi, 2017). Within this model, emphasis is placed not only on the importance of product and process innovations but also on the component of systemic change influencing enterprise value growth, the value proposition offered to customers, and the process of value creation. The successful implementation of an innovative business model determines the enterprise's ability to absorb and, subsequently, diffuse innovations, which often enable positive transformation and development of the enterprise (Velu, 2016). A particularly interesting approach enabling the analysis and creation of business models in innovative enterprises operating in the global economy is the concept of the "New Age of Innovation", developed by C.K. Prahalad and M.S. Krishnan (2009). The authors regard the business model as one of the most important elements of an innovation potential of enterprise, serving its transformation. The model is based on the configuration of social and technical architectures combined through business processes. In addition, the authors

emphasize the importance of collaboration and coordination, as well as of crucial links between business processes and ICT architecture, serving as critical support tools, where created values are based on innovations, as can be observed, for example, in the power sector (Brzóska et al., 2022). Usually, the development of an innovative business model is a stimulus resulting from changes in the external environment, e.g., the introduction of a new breakthrough technology (Lee et al., 2019), legal regulations, or social conditions. The concept of sustainable business models combines multiple approaches integrating social and economic value with the business model (Moratis et al., 2018). In general, a sustainable business model may be defined as one whose social and technical architectures, as well as business processes, are oriented toward creating, delivering, and partially capturing value while simultaneously addressing the three key aspects of the value, i.e. economic, social, and environmental. This brief review of innovation strategy and business modeling-related issues highlights the significant dynamics of their concepts and relationships with innovation management.

3. Research Methods

The study involved synthetic analysis of the subject-specific literature and a diagnostic survey conducted using a research questionnaire covering eight research areas. The authors performed a multiple case study involving four selected enterprises. The case study included observation, detailed analysis of documents, and interviews with managerial and specialist staff. The concept of the New Age of Innovation (Prahalad, Krishnan, 2009) was used to characterize the business models of the four companies under study. Innovation management was assessed using the MIOD method (Monitor of Innovative Organizational Development). The survey was conducted among 50 selected small and medium-sized enterprises located in the Silesian Voivodeship. The primary selection criterion was enterprises' production of metals, plastic materials, ceramic materials, or composites. The questionnaire consisted of 32 comprehensive questions, including both open-ended and closed-ended items, as well as single- and multiple-choice questions. The results presented in this article concern the research panel covering the area of innovation strategy and the business model of an enterprise. The study focused on the relationship between various types of implemented innovations with strategies and business models.

4. Empirical Results

The results presented below pertain to the research panel addressing enterprise's strategy and business model. The analysis focused on evaluating the relationships between various types of implemented innovations and strategy and business model. Respondents were asked to provide information regarding both the actual and the desired states. The information concerned referring innovations to various areas of enterprise's activities, as well as indicators characterizing innovations. The authors obtained opinions regarding the impact of implemented innovations on strategy and business models, as well as on the individual components of these fundamental concepts and ideas for business activity enabling competitiveness. The questions were also concerned with the assessment of the impact of innovations on indicators and outcomes (included in a broad list) reflecting the market position, financial performance, technological capability, human resources and knowledge management.

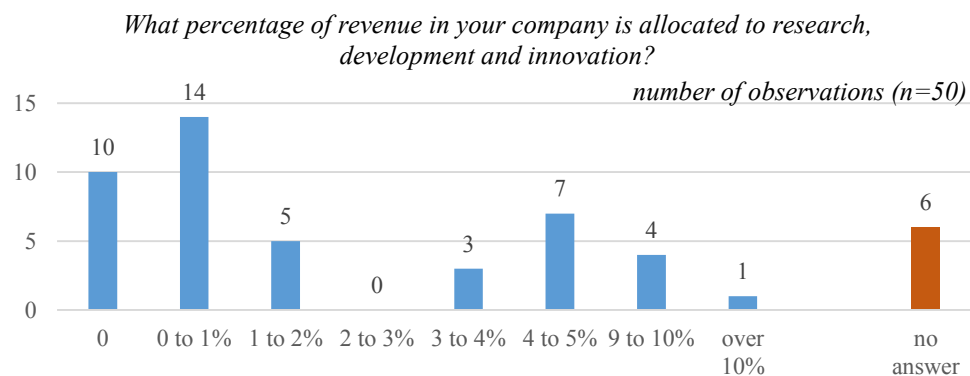


Figure 1. Percent of revenue allocated to research, development and innovation (R&D&I) of the surveyed companies.

Source: own elaboration.

The utilization of innovations, understood as their absorption, implementation, and diffusion, is closely linked to the enterprise's available financial resources. Therefore, a reply to a question concerning the percentage of revenues allocated by enterprises to research, development, and innovations was very important. The distribution of responses to this question is presented in Figure 1. The findings indicate that nearly half of the surveyed enterprises (24) allocate less than 1% of their revenues to R&D&I. Of these, 10 enterprises (representing 20% of the firms) do not finance innovations in this manner. In addition, 10 enterprises (i.e., 20% of the firms) allocate only between 1% and 2% of their revenues to R&D&I. The same number of firms allocate between 3% and 5% of their revenues to development. Only four enterprises (8% of the firms) spend between 9% and 10% of their revenues on R&D&I, whereas just one firm declares spending more than 10% of revenues on these activities. These findings indicate a relatively low level of R&D&I financing from enterprises' own sources, particularly from current revenues, i.e. operating activities. Such a situation may be attributed to awareness of

the high level of risk associated with innovation activities, as well as to the pursuit of external funding sources, including support programs. These findings also highlight the need to identify solutions reducing the risks associated with the implementation of innovation activities by enterprises. The relationships and direct reference of innovations to various areas of enterprise's activities result from the very nature of innovations and their application in both strategic and operational management. The analysis of this issue is presented in relation to the current and the desired states.

In which areas of the enterprise are there direct references to innovation?

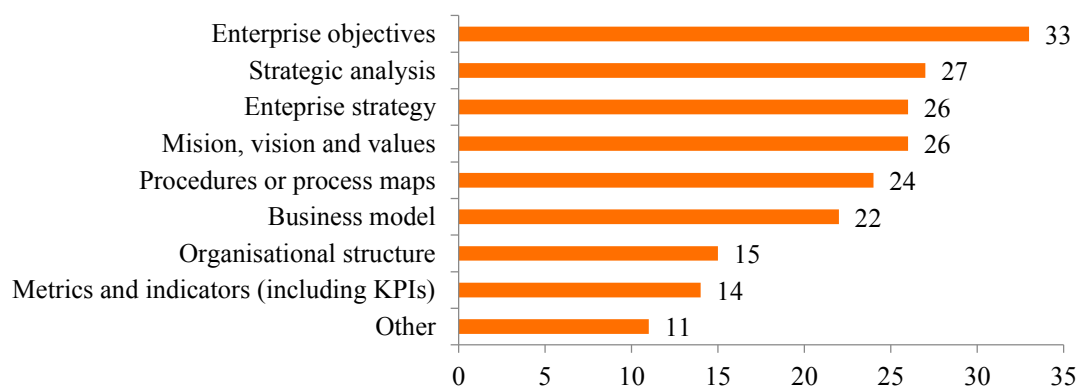


Figure 2. Enterprise areas with the direct references to innovation.

Source: own elaboration.

Figure 2 presents the distribution of respondents' answers to the question regarding the areas of enterprise's activity in which innovations are directly referenced. Figure 3 illustrates the distribution of responses to the question concerning the areas in which such direct references to innovations should be present. With respect to the current state, as many as 33 enterprises (66% of the firms) identified links between innovations and organizational goals as significant. The majority of respondents also recognized important relationships between innovations and fundamental elements of strategic management, such as strategic analysis, corporate strategy, as well as the enterprise's mission, vision, and values. However, fewer than half of the respondents expressed a strong conviction regarding the importance of referring innovations to business models, which suggests a relatively limited interest in applying innovations in such concepts related to the functioning of enterprises. Similarly, fewer than half of the enterprises (24) directly refer innovations to procedures and process mapping or to organizational structures (25), i.e., to elements of operational management. A relatively small number of respondents (14) identify links between innovations and the use of key performance indicators (KPIs). This suggests a limited recognition of the necessity for enhancing operational management using innovations. In turn, the analysis of responses concerning the postulated (model) state, presented in Figure 3, indicates a greater importance of innovations in enterprise management. According to 40 respondents (representing 80% of the total sample), innovations are perceived as playing a significant role primarily in shaping the organisation's goals.

Very many enterprises (approximately 60%) associate innovations with strategy, mission, vision, and the values guiding employees in the enterprise's activity. Compared with the current state, a significant increase (29) was related to the number of indications concerning relationships between innovations and process management, business models and organizational structure, suggesting an appreciation of their importance in operational management. However, fewer than half of the surveyed enterprises (21) identify links between innovations and performance measures and indicators associated with enterprise's day-to-day operations (including KPIs). This indicates an underestimation of the role of innovations in enhancing efficiency and organizational value management, as well as a relatively low application of the Balanced Scorecard in organizational management systems.

In which areas of the enterprise should exist direct references to innovation?

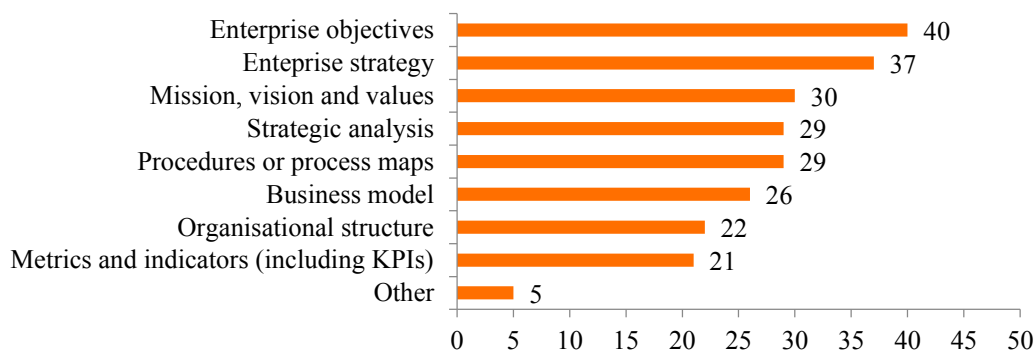


Figure 3. Areas that should exist the direct references to innovation.

Source: own elaboration.

One of the most important issues examined in the study concerned the types of innovations implemented by the enterprises. These innovations constitute both key instruments of innovation strategies and business models as well as tangible outcomes (effects) of their implementation, particularly important for enterprise's competitiveness and development. The type, scale, and structure of innovations reflect the enterprise's preferences and innovation implementation-related needs, which results from competitive position, development policy, financial and organizational capabilities, as well as the organization's knowledge resources (intellectual potential of innovations). Figure 4 presents responses to the question concerning the types of innovations implemented by the enterprises over the past three years. The data indicate the dominance of two types of innovations, i.e. product innovations (80% of enterprises) and process innovations (66% of enterprises). Such a strong position of innovations results from the SMEs' need for differentiation strategies, particularly through the production of materials and products characterized by unique and atypical features. Examples include composites, custom castings, and monocrystals. Such products meet specific customer requirements and are frequently used as inputs in further processing stages, frequently generating advanced products. The need to implement product innovations is also affected by the requirements imposed by large corporations within cooperative supply chain systems,

for example in the automotive industry. The significant role of the implementation of process innovations is linked to the technical and product-specific characteristics of the metallic and non-metallic materials production sector, to which the surveyed business organizations belong. Frequently, the development of novel products depends on the implementation of process innovation, usually in the form of new technologies. Process innovations can contribute to reductions in the consumption of energy, materials and labor input, thereby significantly lowering direct production costs, which, in turn, enhances cost competitiveness and increases the first-level contribution margin. Interest in process innovations may also result from the requirements and principles of sustainable economy, including environmental conditions and circular economy. An example is so-called “green steel,” which is increasingly preferred by investors within the EU and produced using environmentally friendly technologies.

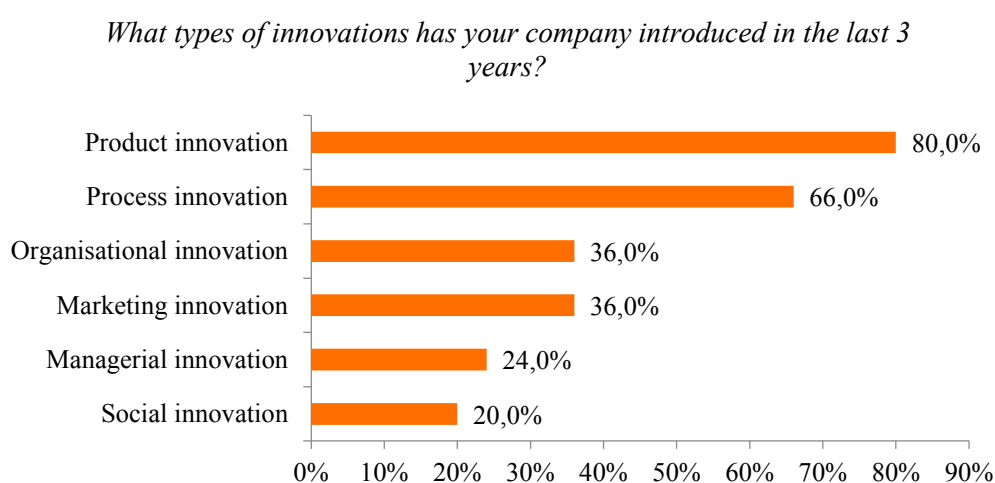


Figure 4. Types of innovations introduced by companies in the material production and processing sector - more than one indication possible.

Source: own elaboration.

As shown in Figure 4, an equal percentage of surveyed enterprises (36%) declare implementing marketing and organizational innovations, while 24% report the implementation of managerial innovations. In view of the fact the surveyed enterprises operate in an open and highly competitive market, the achieved level of implementation of strongly market-, customer- and management-related innovations, may be considered relatively low. A moderately positive finding, however, is the fact that one in five enterprises reports implementing social innovations. This situation indicates a growing interest in the innovation potential within this area, as well as in the possibilities of supporting such innovations, which are gaining increasing importance in the context of sustainable economy development.

The issue of innovation measurement was presented in the context of two aspects, i.e. in relation to the current state and the postulated state. In the first case, the question was connected with innovation-related indicators or measures used in enterprises. The distribution of responses to this question is presented in Figure 5. An analysis of the responses reveals the

relatively rare use of measurement systems for implemented innovations and their outcomes among the surveyed enterprises.

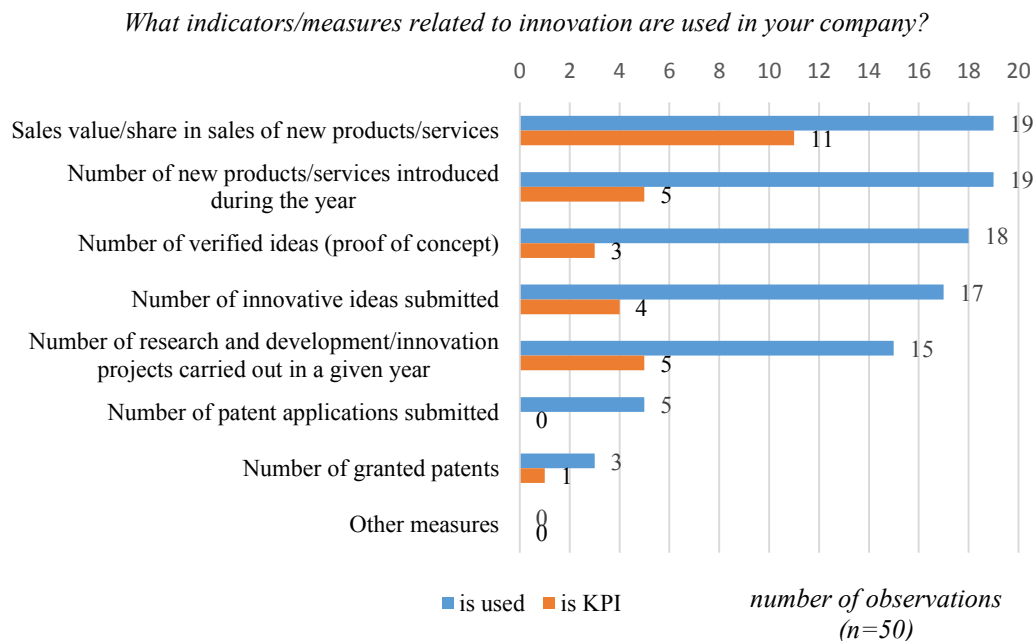


Figure 5. Innovation-related metrics and indicators used in enterprises.

Source: own elaboration.

Among the firms measuring the results of implemented innovations, preferences are related to the following indicators:

- sales value and/or the share of new products in sales, used by 19 enterprises, of which 11 consider it a key indicator of the effectiveness of implemented innovations,
- number of new products (services) introduced within a year, used by 19 enterprises, of which 5 regard it as a key indicator of the effectiveness of implemented innovations.

The use of these indicators corresponds with the significant importance attributed to product innovations in the enterprise operations. In turn, more than 35% of the enterprises associate innovativeness with the number of verified (implemented) ideas, while slightly fewer with the number of submitted ideas. Relatively many enterprises (15) use the number of completed research and innovation projects as a measure of innovativeness. This suggests that such projects are perceived as important, despite the fact the enterprises declare a relatively low percentage of turnover allocated to such activities. The use of the BSC operational instrument (i.e., KPIs) for measuring innovation outcomes remains very limited. Slightly more than one-fifth of the surveyed enterprises apply KPIs with reference to relationships between the results of product innovations and the volume of sales. In terms of the remaining innovation outcome indicators, the use of KPIs does not exceed 10%. Figure 6 presents the distribution of responses to the question concerning innovation-related indicators/measures which should be applied within the surveyed enterprises.

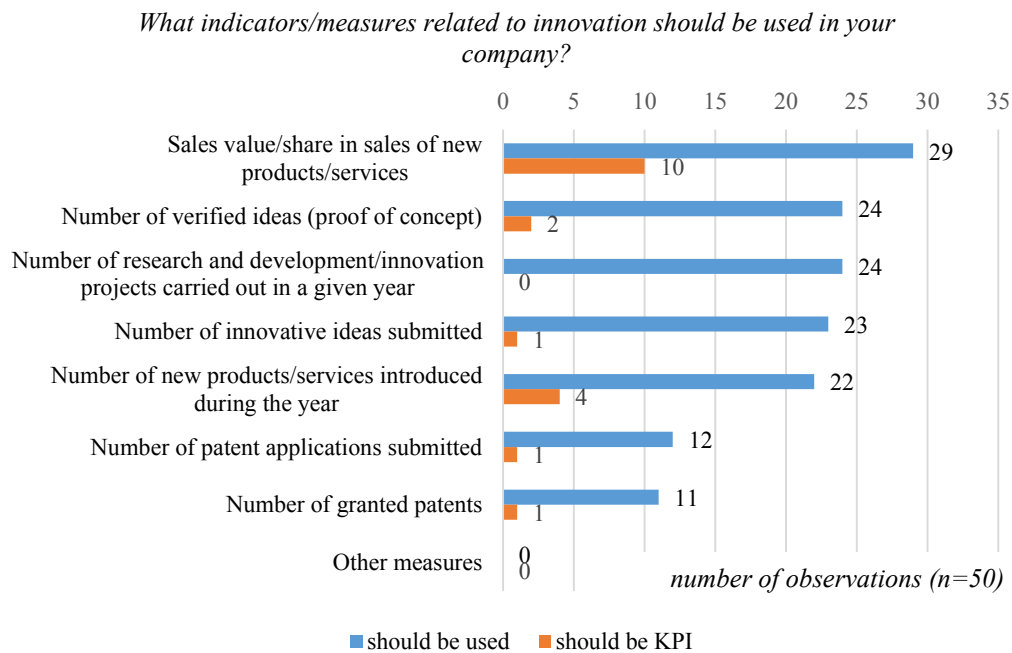


Figure 6. Innovation-related metrics and indicators that should be used in enterprises - respondents' opinion.

Source: own elaboration.

In this case, significantly more enterprises support the use of indicators characterizing implementation of innovations. The largest number, i.e., 58% of the enterprises (29) support the use of the sales value or share of new products in total sales as the innovation implementation-related indicator. Nearly half of the surveyed enterprises believe that the above-mentioned measure should be based on the number of verified (implemented) ideas, the number of completed research and innovation projects, as well as the number of submitted innovative ideas. Similarly to the previous question, the interest in using the BSC operational instrument (i.e. KPIs) remains very limited, and in some cases negligible.

A key research issue is the impact of innovation on the business model, hence the question: “Which elements of the business model have been affected by innovations implemented over the past five years?” The answers to this question are presented in Figure 7. The impact of innovation on the value created for the customer is by far the highest-rated. As many as 86% of the surveyed entities recognize this relationship. This confirms many theoretical considerations regarding business models in particular, the factors that shape their value to the customer. This assessment reflects an awareness of the role of innovation in achieving competitive advantages, which are largely determined by the value created for the customer—enabling their needs to be met or their problems to be solved, and even fostering prosumer relationships, i.e. an exchange of value with the customer. According to the respondents, innovation has a significant impact on a company's tangible assets; 76% of respondents agree with this. This correlation can be explained by the nature of the sector represented by the organisations under analysis; these are predominantly manufacturing enterprises where modernisation

through the introduction of innovations to tangible assets such as machinery, equipment and logistics resources determines the competitiveness and operational efficiency of these enterprises, and often their compliance with environmental requirements or, more broadly, sustainable development.

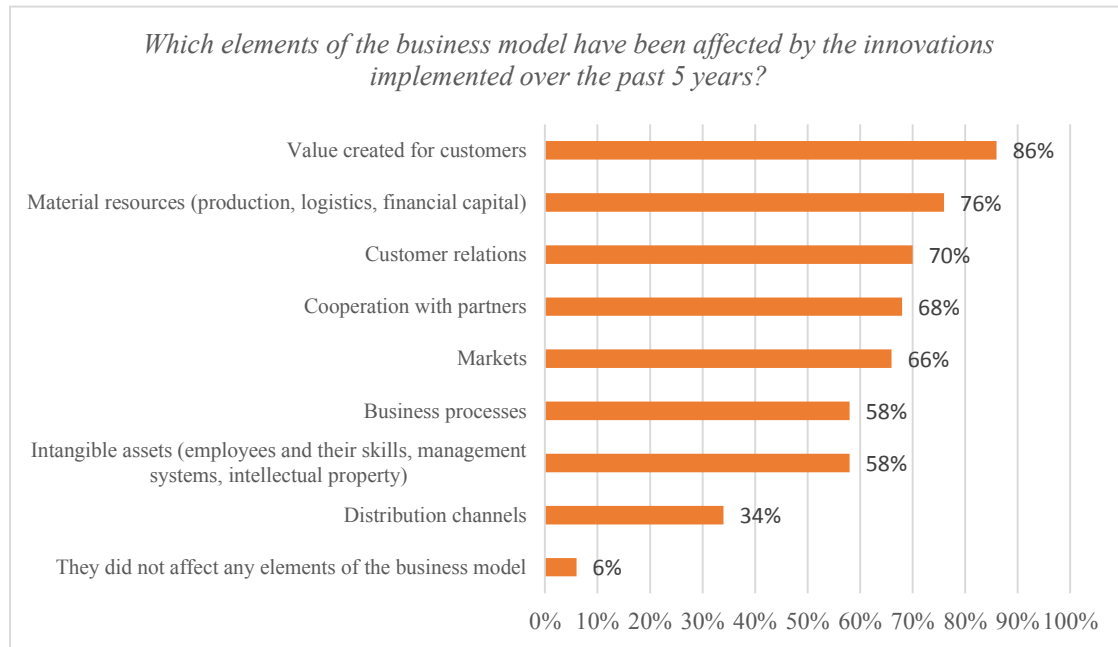


Figure 7 Elements of the business model affected by innovation.

Source: own elaboration.

According to the respondents, innovation had a lesser impact (58.0%) on intangible resources than on tangible resources, although this result should be considered fairly satisfactory (the majority). The same result was obtained when assessing the impact of innovation on another important element of the business model, namely business processes. Comparing this with the extent of the impact of innovation on tangible assets, it can be concluded that companies modernise business processes more often than they introduce new ones. The impact of innovation on distribution channels is rated relatively poorly (34% of companies), which is linked to the nature of the enterprises and their position in the supply chain. Most of these are manufacturers of metals, plastics and ceramic materials using ‘traditional’ logistics processes to supply their products to customers who process them. On the other hand, the impact of innovation on partnerships was rated very highly, with as many as 68% of the surveyed companies agreeing with this. This is a beneficial phenomenon in terms of creating market advantages (coopetition) arising from opportunities for cooperation. The impact of innovation on customer relations was also rated very highly (70% of respondents), which indicates an appropriate product offering that delivers value and the introduction of marketing innovations (e.g. CRM). A large number of companies report that innovation has an impact on the markets they serve, which is linked to the use of product and marketing innovations. Only 6% of the surveyed entities believe that innovation has not affected

the structure of their business model. This means that these companies are able to apply innovations and create a competitive advantage within their existing business model. In turn, the answers to the question “Which elements of the strategy have been affected by the innovations implemented over the last 5 years” refer to the dynamics of the strategy in terms of the innovations applied, and the structure is shown in Figure 7. In the overall projection of the strategy’s elements we can conclude that the impact of the innovations introduced on their operations is significant, although not as widespread as in the case of business models.

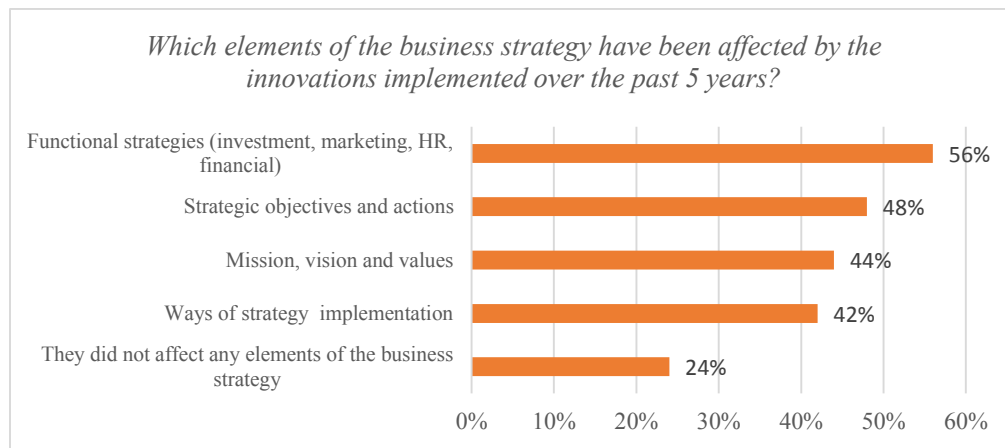


Figure 8 Elements of the business strategy affected by innovation.

Source: own elaboration.

Almost half of the respondents recognise the impact of innovation on strategic changes within their organisations. Innovation influences changes to fundamental elements of strategy, such as strategic objectives and the organisation’s mission and vision. The impact of innovation on strategic objectives and actions is reported by 48% of respondents, which indicates that innovation is being used to formulate new objectives and directions for action, as well as for the strategic reorientation of companies. As many as 44% of respondents recognise the impact of innovation on changes to the mission and vision. These core elements of strategy often have a lasting, long-term and almost imperative nature; they are regarded as the foundation upon which strategic objectives and initiatives are defined, which is why the survey results can be considered rather unexpected. Innovation has a fairly significant impact on strategy implementation, according to 42% of respondents, which points to the significant role of process innovation in the organisations surveyed. The impact of innovation on changes in functional strategies is rated most highly among the surveyed companies, with 56% of respondents stating this. The need to utilise innovation in functional strategies stems from their nature, namely a certain degree of flexibility and the necessity to respond swiftly to changes in the environment. Innovation can serve as an important instrument for implementing changes in investment, marketing or financial strategies aimed at enhancing the company’s competitiveness and efficiency. One in four (24%) of the surveyed entities assess that innovation has no impact on changes in strategy, which means that in these companies, innovation does not constitute a significant long-term factor for development.

The present study can be compared to the work of Safin (2016). Similarities can be observed in the subject matter of the research, which focused on the business models of innovative enterprises in one of Poland's regions (Lower Silesia). The aim of the study was to identify these models, their components, and the relationships between them. Based on the findings of this study, derived from interviews with enterprise management, it is worth emphasizing the significant impact of innovation on business models (as confirmed by our research) and on their structural elements, as well as the necessity of dynamic changes in business models. The author emphasizes the need for further in-depth research on the business models of innovative enterprises, which corresponds to the subject matter of this paper. With regard to the use of KPIs for implementing innovation strategies, the results obtained can be compared with those of Sawang (2011), who conducted his research on a sample of 86 companies in Thailand. He demonstrated, above all, the importance of innovation outcome indicators such as sales and sales growth, as well as indicators characterizing the production process.

5. Case studies

An important component of the empirical study was an in-depth analysis of innovation management in relation to strategy and business model in four selected enterprises (case studies). Table 1 presents the key elements, resulting from the case study, for one of the selected enterprises, referred to as Firm A. In terms of employment and sales revenues, the company qualifies as a medium-sized enterprise. It is a family-owned limited liability company that has been operating for 25 years. The enterprise is active in the sector connected with the production of materials used for marking and automatic product identification across various industries. The firm has used and continues to use EU funds for its development, including digitalization, robotization, and social innovation-related processes. In recent years, the enterprise's annual profit has remained at approximately PLN 30 million, while the values of investments over its 25-year history has reached around PLN 100 million. Over the past 10 years, Firm A has invested nearly PLN 15 million in research and development activities. The enterprise is also strongly engaged in social initiatives within the local community, supporting healthcare and social welfare programs. The MIOD-based evaluation of the innovation management presented in Figure 7 confirms the importance of this process.

Table 1.*Elements and characteristics of Company A's innovative strategy and business model*

Elements and characteristics of an innovative strategy and business model	
Basic strategy	A clearly defined strategy (mission, vision, values, strategic goals) known to employees and stakeholders. A strategy based on innovation: product, process, marketing, organisational and social. The company applies the principles and standards of sustainable development (ESG). Increase in the value of the company through the creation of economic profit (EVA), investments in innovation, and research and development.
Products	Films and textiles, sew-in labels and multicoloured paper labels, electrical safety devices, materials for special applications, advanced multi-layer components, special labels, insulators, thermal pads, tapes, small components for electronics, automotive, automation, aviation and defence industries. A wide range of products, a high level of product innovation, flexible adaptation to customer needs.
Markets and customers	The Company's products are used in manufacturing sectors (household appliances, automotive, consumer electronics, machinery and equipment, visual advertising). The Company's customers include global leaders in these sectors. Well-mastered CRM and flexible market behaviour.
Applied innovations	The company utilises virtually all types of innovation, including social innovation. Product and process innovation are of utmost importance for creating competitive advantage. Thanks to its developing R&D zone, the company applies both external and internal innovation.
Competitive advantage	Although self-adhesive labels have historically been the core of production, the company's competitive advantage lies in its ability to create competitive products that meet the standards and expectations of demanding foreign customers. These are specialised, innovative information, protective and security products.
Customer value generated by the business model	The vast majority of the value is created by innovative, novel, high-quality products. They provide the customer's end products with the following functions: informational, advertising, sealing, securing, insulating, protective, decorative, connecting (adhesive) and warning.
Social architecture of the business model	The pillar of social architecture is highly qualified employees who use digital, telecommunications and IT tools in automated business processes. The Company uses a decentralised management system characteristic of a so-called teal organisation based on autonomy, trust and minimal formalisation. Employee innovation and research and development are also important. The benefits system and employee integration strengthen the motivation system.
Technical architecture and business processes	Modern industrial infrastructure, production and logistics equipment financed from own and EU funds. Continuous process of introducing product and process innovations. Digital Economy tools and automation are used in over 50 short production sequences (business processes).

Source: own study.

It is noteworthy that a high level of agreement was observed between the expert assessment and the enterprise's self-assessment. Consistency was found in seven out of nine cases as regards the factors subjected to evaluation. In summary, the analysed enterprise employs a variety of innovations to implement an innovation-driven sustainable development strategy and an Industry 4.0-oriented business model.

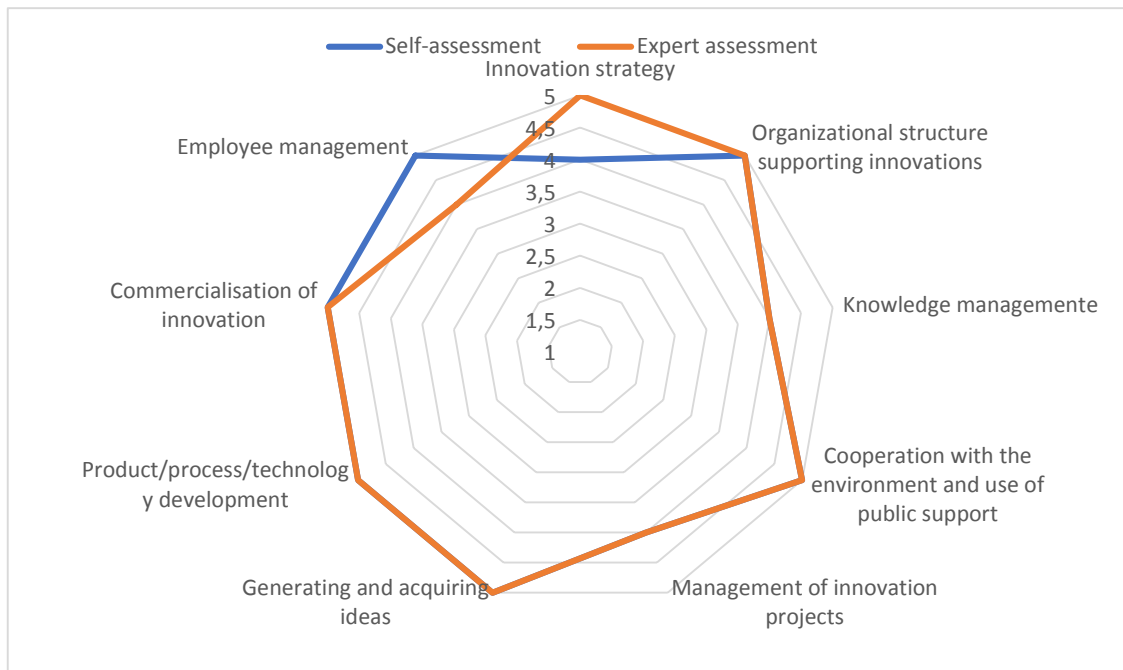


Figure 9. Assessment of company A according to the MIOD method.

Source: own elaboration.

6. Conclusion

The metallic and non-metallic materials production and processing sector continues to represent an important branch of industry in Poland, supplying products to numerous areas of the economy. The development of industries such as defense, automotive, renewable energy, and construction is driving growing demand for increasingly advanced materials. At the same time, Polish enterprises face significant competition, particularly from East Asian countries, making increased innovativeness a necessary condition for operating successfully in an open market. In this context, research in the field of innovation management remains both relevant and justified. The study findings indicate that enterprises very frequently implement product and process innovations. To a lesser extent, this applies to marketing and organizational innovations, which is an unfavorable phenomenon in the context of an open and highly competitive market. A relatively positive situation is the use of social innovations, which indicates that enterprises are increasingly oriented toward sustainable development. The limited share of internal financing allocated to R&D&I activities indicates the need for broader external funding support. Most enterprises recognize strong links between innovations and strategy (with its fundamental elements), whereas the relationship between innovations and business models is recognized by fewer firms. Limited attention is devoted to value management using the BSC instrument. In practice, the operational tool of the Balanced Scorecard, i.e. namely KPIs, is very rarely applied to measure the outcomes of implemented innovations. The scope

of the survey study conducted within the Project enabled the acquisition of knowledge concerning innovations in the materials production and processing sector, thereby providing a significant informational contribution to the Regional Knowledge Management Model. The information and opinions obtained within the Project constitute a component of information resources enabling the development of instruments supporting the management of innovations and reducing the risk associated with their implementation.

The most significant research limitations stem from the nature of the study, in which the sample was restricted to enterprises in a single region (the Silesian Voivodeship) and a single sector (materials production and processing). Nevertheless, the study's findings hold considerable practical and cognitive significance given the importance of the manufacturing industry to the economy. Further regional research will delve deeper into the specific conditions of business models and new challenges related to the implementation of innovations in the materials production and processing sector.

Acknowledgements

The paper presents selected results of research carried out as part of the project 'Network of Regional Specialist Observatories in the Entrepreneurial Discovery Process in the Silesian Voivodeship (SO RIS in PPO - II)', co-financed by the European Regional Development Fund and the state budget under the Regional Operational Programme of the Silesian Voivodeship - project no. WND-RPSL.01.04.01-24-06C8/19.

References

1. Aagaard, A. (2024). *Business Model Innovation. Game Changers and Contemporary Issues*. Palgrave Macmillan.
2. Amit, R., Zott, C. (2017). Value drivers of e-commerce business models. In: M.A. Hitt, R. Amit, C.E. Lucrier, R.D. Nixon (eds.), *Creating Value: Winners in the New Business Environment*. Hoboken NJ: John Wiley & Sons.
3. Bank Danych Lokalnych GUS, <https://bdl.stat.gov.pl>
4. Brzóska, J., Szmal, A. (2016). Business model changes in the presence of challenges brought by Industry 4.0. In: *Carpathian Logistics Congress: CLC'2016*. November 28th 30th 2016, Zakopane, Poland. Conference proceedings, 2017, Tanger, pp. 511-518, ISBN 978-80-87294-76-5

5. Brzóska, J., Knop, L. (2020) Business model changes in the presence of challenges brought by Industry 4.0. In: *The future of management: Industry 4.0 and digitalization*. Buła P., Nogalski B. (ed.). Jagiellonian University, pp. 22-41.
6. Brzóska, J., Knop, L., Odlanicka-Poczobutt, M., Zuzek D.K. (2022). Antecedents of creating business models in the field of renewable energy based on the concept of the new age of innovation.. *Energies*, 15(15), 5511; <https://doi.org/10.3390/en15155511>
7. Brzóska, J., Szmaj, A. (2020). Sustainable economic development and advancing education excellence in the era of global pandemic: *Proceedings of the 36th International Business Information Management Association Conference (IBIMA)*, 4-5 November 2020, Granada, Spain. Soliman K.S. (ed.). International Business Information Management Association, pp. 13584-13591, ISBN 978-0-9998551-5-7
8. Chesbrough, H.W. (2010). Business Model Innovation: Opportunities and Barriers. *Long Range Plann.*, 43(23), pp. 354-363.
9. Dong, Y., Sun, Z., Zhou, Y. (2026). Not all voices are equal: stakeholder environmental pressures and corporate green innovation strategies. *Journal of Business Research*, vol. 202, <https://doi.org/10.1016/j.jbusres.2025.115793>
10. Działowe Bazy Wiedzy, GUS, stat.gov.pl
11. Foss, N.J., Saebi, T. (2017). Fifteen years of research on business model innovation: How far have we come, and where should we go? *Journal of Management*, 43(1), 200-227.
12. Gołębiowski, T., Dudzik, T.M., Lewandowska, M., Witek-Hajduk, M. (2008). *Modele biznesu polskich przedsiębiorstw*. Warszawa: Szkoła Główna Handlowa w Warszawie, pp. 57-65.
13. Grabowska, S. (2026). *Architektura społeczna modelu biznesu czwartej rewolucji przemysłowej: konceptualizacja, modelowanie i wizualizacja konstruktu*. TNOiK, Dom Organizatora, pp. 221-232.
14. Guendez, A.A., Demircioglu, M.A., Mueller, E.M., Cinar, E. (2025). Digital innovation strategies in the public sector. *Research Policy*, no. 54, <https://doi.org/10.1016/j.respol.2025.105274>
15. Hamel, G. (2002). *Leading the revolution*. Harvard Business School Press, pp. 59-119.
16. Hannah, D., Parent, M., Pitt, L., Berthon, P. (2019). Secrets and knowledge management strategy: the role of secrecy appropriation mechanisms in realizing value from firm innovations. *J. Knowl. Manag.*, no. 23, pp. 297-312, 10.1108/JKM-09-2017-0389
17. Jabłoński, A.S., Jabłoński, M. (2023), *Modele biznesu przedsiębiorstw. Perspektywy rozwoju – ujęcie koncepcyjne*. Warszawa: CeDeWu.
18. Knop, L., Brzóska, J. (2016). Rola innowacji w tworzeniu wartości przez modele biznesu. *Zeszyty Naukowe Organizacja i Zarządzanie*, 99. Politechnika Śląska, 213-232.
19. Kubiński, P., Zgrzywa-Ziemak, A., Krajewski, K. (2023). The concept of a sustainable business model: Opportunities and challenges. *Ekonomia — Wrocław Economic Review* 29/2, *Acta Universitatis Wratislaviensis*, No. 4180, 93-105.

20. Lee, J., Suh, T., Roy, D., Baucus, M. (2019). Emerging technology and business model innovation: The case of artificial intelligence. *Journal of Open Innovation: Technology, Market, and Complexity*, 5(3), 44.1-13.
21. Moratis, W.L., Melissen, F., Idowu, S.O. (2017). *Sustainable business models. Principles, promise, and practice*. Springer, pp. 1-15.
22. Newth, F. (2012). *Business Models and Strategic Management. A New Integration*. New York: Business Expert.
23. Osterwalder, A., Pigneur, Y. (2010). *Business Model Generation: A Handbook of Visionaries, Game Changers and Challengers*. Strategyzer Series, Wiley.
24. Perrons, R.K., Richards, M.G., Platts, K. (2005). What the hare can teach the tortoise about make- buy strategies for radical innovations. *Management Decision*, Vol. 43, No. 5, pp. 670-690, doi: <https://doi.org/10.1108/00251740510597707>
25. Pires, R.A.R., Ferreira, J. (2025). Bridging innovation strategies and intellectual property: A systematic review-based conceptual framework and a roadmap for future research. *Technovation*, Vol. 144, <https://doi.org/10.1016/j.technovation.2025.103243>
26. Prahalad, C.K., Krishnan, M.S. (2009). *New Age of Innovation*. Mc Graw Hill, pp. 44-60.
27. Ritter, T., Lettl, C. (2018). The wider implications of business-model research. *Long Range Planning*, 51(1), pp. 1-8.
28. Saebi, T., Lien, L., Foss, N.J. (2017). What Drives Business Model Adaptation? The Impact of Opportunities, Threats and Strategic Orientation. *Long Range Planning*, pp. 567-581.
29. Safin, K. (2016). Modele biznesowe innowacyjnych przedsiębiorstw. Identyfikacja i analiza. *Research Papers of Wrocław University of Economics*, no. 421, pp. 519-529.
30. Sawang, S. (2011). Key Performance Indicators for Innovation Implementation: Perception vs. Actual Usage. *Asia Pacific Management Review*, 16(1), pp. 23-29.
31. Shepherd, D.A., Seyb, S.K., George, G. (2023). Grounding business models: Cognition, boundary objects, and business model change. *Academy of Management Review*, 48(1), pp. 100-122.
32. Szumniak-Samolej, J. (2022). Zrównoważone modele biznesowe – charakterystyka, kryteria, innowacje. *e-mentor*, 1(93), 37-45. <https://doi.org/10.15219/em93.155>
33. Teece, D.J. (2010). Business Models, Business Strategy and Innovation. *Long Range Plann*, 43(2-3), pp. 172-194.
34. Tidd, J., Bessant, J. (2014). *Strategic innovation management*. John Wiley & Sons Inc.
35. Trompenaars, F. (2010). *Kultura innowacji. Kreatywność pracowników źródłem sukcesu firmy*. Warszawa: Wydawnictwo Wolters Kluwer Polska.
36. Trott, P. (2018). *Innovation Managment and New Product Development. 6th Edition*. Pearson.

37. Velu, C. (2016). Evolutionary or revolutionary business model innovation through coopetition? The role of dominance in network markets. *Industrial Marketing Management*, 53, pp. 124-135.
38. Wirtz, B.W., Pistoia, A., Ullrich, S., Göttel, V. (2016). Business models: Origin, development and future research perspectives. *Long Range Planning*, 49(1), 36-54.
39. Zott, C., Amit, R. (2015). Business model innovation: Toward a process perspective. In: *The Oxford handbook of creativity, innovation, and entrepreneurship*, pp. 395-406.

FORMS OF ACTIVITY WITHIN A FARM – LEGAL AND PRACTICAL ASPECTS IN POLAND

Maja CHAMIER-GLISZCZYŃSKA^{1*}, Adam WASILEWSKI²

¹ University of Gdańsk; maja.ch-g@o2.pl, ORCID: 0009-0003-2373-1535

² Institute of Agricultural and Food Economics – National Research Institute; adam.wasilewski@ierigz.waw.pl,
ORCID: 0000-0003-0863-3219

* Correspondence author

Purpose: The aim of the study is to analyse the forms of additional activities within a farm and to identify the legal consequences of selling food as part of such additional activities and in the absence thereof. Furthermore, the study aims to identify the types of additional activities chosen by local food producers in Poland and what is sold on a national scale and broken down by voivodeships.

Design/methodology/approach: The study involves a review of legal provisions relating to food production and sales activities, as well as an examination of the structure of these activities and product sales at the national level and by voivodeships. A quantitative analysis was applied to data concerning the forms of activity chosen by local food producers and the types of food products sold within short food supply chains.

Findings: The study demonstrated the legal possibility of conducting food production and sales within the scope of three forms of ancillary business activity, namely farm retail trade, direct sales, and marginal, local and limited activities. Each of these forms of activity provides legal protection for local food producers. The research findings indicate a clear dominance of farm retail trade as a supplementary form of activity and of bee products within short food supply chains.

Research limitations/implications: The research focuses on local food producers operating in the Polish market. This approach stems from preliminary research conducted as part of the VISION4FOOD project. Furthermore, research in this area will be expanded to include the other project partners.

Originality/value: The article addresses key issues for the modern consumer, who prioritises the quality of food products. It puts the ‘farm-to-table’ concept into practice by utilising short food supply chains, thereby supporting local food producers.

Keywords: farm retail trade (RHD), direct sales (SB), marginal, local and limited activities (MOL), short food supply chains, legal aspects.

Category of the paper: Research paper.

1. Introduction

The ongoing growth in consumer awareness of sustainability has also extended to the food markets (Barska, Wojciechowska-Solis, 2020). A key aspect in this regard is the approach to introducing changes to the current and future food system. It is envisaged that food systems should transition to a fair, sustainable and regenerative model. Such a system can ensure healthy and accessible nutrition for the whole of society, whilst restoring ecosystems and supporting decarbonisation efforts. In response to the rise in consumer awareness regarding the quality of food consumed and the interest in purchasing local products, which has been observed in recent years, an opportunity for growth has consequently emerged for small-scale operators, i.e. small farms and local food producers. This refers to entities involved in food production, processing and sale to the final consumer. The food products traded are fresh, organic, minimally processed and, most importantly, produced using natural methods. Issues concerning local sourcing, shortening food supply chains and strengthening the position of small producers have become particularly significant in the light of crises such as the COVID-19 pandemic or the war in Ukraine, which have highlighted the vulnerability to risks posed by long and centralised food distribution models (Kapała, 2025). Furthermore, growing public awareness of food quality has made people more inclined to purchase products from local food producers, i.e. those of known origin. However, the lack of a legal definition of local food and food from short supply chains, as well as the absence of a dedicated labelling system, means that consumers are unable to easily identify such products on the market (Kapała, 2025).

In order to increase customer trust and confidence in the food they purchase, and in the context of criminal liability, a farmer selling their own food should opt for one of the additional forms of business operation, namely farm retail trade (RHD), direct sales (SB), or marginal, local and limited activities (MOL). An advantage of operating under one of these forms is that there is no need to set up a business to sell one's own food products. Additionally, income from RHD up to 100,000 PLN per year is exempt from income tax. Another characteristic feature is the short food supply chain, in which participation means that the farmer is not only a producer of food products but also involves the farm in the processing, distribution and marketing of agricultural products, thereby minimising the number of intermediaries between the producer and the final customer (Bert, Mulligan, 2016; Wolniak, Olkiewicz, 2018). Short food supply chains involve the sale of products from the farm to the final consumer without the involvement of intermediaries (or with only one intermediary) (Borychowski et al., 2026). Short and medium supply chains constitute a reliable alternative to long supply chains because the food they provide is characterised by local sourcing, naturalness, healthiness and reliability (Aguiar, DelGrossi, Thome, 2018).

The proposed and implemented vision for the food system aims to create the right conditions for food production based on fair incomes and transparency throughout the food chain. It is emphasised that farmers should be the key element in ensuring food security and the supply of healthy, high-quality food to the public. This vision of food systems is reflected in farm retail trade (RHD), direct sales (SB), marginal, local and limited activities (MOL) as additional activities carried out by farmers. It can be unequivocally stated that the key element of the future food system is the additional activities of RHD, SB and MOL. The VISION4FOOD programme has taken steps to support cooperation in the transformation of the food system through co-creation, acceleration, evaluation and the exchange of knowledge regarding the future food system.

The structure of the article is divided into five parts. An introduction to the subject matter is presented in the first part. The second part presents forms of additional activity within the framework of a farm, i.e. farm retail trade (RHD), direct sales (SB) and marginal, local and limited activities (MOL). The following section discusses the criminal law provisions applicable to these forms of activity. Subsequently, the results of research on the number of local food producers at national level and in individual voivodeships, as well as the types and numbers of products involved in these activities, are presented. The final section of the article summarises the issues analysed.

2. Forms of additional activity within the framework of a farm

2.1. Farm retail trade (RHD)

Farm retail trade is one of the additional forms of business activity undertaken by small-scale farmers. This activity involves the production of food on farms and its subsequent marketing via short food supply chains (GIW, March 2026). Article 3 (3) (29b) of the Act of 25 August 2006 on food and nutrition safety provides a definition of farm retail trade, which involves the production of food that originates wholly or partly from the entity's own cultivation, rearing or breeding by an entity operating in the food market, and the sale of such food to the final consumer or to retail establishments intended for the final consumer (Dz.U. 2006). The definition of retail trade under Article 3 (7) of Regulation No 178/2002 applies here, which means the handling and/or processing of food and its storage at the point of sale or at the point of delivery to the final consumer (EU, 178/2002). The term 'retail trade' covers distribution terminals, catering activities, workplace canteens, institutional catering, restaurants and similar food service activities, shops, distribution centres in supermarkets and wholesalers (EU, 178/2002). Food produced within the framework of farm retail trade and intended for the final consumer may be sold throughout the country. Raw materials and

processed products of plant origin must be registered with the State District Sanitary Inspector responsible for the area where the business is conducted at least 14 days before the start of operations (Mrozek, 2023). Conversely, raw materials and processed products of animal origin, as well as composite food consisting of products of both animal and non-animal origin, must be registered with the district veterinary officer competent for the establishment's registered office or place of business at least 30 days in advance of the planned date of commencement of operations (Mrozek, 2023). If, following an inspection, it is found that the establishment meets the requirements of food law, the district veterinary officer will issue a decision approving the establishment, assign it a veterinary identification number and enter it in the district veterinary officer's register (Sokołowski, 2025).

In response to growing consumer interest in short food supply chains, Poland has adopted legislation governing the retail trade in agricultural products. The aim of these measures was to increase sales of food produced by farmers on their own farms and supplied directly to final consumers. Although the retail sale of agricultural products is not classified as an agricultural activity, it is exempt from commercial law and farmers may operate it without the need for registration. Farmers therefore do not become entrepreneurs and can continue to benefit from their privileges, i.e. social security and tax exemptions, which strengthens their market position relative to food companies (Kapała, 2020). However, certain conditions have been set out that must be met in order to engage in the retail trade of agricultural products. Food processing must take place in a manner other than industrial. The final product should consist of at least 50% of products originating from the farm, which allows farmers to purchase products from outside their own farm for the purpose of food production (Kapała, 2020). It is important to note that food subject to the retail trade in agricultural products may only be sold to a specific group of buyers, i.e. final consumers throughout the country, retail shops and other entities, such as care homes and local restaurants. It is also possible to supply products to entities that deliver food to final consumers, but only to those located in the same voivodeship as the farm in question (Kapała, 2020). RHD operations utilise short food supply chains, which serve to shorten the distance products travel in line with the 'farm-to-table' concept and are also aimed at supporting local farmers and food producers. They also aim to eliminate or at least reduce the number of intermediaries involved in delivering the final product to the final consumer (Sikorska, 2019; Olkiewicz, 2025). This approach aligns with the mindset of the modern consumer, who prioritises fresh, minimally processed and organic food. Farm retail trade is gaining in importance due to consumers' increasing demand for local, organic and seasonal products, which offer an alternative to mass production (Pawlewicz, 2025). There is a noticeable trend whereby an increasing number of consumers are choosing to buy products 'from their neighbours', i.e. from local farmers, as they perceive these products to be of the highest quality and a guarantee of safety when consumed (Sikorska, 2019). A major advantage of setting up an RHD business is direct contact with the final consumer, which enables a better understanding of the expectations, needs and preferences of final customers. Furthermore, reducing

intermediary costs usually results in lower prices for end consumers as well as an increase in the farmer's margin as a local food producer (Hodór, 2025). The freshness, taste and unique character of the products on offer also attract customers' interest. The only difficulty in running an RHD business is the need to familiarise oneself with and comply with the numerous regulations governing this type of activity; however, the time-consuming effort invested in understanding the requirements and adapting to them in the future can pay off handsomely (Hodór, 2025). It is important that the production and sale of food do not pose a threat to food safety or adversely affect public health. Fresh meat intended for processing within the RHD must be obtained lawfully, e.g. from a slaughterhouse or a wholesale market. It must not originate from the slaughter of animals carried out on a farm for the production of meat intended for personal consumption (Ficek, 2023). The Veterinary Inspection supervises the appropriate health standards of products of animal origin, whilst the State Sanitary Inspection authorities supervise the appropriate health standards of food of non-animal origin (Ficek, 2023). The signage at the premises where food is sold under the RHD scheme must be legible and visible, and must include the words 'farm retail trade' and the following details: the full name of the entity conducting the farm retail trade or its name and registered office, the address of the premises where the food being sold is produced, and the veterinary identification number (WNI) (Balaweneder, 2022).

2.2. Direct sales (SB)

Direct sales are another form of business activity (GIW, March 2026) reserved for farmers. Although it has a long history, it is only since 1 January 2016 that farmers in Poland have been able to legally sell food products they have produced from their own raw materials without having to register a business (Kokoszka, Pink, 2018). On 1 January 2017, the Act of 16 November 2016 amending certain acts to facilitate the sale of food by farmers came into force (Kokoszka, Pink, 2018). Direct sales cover only products of animal origin and may relate only to products produced from raw materials sourced from farms whose activities include the production of products of animal origin intended for direct sale (Mrozek, 2023). This form of sale may be directed at the following recipients: the final consumer or a retail outlet directly supplying the final consumer (Mrozek, 2023). The sale of products may take place on the producer's farm and at local markets. The geographical scope of direct sales is limited to the voivodeship in which the animal products are produced, to neighbouring voivodeships, and to other voivodeships within Poland, however, only during exhibitions, festivals, fairs or markets organised for the purpose of promoting these products (GIW, March 2026). However, before commencing operations, it is necessary to register direct sales with the District Veterinary Inspectorate at least 30 days in advance (Mrozek, 2023). In the case of direct sales at exhibitions, festivals, fairs or markets organised to promote products in a voivodeship other than the one where they are produced, it is necessary to notify the district veterinary officer responsible for the location where the planned sales are to take place, 7 days before the start of

such sales (GIW, March 2026). Such notification must include the full name or business name of the entity engaged in the production of these products, as well as the address of the premises where this activity is carried out. Furthermore, details must be provided regarding the location and the period during which the sale of these products will take place (GIW, March 2026). Direct sales are characterised by short food supply chains, which protect farmers from unfair commercial practices in processing and distribution. Short food supply chains enable price control and, consequently, a fairer income from the perspective of the local producer (farmer). Furthermore, as short food supply chains do not require long-term storage, the food reaching the final consumer is fresher and of better quality. It is also important that the absence of long-distance food transport contributes to reducing the carbon footprint of local food distribution (Sieczko, 2019). The sale of animal products via direct sales is regulated in detail by the Regulation of the Minister of Agriculture and Rural Development of 30 September 2015 on veterinary requirements for the production of animal products intended for direct sales (GIW, March 2026). It is specified therein that the following products fall within the scope of direct sales: 1) carcasses or offal obtained from poultry slaughtered on the operator's farm, 2) carcasses or offal obtained from lagomorphs slaughtered on the operator's farm, 3) carcasses and offal obtained by a hunting club, 4) fishery products, 5) live land snails, 6) raw milk, raw cream, obtained on the farm during the milk production stage, 7) eggs obtained from poultry or ratites, 8) unprocessed bee products, including honey, bee pollen, bee bread and royal jelly (Dz.U. 2015). Direct sales provide farmers with the opportunity to increase their income, receive feedback from final customers, and build their own brand (Kawecka, Gębarowski, 2015). For consumers, direct sales offer access to higher-quality food with better taste, knowledge of its origin, and support for the local economy (Kawecka, Gębarowski, 2015). One of the factors influencing the effectiveness of direct sales is the salesperson's communication skills. In the face of continuous market development and increasing competition, the seller's knowledge and experience, as well as their ability to close a sale, can help in building lasting relationships with customers (Jaska, Stolarska, Werenowska, 2020).

2.3. Marginal, local and limited activities (MOL)

Marginal, local and limited activities refer to the processing and sale of food of animal origin carried out on a small scale in small or medium-sized establishments (Mrożek, 2023). The possibility of conducting such activities responds to the expectations of local food producers (farmers) who wish to operate in establishments producing specific types of products, often with distinctive characteristics, for which demand exists mainly in the local market (GIW, March 2026). A prerequisite for MOL operations is the sale of food directly to the final consumer as well as to establishments engaged in retail trade intended for the final consumer, i.e. canteens and restaurants (Mrożek, 2023). In the case of this type of activity, the provision of deliveries is mandatory. As regards sales to final consumers, there are no quantitative restrictions; however, deliveries to other establishments engaged in retail trade for final

consumers are subject to quantitative restrictions and applicable limits (GIW, March 2026). As regards territorial scope, MOL's activities and deliveries to other establishments must take place within a single voivodeship, within the districts neighbouring that voivodeship, or within the cities serving as the seat of the provincial governor or provincial council, located in voivodeships neighbouring the voivodeship where these products are manufactured. The only exception where these restrictions do not apply is the sale of products of animal origin or ready-made meals to consumers during festivals, exhibitions, fairs and markets organised for the purpose of promoting these products. In such cases, sales are permitted throughout Poland; however, the district veterinary officer responsible for the place of sale must be notified in writing at least 7 days before the start of such sales (GIW, March 2026).

MOL activities are subject to mandatory registration with the District Veterinary Inspectorate upon a written application submitted at least 30 days before the planned start of operations. Commencement of activities is possible after obtaining an administrative decision regarding entry in the relevant register and the allocation of an identification number (Mrozek, 2023). The scope of MOL activities is defined by the Regulation of the Minister of Agriculture and Rural Development of 21 March 2016 on the detailed conditions for the recognition of marginal, local and limited activities. It follows from this that the scope of production and sale of products of animal origin within the framework of MOL activities includes: 1) dairy products and colostrum-based products, 2) pre-processed or processed fishery products, 3) egg products obtained as a result of the treatment or processing of eggs that have previously been cooked in their shells, 4) meat products, minced meat, raw meat products, 5) the cutting of fresh beef, pork, mutton, goat, horse, poultry or lagomorph meat, game animals shot in accordance with hunting regulations, and wild animals kept on farms, 6) ready meals (dishes) made from products of animal origin or containing such products, provided that at least one product of animal origin constituting a main ingredient of the meal was produced at that establishment (Dz.U. 2016).

3. Criminal liability in relations to business activities – legal aspects

The Act of 25 August 2006 on food and nutrition safety contains criminal provisions (Srogosz, 2025) in the form of sanctions and financial penalties for various infringements committed in connection with or in the course of business activities. The production or placing on the market of a foodstuff commonly consumed that is harmful to human health or life may result in a fine, a penalty of restriction of liberty or imprisonment for up to two years (Art. 96, ust. 1, Dz.U. 2006).

Committing a similar act, but in relation to a foodstuff for special dietary purposes, a food supplement or a novel food, is punishable by a fine, a sentence of restriction of liberty or imprisonment for up to 3 years (Art. 96, ust. 2, Dz.U. 2006). In the case of an unintentional act, the offender is liable to a fine, a penalty of restriction of liberty or imprisonment for up to one year (Art. 96, ust. 4, Dz.U. 2006). A more severe penalty in the form of imprisonment for a term of between 6 months and 5 years applies where the offender has made a regular source of income from the above offences or where these offences are committed in relation to foodstuffs of significant value (Art. 96, ust. 3, Dz.U. 2006).

Article 97(1) of the Act on Food and Nutrition Safety uses the term ‘adulterated foodstuff’, the definition of which is set out in Article 3 (3) (45) of that Act (Srogosz, 2025). The production or placing on the market of a foodstuff that is spoiled or adulterated is punishable by a fine, a restriction of liberty or imprisonment for up to one year (Art. 97, ust. 1, Dz.U. 2006), and if it concerns foodstuffs of significant value, to imprisonment for a term of between 6 months and 3 years (Art. 97, ust. 2, Dz.U. 2006). A fine, restriction of liberty or imprisonment for up to 2 years may be imposed for, amongst other things: labelling genetically modified food in breach of Regulations No 1829/2003 and No 1830/2003, placing genetically modified food on the market without authorisation or in breach of the conditions set out in that authorisation, failure to comply with the obligation to monitor genetically modified food placed on the market in the manner specified in Regulation No 1829/2003, and failure to withdraw from the market genetically modified food that does not meet the requirements laid down in Regulation No 1829/2003 (Art. 99, ust. 1, Dz.U. 2006).

A fine may be imposed for, amongst other things: using a foodstuff in production or placing it on the market after its use-by date or best-before date has expired; failing to implement procedures based on the principles of the HACCP system within the establishment; or failing to comply with hygiene requirements; failure to carry out activities relating to the identification of food suppliers or recipients, and failure to display a label at the point of sale of food within the farm retail trade, or providing incomplete or false information on such a label (Art. 100, ust. 1, Dz.U. 2006). Financial penalties are imposed in the event of non-compliance with food labelling requirements, including in relation to presentation, advertising and promotion, and non-compliance with food labelling requirements set out in the provisions of: a) Regulation No 1333/2008 on food additives, b) Regulation No 1334/2008 on flavourings, c) Regulation No. 1169/2011, the marketing of a non-food product as food, and the failure to withdraw from the market a foodstuff harmful to human health or life, a spoiled foodstuff or an adulterated foodstuff (Art. 103, ust. 1, Dz.U. 2006). In the cases mentioned, the amount of the financial penalty may be set at up to five times the gross value of the disputed quantity of the foodstuff or non-food product placed on the market as food (Art. 103, ust. 2, Dz.U. 2006).

A financial penalty is imposed for the production or placing on the market of food in a manner inconsistent with the establishment approval decision (Art. 103, ust. 1, Dz.U. 2006) in an amount of not less than PLN 500 (Art. 103, ust. 2, Dz.U. 2006). The following are also

subject to a financial penalty: conducting activities involving the production or marketing of food without submitting an application for entry in the register of establishments or for approval of the establishment and entry in the register of establishments, or contrary to a decision refusing approval of the establishment in accordance with the procedure and principles laid down in Regulation No 852/2004, selling, as part of business activities, foodstuffs to an educational establishment other than those falling within the categories of foodstuffs intended for sale to children and young people, advertising or promoting, as part of business activities within an educational establishment, foodstuffs other than those falling within the categories of foodstuffs intended for sale to children and young people; and, whilst carrying out activities relating to the mass catering of children and young people within an educational establishment, using foodstuffs that do not meet the requirements (Art. 103, ust. 1, Dz.U. 2006). In the situations indicated, the amount of the financial penalty may be set at up to PLN 5000, but not less than PLN 1000 (Art. 103, ust. 2, Dz.U. 2006). Carrying out activities in the field of food production or trade contrary to a decision to withdraw or suspend the approval of an establishment, or contrary to a decision to temporarily suspend the operation or close all or part of a given establishment pursuant to Regulation No 882/2004, as well as obstructing or preventing the performance of official food controls, also result in the imposition of financial penalties (Art. 103, ust. 1, Dz.U. 2006). All the financial penalties listed are imposed in an amount of up to thirty times the average monthly wage in the national economy for the preceding year, as announced by the President of the Central Statistical Office, on the basis of the provisions on pensions from the Social Insurance Fund, in the Official Journal of the Republic of Poland 'Monitor Polski' (Art. 103, ust. 1, Dz.U. 2006). Financial penalties are imposed, by way of a decision, by the competent provincial sanitary inspector (Art. 104, ust. 1, Dz.U. 2006), taking into account, when determining the amount of the financial penalty, the degree of harmfulness of the act, the degree of culpability and the scope of the infringement, the entity's previous activity in the food market, and the scale of the establishment's production (Art. 104, ust. 2, Dz.U. 2006). Financial penalties constitute revenue for the State budget (Art. 104, ust. 4, Dz.U. 2006), and in matters not regulated by this Act, the provisions of Section III of the Act of 29 August 1997 – Tax Ordinance, subject to the proviso that the powers of the tax authority are vested in the competent provincial sanitary inspector (Art. 104, ust. 3, Dz.U. 2006).

4. An analysis of the structure of additional activities carried out by farmers in Poland

In order to better illustrate the situation regarding farm retail trade, direct sales and marginal, local and limited activities in Poland, data from the register of registered establishments available on the website of the Chief Veterinary Inspectorate was analysed and compared. The study examined the register of entities engaged in farm retail trade, the register of entities engaged in direct sales, and the register of entities engaged in marginal, local and limited activities. The study will take into account the following information: the total number of entities carrying out a given activity nationwide, the number of entities per voivodeship, as well as the types and number of products involved in a given activity. A significant limitation is that some entities may operate without being registered and are therefore not included in the registers. The aim of the analysis is to demonstrate which activity is conducted on the largest scale, which voivodeships dominate in carrying out particular forms of activity, and which products are most frequently sold within the framework of farm retail trade, direct sales, and marginal, local and limited activities.

Nationwide, 21,111 entities operate in the RHD sector, 16,225 in direct sales, and 2,161 in MOL activities (Figure 1). RHD is the most popular form of activity and is currently the largest-scale activity nationwide among the additional forms of activity carried out by farmers. Direct sales rank second in terms of the scale of operations nationwide. MOL activities are conducted on a significantly smaller scale compared to other forms of business and are the least popular.

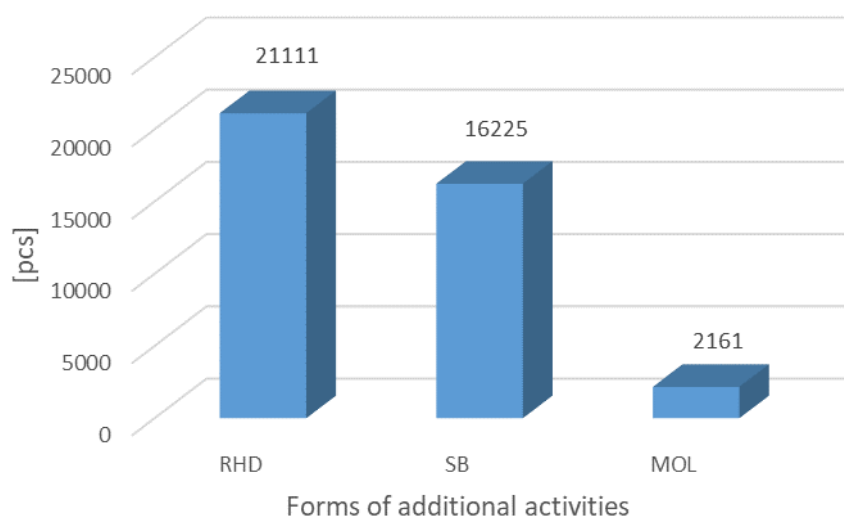
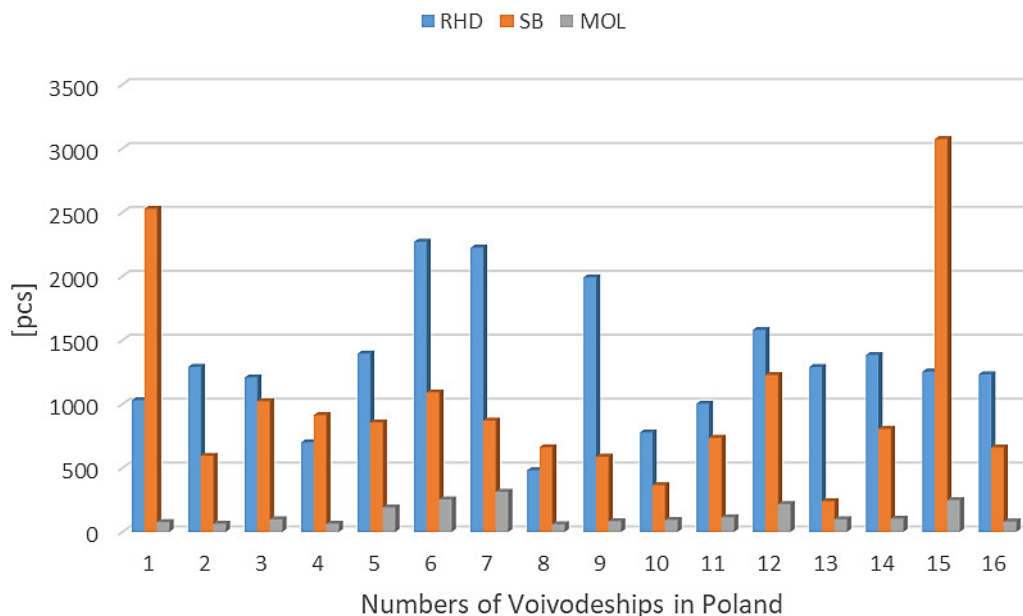


Figure 1. Structure of additional activities carried out by farmers in Poland: RHD – farm retail trade, SB – direct sales, MOL – marginal, local and limited activities.

Source: own calculations based on GIW, March 2026.

Breaking down the national picture into individual voivodeships, the following trends can be observed (Figure 2). Two voivodeships dominate in terms of the number of entities engaged in farm retail trade: Małopolskie Voivodeship (2270) and Mazowieckie Voivodeship (2223). Next in line are the voivodeships of Podkarpackie (1991), Śląskie (1580), Łódzkie (1395) and Warmińsko-Mazurskie (1384). An even smaller number of RHD businesses are operated in the Kujawsko-Pomorskie Voivodeship (1291), Świętokrzyskie Voivodeship (1290), Wielkopolskie Voivodeship (1254), Zachodniopomorskie Voivodeship (1232) and Lubelskie Voivodeship (1208). A small number of RHD entities operate in the Dolnośląskie Voivodeship (1030) and Pomorskie Voivodeship (1003). The fewest RHD entities are found in the following three voivodeships: Podlaskie (778), Lubuskie (701) and, by far the fewest, in the Opolskie (482).

Conversely, the highest number of direct sales outlets was recorded in the Wielkopolskie Voivodeship (3072). The Dolnośląskie Voivodeship ranks second in terms of the scale of this activity (2526). Next in line are the following voivodeships: Śląskie (1227), Małopolskie (1091), Lubelskie (1021), Lubuskie (913), Mazowieckie (871), Łódzkie (856) and Warmińsko-Mazurskie (805). Direct sales are conducted on a small scale in the Pomorskie Voivodeship (735), Opolskie Voivodeship (662), Zachodniopomorskie Voivodeship (660), Kujawsko-Pomorskie Voivodeship (595) and Podkarpackie Voivodeship (588). The lowest number of direct sales businesses is found in the Podlaskie Voivodeship (365) and Świętokrzyskie Voivodeship (239). The structure of direct sales businesses by voivodeships is shown in Figure 2.



RHD – farm retail trade, SB – direct sales, MOL – marginal, local and limited activities, 1 – Dolnośląskie Voivodeship, 2 – Kujawsko-Pomorskie Voivodeship, 3 – Lubelskie Voivodeship, 4 – Lubuskie Voivodeship, 5 – Łódzkie Voivodeship, 6 – Małopolskie Voivodeship, 7 – Mazowieckie Voivodeship, 8 – Opolskie Voivodeship, 9 – Podkarpackie Voivodeship, 10 – Podlaskie Voivodeship, 11 – Pomorskie Voivodeship, 12 – Śląskie Voivodeship, 13 – Świętokrzyskie Voivodeship, 14 – Warmińsko-Mazurskie Voivodeship, 15 – Wielkopolskie Voivodeship, 16 – Zachodniopomorskie Voivodeship.

Figure 2. Structure of additional activities carried out by farmers across the 16 Voivodeships of Poland.

Source: own calculations based on GIW, March 2026.

In contrast, marginal, local and limited activities MOL are conducted on the largest scale in the Mazowieckie Voivodeship (314). MOL activities are conducted on a fairly large scale in the following voivodeships: Małopolskie (254), Wielkopolskie (248) and Śląskie (217). Next in terms of the number of MOL activities are the voivodeships of Łódzkie (191), Pomorskie (115), Warmińsko-Mazurskie (104), Świętokrzyskie (99), Lubelskie (98), Podlaskie (93), Podkarpackie (83), Zachodniopomorskie (81) and Dolnośląskie (77). The lowest number of MOL activities is found in the voivodeships of Kujawsko-Pomorskie (64), Lubuskie (63) and Opolskie (60). The structure of MOL activities by voivodeships is shown in Figure 2.

When comparing the results of all types of additional activities in terms of their prevalence across individual voivodeships in Poland, it can be observed that different voivodeships dominated in each of the listed forms of additional activity, and the situation also varied among the voivodeships at the bottom of the ranking in terms of the popularity of a given form of activity. RHD activity dominates in the Małopolskie Voivodeship, direct sales in the Wielkopolskie Voivodeship, and MOL activities in the Mazowieckie Voivodeship. The fewest entities operate RHD in the Opolskie Voivodeship, whilst direct sales are least popular in the Świętokrzyskie Voivodeship, and MOL activities are least prevalent in the Kujawsko-Pomorskie, Lubuskie and Opolskie Voivodeships.

What types of products are sold within the farm retail trade, and which of these are the most common and which the least common?

The list of entities engaged in farm retail trade shows that the most frequently cited type of product is unprocessed bee products, including honey, bee pollen, bee bread and royal jelly, totalling 16,194. Their number far outweighs that of other product types, as the next most common are poultry eggs, numbering 2923, and food, including ready meals (dishes), containing both foodstuffs of non-animal origin and products of animal origin, numbering 1307. Next in line are dairy products or colostrum-based products at 1141 and meat products at 1045. The following product types numbered fewer than 1000: raw milk or raw milk and colostrum 994, fresh beef, pork, mutton, goat or horse meat, or raw meat products or minced meat made from such meat 892, and ready-made meals (dishes) from products of animal origin 547. Fewer than 500 RHD operators indicated pastries, cakes and biscuits 478, raw cream 456, fresh poultry or lagomorph meat, or raw meat products or minced meat produced from such meat 442, live or killed fishery products that have not undergone any processes altering their original anatomical structure 367, and confectionery products 343. Ready-made non-meat meals (dishes) 274, pre-processed or processed fishery products 241 and egg products 126 are relatively unpopular choices. The following types of products are the least common within RHD activities: fresh meat of farmed game animals or raw meat products or minced meat produced from such meat 47, eggs from ratites 44 and live land snails of the species *Helix pomatia*, *Cornu aspersum aspersum*, *Cornu aspersum maxima*, *Helix lucorum* and of the family Achatinidae 16. It follows that, among the listed types of products subject to farm retail trade, unprocessed bee products were mentioned most frequently, whilst live land snails were mentioned least frequently.

However, what types of products are sold through direct sales?

The list of entities engaged in direct sales shows that the most common type of product is unprocessed bee products, totalling 12,615. The situation is similar to that in farm retail trade, where this type of product also dominated over the others. In second place, with a much smaller number compared to the first, were table eggs, totalling 1803. Here too, the situation is similar to that in farm retail trade. Next came fishery products with 1113. It is worth noting here that the number of fishery products sold through direct sales was three times higher than in the RHD sector. Next came game at 490, poultry at 369, and milk and cream at 177. In second-to-last place in the product type category for direct sales were lagomorphs at 61. By far the rarest product, which came last in direct sales, is live snails with 4 units. Here, the situation is similar to that in RHD activities, where live snails also came last in very small quantities. To summarise the frequency of occurrence of specific product types in direct sales, bee products can be identified as the most common, and live snails as the rarest; this conclusion is analogous to that for RHD activities, where the same products also appeared at both opposite ends of the frequency hierarchy.

5. Conclusions

To summarise the research conducted on the impact of legislation on local producers, short supply chains can be identified as a common component of all forms of additional activities carried out within the farm. Farm retail trade has the widest territorial reach, as it can be sold throughout the country. Direct sales are restricted to the voivodeship in which products of animal origin are produced, neighbouring voivodeships, and other voivodeships within Poland, provided that such sales take place at exhibitions, festivals, fairs or markets as part of the promotion of the products produced. Marginal, local and limited activities are carried out within a single voivodeship and in neighbouring counties and towns, whilst sales throughout the country are only possible at exhibitions, festivals, fairs and markets. The subject of RHD may include raw materials and processed products of plant origin, as well as raw materials and processed products of animal origin, and composite food consisting of products of both animal and non-animal origin. Direct sales apply exclusively to products of animal origin. In contrast, MOL's activities, unlike direct sales, include the processing and sale of food of animal origin.

As for the criminal provisions applicable to offences committed in the course of or in connection with business activities, these are regulated by the Act of 25 August 2006 on food and nutrition safety. These include the production or placing on the market of a foodstuff commonly consumed that is harmful to human health or life, punishable by a fine, restriction of liberty or imprisonment for up to two years. A fine may also be imposed for using a foodstuff in production or placing it on the market after the expiry date or the best-before date has passed.

Financial penalties are imposed for failure to comply with food labelling requirements, including those relating to presentation, advertising and promotion, or for carrying out food production or marketing activities without applying for entry in the register of establishments or for approval of the establishment and entry in the register of establishments, or in contravention of a decision refusing approval of the establishment.

The results of the studies cited in the article, which aimed to illustrate the scale of local producers' activities in Poland at national level and within individual voivodeships, as well as to identify the types and quantities of products involved in supplementary activities carried out on farms, are as follows. Nationwide, RHD activities dominate (21,111), followed by direct sales (16,225), whilst MOL activities are the least common (2,161). As regards individual voivodeships, farm retail trade is most prevalent in the Małopolskie Voivodeship (2270), whilst it is least common in the Opolskie Voivodeship (482). In turn, direct sales are conducted on the largest scale in the Wielkopolskie Voivodeship (3072), and on the smallest scale in the Świętokrzyskie Voivodeship (239). MOL activities are most popular in the Mazowieckie Voivodeship (314), and least popular in the Opolskie Voivodeship (60). As regards the types of products and their frequency of occurrence, in both farm retail trade and direct sales, bee products are the most common, whilst live snails are the least common. The dominance of bee products in sales stems, amongst other things, from the long tradition of beekeeping in Poland, the relatively straightforward production methods, and the seasonal nature of this production. By contrast, the sale of live snails is a new product category which is still in its infancy in Poland.

The issues analysed in this article are significant for efforts to shape the future of agriculture and the agri-food sector for future generations in Poland, as well as at European and global levels. In February 2025, the European Commission presented its Vision for Agriculture and Food, in which local food is a key element of future food systems. It emphasises the key role of farmers in our lives, and the proposed vision for the food system aims to create conditions that ensure the development of RHD, SB and MOL activities. Such measures can benefit society today, tomorrow and in 2040.

Acknowledgements

Funding: This work was supported by the 'Envisioning an integrated quadruple helix and RRI framework for food system transformation and regional innovation ecosystem enhancement' (VISION4FOOD) project - Funded by the European Union. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

References

1. Aguiar, L.D.C., DelGrossi, M.E., Thomé, K.M. (2018). Short food supply chain: characteristics of a family farm. *Rural Sociology*, No. 48, Iss. 5, e20170775, doi: <https://doi.org/10.1590/0103-8478cr20170775>
2. Balaweneder, K. (2022). *Rolniczy Handel Detaliczny w praktyce. Zapewnienie bezpieczeństwa żywności i higieny produktów pochodzenia zwierzęcego przetwarzanych w gospodarstwie*. Wojewódzki Inspektorat Weterynarii w Gdańsku, https://podr.pl/wp-content/uploads/2022/03/stare-pole-rdh_WIW-w-Gdansk.pdf, 19.02.2026.
3. Barska, A., Wojciechowska-Solis J.(2020). E-Consumers and Local Food Products: A perspective for Developing Online Shopping for Local Goods in Poland. *Sustainability*, No. 12, Iss. 12, 4958, doi: 10.3390/su12124958
4. Berti, G., Mulligan, C. (2016). Competitiveness of small farms and innovative food supply chains: the role of food hubs in creating sustainable regional and local food systems. *Sustainability*, No. 8, Iss. 7, 616, doi: <https://doi.org/10.3390/su8070616>
5. Borychowski, M., Stępień, S., Matuszczak, A., Sapa, A., Smędzik-Ambroży, K., Majchrzak, A. (2026). Are farms in short food supply chains more resilient to external shocks? The assessment of Polish farmer's perception. *Agricultural and Food Economics*, No. 14, Iss. 5, doi: <https://doi.org/10.1186/s40100-025-00447-6>
6. Ficek, W. (2023). *Produkcja i sprzedaż żywności pochodzenia zwierzęcego i żywności złożonej w ramach rolniczego handlu detalicznego w świetle obowiązujących regulacji prawnych*. Wojewódzki Inspektorat Weterynarii w Olsztynie, <https://wmodr.pl/files/Nk5LaF0ucpXov2Hsy3Izd3unDazMFFJhVYJrP8yq.pdf>, 20.02.2026.
7. GIW (March, 2026). *Główny Inspektorat Weterynarii*, <https://www.wetgiw.gov.pl/>, 25.03.2026.
8. Hodór, M. (2025). *Rolniczy handel detaliczny- wybrane zagadnienia*. Warmińsko-Mazurski Ośrodek Doradztwa Rolniczego z Siedzibą w Olsztynie, <https://wmodr.pl/files/DSTScDM1y5tAMAdtBa8FITkTwvT5g4qMxZexLeok.pdf>, 19.02.2026.
9. Jaska, E., Stolarska, P., Werenowska, A. (2020). Kompetencje komunikacyjne sprzedawcy-determinanta skutecznej sprzedaży. *Turystyka i Rozwój Regionalny*, No. 14, pp. 115-125, doi: <https://doi.org/10.22630/TIRR.2020.14.23>
10. Kapała, A. (2020). Legal status of direct sales of agricultural and food products in the legislation of selected EU Member States. *Przegląd Prawa Rolnego*, No. 1, Iss. 26, pp. 65-77, doi: <https://doi.org/10.14746/ppr.2020.26.1.4>
11. Kapała, A. (2025). The concept of food in European Union law in the context of short supply chains and local food systems. *Przegląd Prawa Rolnego*, No. 1, pp. 29-46, doi: <https://doi.org/10.14746/ppr.2024.36.1.2>

12. Kawecka, A., Gębarowski, M. (2015). Short food supply chains: Benefits for consumers and food producers. *Journal of Agribusiness and Rural Development*, No. 3, Iss. 37, pp. 459-466, doi: 10.17306/JARD.2015.48
13. Kokoszka, K., Pink, M. (2018). Instytucjonalne uwarunkowania sprzedaży bezpośredniej żywności w Polsce. *Wieś i Rolnictwo*, No. 3, Iss. 180, pp. 155-173, doi: <https://doi.org/10.53098/wir032018/07>
14. Mrożek, M. (2023). *Sprzedaż bezpośrednia, rolniczy handel detaliczny oraz MOL – podobieństwa i różnice*. Centrum Doradztwa Rolniczego w Brwinowie Oddział w Radomiu, <https://www.cdr.gov.pl/transfer-wiedzy/broszury-publicacje/4362-sprzedaz-bezposrednia-rolniczy-handel-detaliczny-oraz-mol-podobienstwa-i-roznice>, 28.02.2026.
15. Olkiewicz, M. (2025). Social responsibility of business in the shaping of food safety quality. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, no. 236, pp. 387-402. doi:10.29119/1641-3466.2025.236.24
16. Pawlewicz, A. (2025). Uwarunkowania rozwoju rolniczego handlu detalicznego jako formy przedsiębiorczości rolników. In: A. Będycka-Bórawska, I. Zuchowski (eds.), *Zarządzanie w sektorze agrobiznesu w Polsce* (pp. 179-205). Ostrołęka: Ostrołęckie Towarzystwo Naukowe im. Adama Chętnika.
17. Rozporządzenie (UE) Nr 178/2002 Parlamentu Europejskiego i Rady z dnia 28 stycznia 2002 r. ustanawiające ogólne zasady i wymagania prawa żywnościowego, powołujące Europejski Urząd ds. Bezpieczeństwa Żywności oraz ustanawiające procedury w zakresie bezpieczeństwa żywności, <https://www.gov.pl/attachment/ac2dc8c9-82ee-47d6-8d97-4a46f9fe0c23>, 18.02.2026.
18. Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 21 marca 2016 r. w sprawie szczegółowych warunków uznania działalności marginalnej, lokalnej i ograniczonej (Dz.U. 2016 poz. 451), <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20160000451>, 24.02.2026.
19. Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 30 września 2015 r. w sprawie wymagań weterynaryjnych przy produkcji produktów pochodzenia zwierzęcego przeznaczonych do sprzedaży bezpośredniej (Dz.U. 2015 poz. 1703), <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20150001703>, 23.02.2026.
20. Sieczko, A. (2019). Direct Sales of Products of Animal Origin in Poland. *Annals of the Polish Association of Agricultural and Agribusiness Economists*, Vol. XXI, No. 4, pp. 413-420, doi: <https://doi.org/10.5604/01.3001.0013.5354>
21. Sikorska, S. (2019). *Krótkie łańcuchy dostaw i RHD jako determinanty rozwoju lokalnego rolnictwa*. Podlaski Ośrodek Doradztwa Rolniczego w Szepietowie, <https://odr.pl/wp-content/uploads/2019/10/calosc.pdf>, 17.02.2026.
22. Sokołowski, Ł. (2025). Changes to the establishment register and food labelling- selected legal aspects. *Przegląd Prawa Rolnego*, No. 2, Iss. 37, pp. 217-232, doi: <https://doi.org/10.14746/ppr.2025.37.2.11>.

23. Srogosz, T. (2025). International legal aspects of illegal food trade. *Przegląd Prawa Rolnego*, No. 1, Iss. 36, pp. 189-205, doi: <https://doi.org/10.14746/ppr.2025.36.1.10>
24. Ustawa z dnia 25 sierpnia 2006 r. o bezpieczeństwie żywności i żywienia (Dz.U. 2006, nr 171, poz. 1225), <https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20061711225/U/D20061225Lj.pdf>, 16.02.2026.
25. Wolniak, R., Olkiewicz, M. (2018). The Relationship Between the Economic Development of the Country and Food Security. *Annual Set The Environment Protection*, vol. 20, pp. 804-818.

MODEL FOR ELIMINATING MOTION WASTE IN A MANUFACTURING COMPANY USING KPIS

Karolina CZERWIŃSKA¹, Andrzej PACANA^{2*}

¹ Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics; app@prz.edu.pl,
ORCID: 000-0003-2150-0963

² Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics;
k.czerwinska@prz.edu.pl, ORCID: 0000-0003-1121-6352

* Correspondence author

Purpose: The aim of this article was to develop and validate a model for identifying and eliminating motion waste in a selected production process using Lean Manufacturing principles. The paper also proposes a set of key performance indicators (KPIs) to support the measurement, monitoring, and continuous improvement of operational efficiency in a manufacturing environment.

Design/methodology/approach: The research objectives were achieved by analysing work organisation at two production workstations using a spaghetti diagram and a set of KPIs. The approach was based on the principles of Lean Manufacturing, focussing on identifying and eliminating motion waste.

Findings: A high level of motion waste was identified at both workstations. A lack of smooth workflow and excessive operator movement was observed. The proposed improvements will significantly reduce walking distances and improve work organisation.

Research limitations/implications: A limitation of the study is that it is restricted to two workstations within a single company, which may affect the generalisability of the results. Furthermore, the analysis focused primarily on motion waste, overlooking other forms of muda. Further research will aim to extend the analysis to other types of muda, other types of production processes, and workstations, and to conduct an in-depth analysis of the impact of the implemented improvements on work efficiency and ergonomics.

Practical implications: The results indicate that efficiency can be improved by reorganising the workstations. The use of KPIs plays a significant role, as they enable the ongoing measurement, monitoring, and evaluation of the effectiveness of the improvements being implemented. The proposed solutions, supported by the KPI system, can help reduce operating costs and increase production efficiency.

Social implications: Optimising traffic flow has a positive impact on ergonomics in the workplace, which can improve staff comfort and safety.

Originality/value: The value of this work lies in the integration of the spaghetti chart with KPIs in the analysis of waste in production. This study is aimed at Lean practitioners and production managers.

Keywords: Lean Manufacturing, workflow analysis, operational efficiency, process optimisation, production engineering.

Category of the paper: Research paper.

1. Introduction

The operation of modern manufacturing enterprises requires ensuring both high-quality products and efficient execution of processes under dynamically changing market conditions. At the same time, there is a growing need to reduce order fulfilment times (Muller et al., 2021). Consequently, the importance of proper work organisation and optimal use of available resources throughout the entire production process is increasing (Pietrewicz, 2019; Ostasz et al., 2020). This requires systematic improvement of operational procedures and a continuous search for opportunities to improve process efficiency. It requires monitoring and systematic improvement in operations execution, as well as the identification of opportunities to increase process efficiency (Ingaldi, Ulewicz, 2019; Czerwińska, Pacana, 2019).

One of the key factors reducing the operational efficiency of production processes is waste (Yamazaki et al., 2016). It is perceived as the unjustified use of resources or the performance of activities that do not contribute to the creation of added value. Despite its prevalence, waste is not always fully detected (Furugaki et al., 2007). This situation comes from the fact that it is sometimes treated as a natural part of a company's operations. As a result, some inefficiencies remain unidentified and are not subject to improvement measures. This limits the possibilities for systematic improvement of process efficiency and hinders their rational management (Szkudlarek, Zarzycka, 2011).

In the face of growing demands for operational efficiency, it is becoming increasingly important to identify activities that do not add value to production processes (Pacana, Czerwińska, 2019; Memari et al., 2024). The issue of waste in the industrial sector is the subject of management concepts focused on process improvement. Among these, the Lean Manufacturing approach stands out, which involves creating value from the customer's perspective while simultaneously eliminating activities that do not create this value (Melo et al., 2020; Zhang et al., 2018). In this context, the concept of 'muda' has been introduced, which refers to losses occurring within production processes (for example, inventory, overproduction, unnecessary processing, transport, waiting, defects, and inefficient movement) (Ulewicz, Kucęba, 2016; Ingaldi et al., 2018). Despite the widespread implementation of the Lean concept in manufacturing practice, its operationalisation is often difficult. This mainly concerns the identification and measurement of waste arising from operators' movements (Wolniak, 2013; Melo et al., 2020).

Motion waste refers to unnecessary movements by workers and inefficient manual tasks carried out within the workstation (Gajdzik, 2017). These activities do not add value to the product. Although individual movements may be considered insignificant, their accumulation results in measurable time losses. Unnecessary movements also lead to increased worker fatigue and reduced productivity (Mika, 2025). Motion waste is often the result of a failure to optimise the layout of workstations. Inadequate organisation of the workspace also plays a significant

role, as does the lack of standardisation of the operations carried out. In industrial practice, this means that a significant proportion of an employee's activities do not lead to value creation, but are a consequence of organisational imperfections in the process (Piekowski, 2021).

Effective identification of motion waste requires an analysis of the actual flow of the process. It is important to identify and analyse in detail the tasks performed by operators. This approach enables an understanding of the true scale of the problem. It also helps identify the areas with the greatest potential for improvement (Doliska-Dawson et al., 2015). In this regard, tools for visualising workflow play an important role, including spaghetti diagrams and process flow maps (Michłowicz, Witoniowski, 2011). These tools are used to map the actual routes of movement of workers and materials within the production environment (Bajic et al., 2024). Their use aids in identifying unnecessary movements, backtracking, excessively long transport routes, and intersecting paths. The use of this group of tools supports the analysis of workstation organisation and the assessment of their ergonomics, which is crucial in the context of reducing the number of inefficient movements (Pilch, Baron-Puda, 2024).

The analyses of motion waste are complemented by quantitative performance assessment methods, particularly key performance indicators (KPIs), which translate observed phenomena into measurable parameters (Czerwińska et al., 2025; Borsos et al., 2016). Their use facilitates an objective assessment of the scale of waste and enables a comparison of alternative ways of organising work both within the production line (for example, the layout of workstations, the organisation of production cells, the flow of materials), as well as at individual workstations (for example, the sequence of operations, the arrangement of tools and materials within the work area) (Sujová et al., 2023). Integration of qualitative and quantitative approaches within motion waste enables not only a more accurate diagnosis of the problem but also an assessment of the effectiveness of the improvement measures implemented (Pacana, Czerwińska, 2025; Pacana et al., 2022).

The literature indicates that research is being conducted into the reduction of the 3Ms (Muda, Mura, Muri) through improved layouts and ergonomic interventions in the Lean implementation process (Melo et al., 2020), as well as the integration of ergonomics into the Lean concepts of Muda, Muri, and Mura (Umar et al., 2024). Research is also being conducted that focusses on the identification and analysis of waste (muda) in the context of Lean Management and Industry 4.0, with a particular emphasis on its new form, 'digital waste'. Inefficient data use has been shown to constitute a significant source of loss, negatively impacting the efficiency of production processes and the quality of decision-making (Alieva, Haartman, 2020). Companies are implementing methods to eliminate motion muda, e.g., the Glenday sieve method to identify areas requiring value stream mapping and those of excessive complexity that do not create added value (Ulewicz et al., 2016). However, despite the interest in the issue of waste in the literature, there is a noticeable lack of structured approaches aimed at the comprehensive identification and elimination of motion waste.

There is a clear lack of integration between flow visualisation tools, such as spaghetti diagrams, and key performance indicator systems. This limits the ability to quantitatively assess the effects of improvement measures and makes it difficult to compare them.

Consequently, it is appropriate to focus research on developing an approach that enables the identification, analysis, and reduction of motion waste in production processes. In this regard, the aim of this article was to develop and validate a model for identifying and eliminating motion waste in a selected production process using Lean Manufacturing principles. The paper also proposes a set of key performance indicators (KPIs) to support the measurement, control, and continuous improvement of operational efficiency in a manufacturing environment.

2. Method

Modern industrial enterprises focus on eliminating waste that negatively impacts process efficiency. One of the key areas of waste in Lean Manufacturing is the inefficient movement of operators and materials.

The procedure adopted within the developed model comprises a structured set of actions that enable the identification of waste sources and their quantitative assessment using KPIs. The adopted approach is characterised by a systematic nature aimed at supporting improvement activities within the production environment. The following stages of the procedure have been identified:

1. Specifying the objective and scope of the study

The definition of the study objective should be based on a precise definition of the research problem within the analysed process, as well as on identifying the intended outcome of the analysis. Next, the scope of the study must be defined, that is, a selection must be made of the process, the production line or the workstations, taking into account criteria relevant to the objective of the study, such as the nature and complexity of the process, the level of losses, or the potential for improvement.

2. Characteristics of the process and production stations

The process description should include a description of its structure, including the definition of inputs, the sequence of technological operations, and the process outputs. At this stage, the workstations to be included in the analysis are also identified, and their role within the production flow is determined. The aim of this stage is to gain a full understanding of the system under analysis prior to performing the loss analysis.

3. Development of a Spaghetti Diagram

On the basis of observations of the actual process flow, a spaghetti diagram is created, illustrating the actual routes taken by operators and materials. The diagram helps identify inefficient movement patterns (ie, backtracking, loops, and intersecting flow paths).

4. Identification and classification of movements

The movements identified within the Spaghetti diagram are classified according to their impact on value creation. Three categories are distinguished: value-adding (VA) movements, necessary but non-value-adding (NNVA) movements, and non-value-adding (NVA) movements. This stage is carried out to identify activities that constitute waste in the process or the workstation under investigation.

5. Quantification of movement (KPI)

Identified movements within a process or workstation are converted into measurable performance indicators. Quantification allows for an objective assessment of the scale of waste and enables a comparison of different work organisation options, workstation layouts, and process flows before and after the implementation of improvement measures.

6. Identification of sources of MUDA in movement

This stage involves analysing the root causes of movement waste. On the basis of the results of the analysis, the root causes of the phenomenon under investigation are identified. These may result from a lack of standardisation of operations, suboptimal workstation layout, inadequate organisation of the workspace, or ergonomic mismatches.

7. Development of improvement measures

At this stage, measures are formulated aimed at reducing or eliminating the identified losses, i.e. movements that do not add value to the process.

8. Defining the future state

This stage involves designing the operation of the target process, taking into account the proposed improvement measures. Improvements focus on simplifying the workflow, reducing distances, and eliminating unnecessary movements of operators and materials.

This structured methodology organises the activities involved in analysing and reducing waste of movement within the production area. It enables a systematic progression from defining how the process is carried out, through identifying inefficiencies and quantifying them, to developing and implementing improvement measures.

3. Results

The study was carried out at a company specialising in the manufacture of external wooden doors, internal panel doors and hybrid twin doors. The company is located in south-eastern Poland. The study was carried out in the third quarter of 2025.

The main focus of the research was the analysis and evaluation of the stile door production process to identify areas requiring a reduction in motion waste. The scope of the research was limited to a single production line, characterised by the most complex manufacturing process within the company. The production process for frame doors consisted of 32 operations, which, due to the technological process, were divided into primary, auxiliary and support manufacturing processes. The breakdown of the processes is as follows:

- core manufacturing processes (directly forming the product): cutting MDF boards, producing door frame components, mouldings, trim strips, quarter-round mouldings, edge banding, milling holes for fittings and seals, fitting hardware, milling base stiles, double-sided edge banding, milling of crossbars, drilling of holes, tenoning, insertion of dowels, machining of vertical stiles, trimming, milling of the top rebate, application of Touchwood film, drilling of holes for dowels, hinges and locks, assembly, pressing, fitting of fittings;
- auxiliary processes (supporting production but not directly adding value): purchasing raw materials and semifinished products, collecting raw materials and semi-finished products from the warehouse, transport to the production department, selection of components (crossbars, vertical stiles, glass), arrangement on transport racks;
- support processes (inspection, logistics, dispatch preparation): in-process inspection, final inspection, quality control, packing, labelling, transport to the finished goods warehouse, storage.

During the study, activities were carried out to gather the data required to perform a comprehensive analysis of motion waste.

A spaghetti diagram was drawn based on observations of employees performing tasks at individual workstations on the door stile production line. The distances covered by the workers were marked and numbered. Due to the large number of workstations and industrial confidentiality, Figure 1 shows only a section of the stile door production line diagram, illustrating the spaghetti diagram for the operations carried out at workstations 5 and 6.

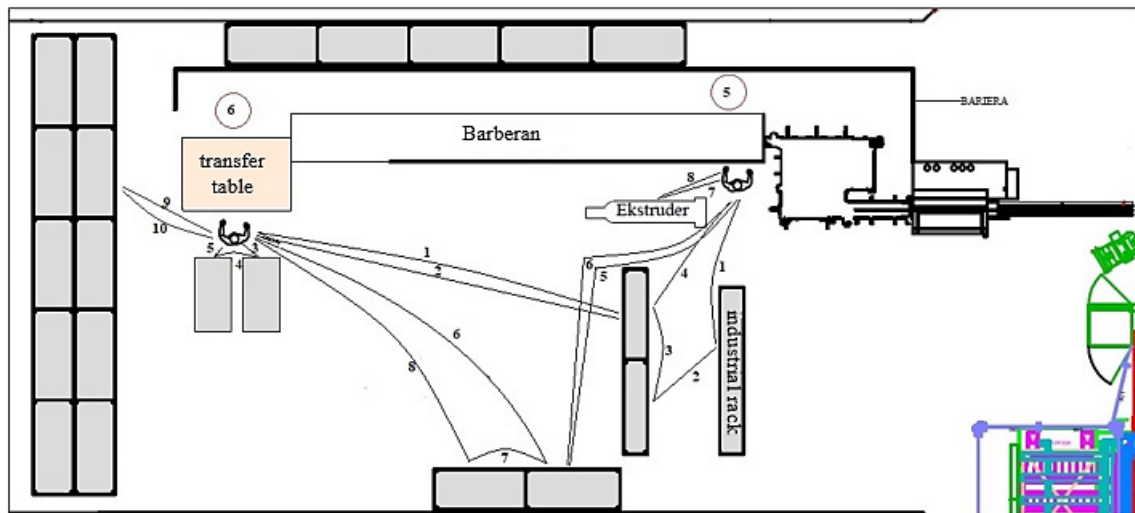


Figure 1. Spaghetti chart for the planing and edging station.

Source: own work.

Based on an analysis of the spaghetti diagram (Figure 1), a motion tracking table (Table 1) was compiled, taking into account the actual movement patterns of the operators and materials at workstations 5 and 6. The data collected form the basis for further analysis of motion waste and for determining process efficiency indicators.

Tabela 2.

Traffic monitoring – stations 5 and 6

Track number	Number of repetitions	Distance [m]	Time [s]	Added value	Movement category
Station 5					
1	1	5	6	No	NNVA
2		2.5	4	No	NNVA
3		2.5	4	No	NVA
4		4.6	6	No	NVA
5		9.0	10	No	NNVA
6		9.0	10	No	NVA
7		1.9	3	Yes	VA
8		1.9	3	Yes	VA
Station 6					
1	1	7.0	9	No	NNVA
2		7.0	9	No	NNVA
3		0.5	1	No	NVA
4		0.5	1	No	NVA
5		0.5	1	No	NVA
6		7.0	9	No	NNVA
7		1.5	3	No	NNVA
8		1.5	3	No	NNVA
9		3.25	5	No	NVA
10		3.25	5	No	NVA

The spaghetti diagram (Figure 1) and the motion log data for workstations 5 and 6 indicate a significant amount of motion waste, resulting mainly from the suboptimal layout of workstations and the repeated movement of operators and materials. Within workstation 5,

there is considerable variation in path lengths, indicating a lack of standardisation in the sequence of operations and a chaotic nature of the flow. In contrast, workstation 6 is characterised by repetitive and relatively long routes, which indicates systemic losses associated with transport. Within both workstations, there is a lack of smooth, linear material flow, which contributes to an increase in the proportion of activities that do not add value throughout the production cycle.

To monitor the efficiency of operations on the workstations, an appropriate set of KPIs relating to motion waste has been proposed. The KPIs and their characteristics are presented in Table 2.

Tabela 3.

Analysis of KPIs related to traffic wastage for workstations 5 and 6

KPI	Definition / method of measurement	Interpretation	Purpose	KPI achieved for the position:	
				5	6
Total length of the operator path [m]	Total distance covered by the operator during the cycle	A high value indicates an inefficient workstation layout and excessive movement	Minimisation	36.4	37.5
Number of movements per cycle [pcs/cycle]	Number of movements between workstations (e.g. rack–extruder–table)	A high number indicates a scattered workflow and a lack of continuity	Reducing the number of transitions	8	10
Proportion of movement time [%]	Time spent on movement and auxiliary actions / total time taken	A high proportion indicates a predominance of non-value-adding activities	< 20-30%	~38	~40
Unnecessary movement index [%]	Proportion of unnecessary movements (e.g., backtracking, reaching again)	It points to a lack of standardisation and poor tool placement	Elimination	~38	~25
Number of material contact points [pcs]	Number of times an item is picked up and put down during the task	The more contacts there are, the more time wasted and the risk of damage	Minimisation	5-6	4-5
Ergonomic index (forced movements) [forced movements/cycle]	Number of bends, turns, and reaches outside the comfort zone	High values indicate operator overload and a risk of errors	Limiting forced movements	~ 9	~ 8
Linear flow index [%]	Proportion of movements in a single direction (without turning back)	A low level indicates chaotic workflow and the need to reorganise the workstation	Maximisation (unidirectional flow)	~ 50	~ 55

Based on the KPI values obtained (Table 3), it can be seen that both workstations exhibit a high level of motion waste, as evidenced by the considerable length of the operator's walking routes and the high proportion of time spent moving. A significant proportion of the work carried out in the workstations under analysis does not add value; rather, it is the result of inefficient workstation organisation.

At workstation 5, the motion muda is chaotic and non-standard (high variability of routes and a high proportion of unnecessary movements). In contrast, at workstation 6, muda resulting from repetitive, long movement routes predominates, indicating a problem with the layout of workstations. At both workstations, there is a lack of smooth linear flow, as well as an excessive number of movements and staging areas, which exacerbates losses. The KPI values clearly indicate that motion muda is a key problem and requires the implementation of optimisation measures to shorten routes and streamline material flow.

To address the issue of wasted movement at workstation 5, the following measures were proposed:

- standardisation of the operator's workflow (defining the optimal sequence of tasks),
- implementation of the 5S principles (organisation and assigning designated locations for materials and tools),
- equipping the workstation with a multi-tiered rack for storing parts (strips, clamps),
- relocating the tool rack (ensuring that the rack is positioned as close as possible to and in a convenient location relative to the workstation),
- reducing the number of storage points (reducing the number of operator movements).

However, to eliminate wasted movement at the busiest workstation – workstation 6 – the following was proposed:

- bringing cooperating workstations closer together, including the shelving unit with spare parts (elimination of unnecessary transport distances),
- reducing intermediate transport (direct handover of components between operations).

Proposals for improvements to the workstations analysed (5 and 6) are presented in the form of visualisations of the solutions (Figure 2).

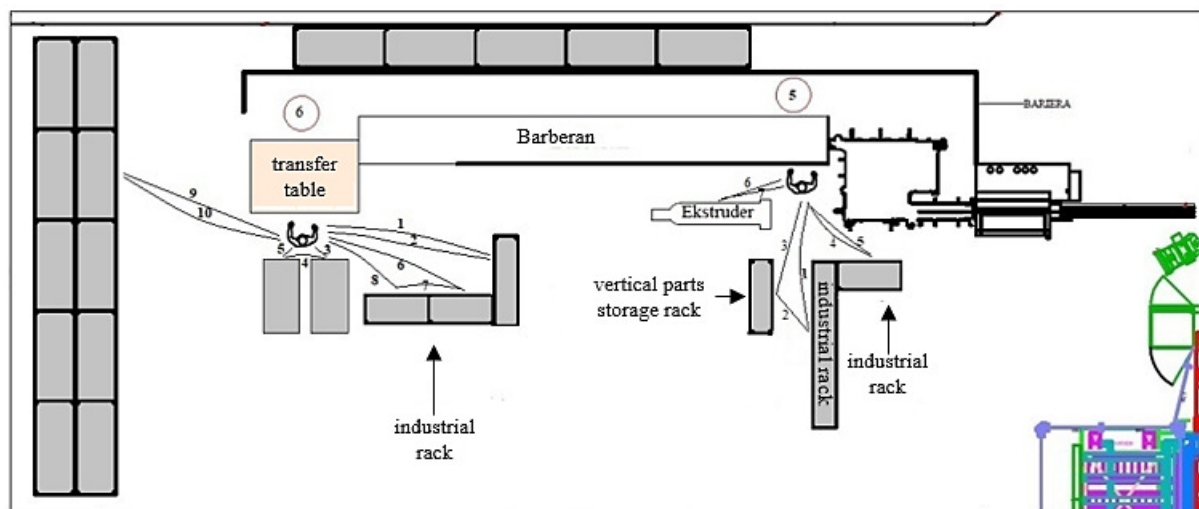


Figure 2. Spaghetti chart for the planing and edging station: suggestions for improvement.

Source: own work.

Following the relocation and refit of workstation 5 in accordance with the proposed layout (Figure 2), the length of the movement path will be reduced from 36.4 m to approximately 18 m. It is not possible to relocate the tool rack because the extruder is permanently fixed to the floor. In the case of workstation 6, following the implementation of the proposed improvements, involving the transfer of parts stock to the designated location, motion waste will be reduced to approximately 13 m. At the same time, the elimination of paths 9 and 10 (3.25 m), leading to storage racks, is not possible due to their permanent attachment to the floor.

The proposed improvement measures focus on two main issues: streamlining the workflow (station 5) and reducing transport distances (station 6). Their implementation leads to a significant reduction in motion waste and, additionally, to improved work ergonomics and increased efficiency of the production process.

4. Summary

Given the growing pressure to improve the efficiency of production processes, identifying and eliminating motion waste has become crucial. The aim of this article was to develop and validate a model for identifying and eliminating motion waste in a selected production process using Lean Manufacturing principles. The paper also proposes a set of key performance indicators (KPIs) to support the measurement, control, and continuous improvement of operational efficiency in a manufacturing environment.

As part of the research carried out, an analysis of work organisation was carried out at selected workstations using a spaghetti diagram, which helped identify the actual movement patterns of operators and materials within the workstation and to pinpoint areas generating motion waste. The analyses were supplemented by the use of appropriately selected KPIs. This approach enabled a quantitative assessment of the scale of the identified problem, movement inefficiency. Based on the results obtained, improvement measures were proposed for the analysed workstations. The proposed solutions focused on reducing distances, reducing unnecessary movements, and streamlining material flow. Their implementation confirms the practical usefulness of the Lean concept in the analysed process.

The model for eliminating motion waste presented in this study may be useful for Lean Manufacturing specialists, process engineers, and production managers responsible for organising efficient workstations and operational improvement. The research findings form the basis for further research aimed at extending the analysis to other types of muda, other types of production processes and workstations, and an in-depth analysis of the impact of the implemented improvements on work efficiency and ergonomics.

References

1. Alieva, J., von Haartman, R. (2020). Digital Muda - The new form of waste by Industry 4.0. *Operations and Supply Chain Management-An International Journal*, Vol. 13, Iss. 3, pp. 269-278. DOI: 10.31387/oscm0420268
2. Bajic, F., Habijan, M., Nenadic, K. (2024). A synthetic dataset of different chart types for advancements in chart identification and visualization. *Data in Brief*, Vol. 53. DOI: 10.1016/j.dib.2024.110233
3. Borsos, G., Lacob, CC., Calefariu, G. (2016). The use KPI's to determine the waste in production process. *20TH Innovative Manufacturing Engineering and Energy Conference (IMANEE 2016), IOP Conference Series-Materials Science and Engineering*, Vol. 161. DOI: 10.1088/1757-899X/161/1/012102
4. Czerwińska, K., Pacana, A. (2019). Analysis of the implementation of the identification system for directly marked parts-DataMatrix code. *Production Engineering Archives*, Vol. 23, Iss. 23. DOI: 10.30657/pea.2019.23.04
5. Czerwińska, K., Pacana, A., Ostasz, G. (2025). A model for sustainable quality control improvement in the foundry industry using key performance indicators. *Sustainability*, Vol. 17, Iss. 4. DOI: 10.3390/su17041418
6. Furugaki, K., Takagi, T., Sakata, A., Okayama, D. (2007). Innovation in software development process by introducing Toyota Production System. *Fujitsu Scientific & Technical Journal*, Vol. 43, Iss. 1, pp. 139-150.
7. Gajdzik, B. (2017). Użyteczność ocen pracowniczych w ograniczeniu marnotrawstwa w administracji publicznej. *Problemy Jakości*, no. 7, pp. 9-16.
8. Golińska-Dawson, P., Kosacka, M., Werner-Lewandowska K. (2015). Gdzie i jak usprawnić procesy? – Identyfikacja potencjałów optymalizacyjnych przez analizę marnotrawstw (muda) w perspektywie zrównoważonego wykorzystania zasobów. *Logistyka*, No. 2, pp. 167-178.
9. Ingaldi, M., Dziuba, S.T., Cierniak-Emerych, A. (2018). Analysis of problems during implementation of Lean Manufacturing elements. *MATEC Web of Conferences*, Vol. 183. DOI: 10.1051/mateconf/201818301004
10. Ingaldi, M., Ulewicz, R. (2019). Problems with the implementation of Industry 4.0 in enterprises from the SME sector. *Sustainability*, Vol. 12, Iss. 1. DOI: 10.3390/su12010217
11. Melo, T., Alves, AC., Lopes, I., Colim, A. (2020). Reducing 3M by improved layouts and ergonomic intervention in a lean journey in a cork company. *Occupational and Environmental Safety and Health II*, Vol. 277, pp. 537-545. DOI: 10.1007/978-3-030-41486-3_58

12. Memari, A., Panjehfouladgaran, H.R., Rahim, A.A., Ahmad, R. (2022). The impact of lean production on operational performance: a case study. *Asia-Pacific Journal of Business Administration*, Vol. 16, Iss. 3, pp. 530-552. DOI: 10.1108/APJBA-04-2022-0190
13. Michlowicz, E., Świątoniowski, A. (2011). Doskonalenie ciągłości przepływu metodą mapowania VSM. *Automatyka*, Tom 15, Zeszyt 2.
14. Mika, M. (2025). Odchudzanie procesów w przedsiębiorstwie poprzez lean management. *Management & Quality [Zarządzanie i Jakość]*, Vol. 7, Iss. 3, p. 160.
15. Muller, J.M., Buliga, O., Voigt, K.I. (2021). The role of absorptive capacity and innovation strategy in the design of industry 4.0 business Models-A comparison between SMEs and large enterprises. *European Management Journal*, Vol. 39, Iss. 3, pp. 333-343. DOI: 10.1016/j.emj.2020.01.002
16. Ostasz, G., Czerwinska, K., Pacana, A. (2020). Quality management of aluminum pistons with the use of quality control points. *Management Systems In Production Engineering*. Vol. 28, Iss. 1, pp. 29-33. DOI: 10.2478/mspe-2020-0005
17. Pacana, A., Czerwińska, K. (2019). Model of diagnosing and searching for incompatibilities in aluminium castings. *Materials*. Vol. 14, Iss. 21. DOI: 10.3390/ma14216497
18. Pacana, A., Czerwińska, K. (2025). Validation of the use of KPIs to measure information security management system performance in manufacturing companies. *Production Engineering Archives*. Vol. 31, Iss. 2, pp. 266-275. DOI: 10.30657/pea.2025.31.26
19. Pacana, A., Czerwińska, K., Grebski, M.E. (2022). Analysis of development processes effectiveness using KPI. *Zeszyty Naukowe Organizacja i Zarządzanie*, Vol. 157, Politechnika Śląska, pp. 387-396.
20. Pieńkowski, M. (2021). *Kompleksowy model dojrzałości Lean Manufacturing*. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, p. 28.
21. Pietrewicz, L. (2019). Technology, Business Models and Competitive Advantage in the Age of Industry 4.0. *Problemy Zarządzania [Management Issues]*, Vol. 17, Iss. 2, pp. 32-53. DOI: 10.7172/1644-9584.82.2
22. Pilch, K., Baron-Puda, M. (2024). Wybrane metody identyfikacji i ograniczania marnotrawstwa w procesie produkcyjnym. *Technologie, procesy i systemy produkcyjne Technologies, processes and systems of manufacturing Engineer of XXI Century'2024*, pp. 85-90. DOI: 10.53052/9788367652278.08
23. Sujova, E., Vyslouzilova, D., Koleda, P., Bajdzik, B. (2023). Research on the evaluation of the efficiency of production processes through the implementation of key performance indicators. *Management Systems in Production Engineering*, Vol. 31, Iss. 4, pp. 404-410. DOI: 10.2478/mspe-2023-0045
24. Szkudlarek, B., Zarzycka E. (2011). Identyfikacja i pomiar marnotrawstwa jako etap wstępny procesu wdrażania szczupłego zarządzania. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, No. 182, pp. 504-513.

25. Ulewicz, R., Jalonek, D., Mazur, M. (2016). Implementation of logic flow in planning and production control. *Management and Production Engineering Review*, Vol. 7, Iss. 1, pp. 89-94. DOI: 10.1515/MPER-2016-0010
26. Ulewicz, R., Kucęba, R. (2016). Identification of problems of implementation of Lean concept in the SME sector. *Engineering Management in Production and Services*, Vol. 8, Iss. 1, pp. 19-25. DOI: 10.1515/emj-2016-0002
27. Umar, R.Z.R., Tiong, J.Y., Ahmad, N., Dahalan, J. (2024). Development of framework integrating ergonomics in Lean's Muda, Muri, and Mura concepts. *Production Planning & Control*, Vol. 35, Iss. 12, pp. 1466-1474. DOI: 10.1080/09537287.2023.2189640
28. Wolniak, R. (2013). Metody i narzędzia lean production i ich rola w kształtowaniu innowacji w przemyśle. In: R. Knosala (ed.), *Innowacje w zarządzaniu i inżynierii produkcji* (pp. 524-533). Opole: Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, http://www.ptzp.org.pl/files/konferencje/kzz/arttyk_pdf_2013/p049.pdf
29. Yamazaki, Y., Takata, S., Onari, H., Kojima, F., Kato, S. (2016). Lean automation system responding to the changing market. *Factories of the Future in the Digital Environment*, Vol. 57, pp. 201-206. DOI: 10.1016/j.procir.2016.11.035
30. Zhang, L.D., Narkhede, B.E., Chaple, A.P. (2018). Evaluating lean manufacturing barriers: an interpretive process. *Journal of Manufacturing Technology Management*, Vol. 28, Iss. 8, pp. 1086-114. DOI: 10.1108/JMTM-04-2017-0071

ORGANIZATIONAL CAPABILITIES IN THE FIELD OF CYBERSECURITY FOR IMPORTANT ENTITIES UNDER THE NIS2 DIRECTIVE. AN ANALYSIS OF SELECTED MANAGEMENT CHALLENGES. THE POLISH PERSPECTIVE

Lukasz DOMŻAŁ-DRZEWICKI

Lublin University of Technology; d639@pollub.edu.pl, ORCID: 0009-0003-7314-8348

Purpose: The purpose of this paper is to identify and analyse key management challenges related to building organizational capabilities in important entities in Poland, which are subject to the NIS2 Directive and its national implementation.

Design/methodology/approach: The research is based on qualitative analysis of regulatory documents and industry literature. The study uses desk research of EU and Polish legal acts, complemented by a review of standards and best practices and recent academic publications on cybersecurity management and organizational resilience. On this basis, a conceptual framework of three challenge groups is developed: identification, organizational and operational, with a focus on the Polish interpretation of NIS2 for important entities.

Findings: The analysis shows that effective NIS2 implementation requires capabilities in three interrelated dimensions. Identification challenges concern status assessment, sectoral qualification and designation of systems covered by ISMS. Organizational challenges involve responsibility models, competence structures, and governance over internal and outsourced cybersecurity, including ICT supply chains. Operational challenges include monitoring, incident reporting, documentation and cooperation with authorities under time pressure, affecting continuity and costs.

Research limitations/implications: The paper is conceptual and based on secondary sources; it does not include empirical verification at the level of individual organizations. Future research should involve empirical studies of important entities in different sectors together with quantitative assessment of the impact of NIS2 on organizational maturity and costs.

Practical implications: The results provide a structured lens for managers and policymakers to plan NIS2 implementation as a long-term management process rather than a one-off compliance project.

Social implications: By strengthening organizational capabilities of important entities in defined sectors, the implementation of NIS2 contributes to higher digital resilience of the state and economy. This may translate into improved continuity of essential services, greater protection of citizens and increased trust in public and private institutions.

Originality/value: The paper offers a management-oriented interpretation of NIS2 and national act focused specifically on important entities. It proposes a clear, three-part framework of challenges that links legal requirements with organizational practice, providing added value for both researchers and practitioners in cybersecurity governance.

Keywords: NIS2, important entity, risk management, uKSC, organizational capabilities.

Category of the paper: Research paper.

1. Introduction

The current development momentum of both the economy and public administration in Poland and Europe is driving an increasing dependence on complex, interdependent information and communication technology (ICT) systems. This reality objectively improves quality of life, offering hope for multi-domain economic development and the elimination of various forms of social and civilizational exclusion. At the same time, however, it multiplies new and deepens existing problems associated with the consequences of cybersecurity incidents, ranging from disruptions to organizational continuity and supply chains, through threats to citizen and national security, to the broader destabilization of the economic system. One measure of the scale of this phenomenon is the fact that in 2025 alone, Polish CSIRT teams recorded 272,941 cybersecurity incident reports. The intensity and professionalization of cybersecurity events is systematically increasing. Their perpetrators include both organized criminal groups and state-sponsored actors, increasingly targeting critical infrastructure and supply chains. Industry 5.0, along with the current expansion of artificial intelligence-based solutions, means that cybersecurity management is ceasing to be an exclusively technical domain and is becoming a pillar of organizational resilience and a foundation of stakeholder trust (Dacko-Pikiewicz, Szczepańska-Woszczyńska, Lis, 2025; ENISA, 2023; Hubbard, Seiersen, 2024; Ministerstwo Cyfryzacji 2026; NIST, 2018).

The European Union's (EU) response to the growing digital risks is the NIS2 Directive (Directive (EU) 2022/2555), establishing a legal framework for key and important entities operating in 18 sectors designated in Annexes I and II of the aforementioned directive, extending the scope of obligations in risk management, incident reporting, and supervision. In Poland, the transposition of the NIS2 Directive is ensured by the Act of 23 January 2026 amending the Act on the National Cybersecurity System and certain other acts (uKSC), amending the parent act of 5 July 2018. The amendment introduces principles and obligations concerning the organization of the national cybersecurity system, defining requirements for important entities in the areas of risk management, incident reporting, and maintaining digital resilience (UE L 333, 2022; Dz.U.2026 poz. 252; Ministerstwo Cyfryzacji, 2026).

NIS2 and the uKSC operate within the broader EU regulatory ecosystem, encompassing among other GDPR, DORA, and the AI Act, which together create a multi-layered framework of accountability for digital security. DORA (Regulation (EU) 2022/2554), as a sectoral regulation for the financial sector, consolidates requirements for ICT risk management, incident reporting, resilience testing, and ICT provider oversight, assigning full responsibility for ICT risk to the management body, thereby reinforcing ongoing board engagement and investment levels, a logic consistent with the managerial accountability regime under NIS2. The AI Act (Regulation (EU) 2024/1689) introduces a risk-based AI governance system, prohibiting unacceptable practices, defining requirements for high-risk systems, and establishing

transparency obligations; for key and important entities, this requires ensuring the cybersecurity and resilience of AI systems throughout their lifecycle and continuous improvement of security processes by operators and providers, increasing managerial accountability across the organizational ecosystem (Rozporządzenie (UE) 2024/1689; Rozporządzenie (UE) 2022/2554; Dyrektywa (UE) 2022/2555).

Organizational cybersecurity management has long rested on widely accepted frameworks. Including ISO/IEC 27001, NIST CSF, OWASP, and MITRE ATT&CK, to which NIS2 refers. The Directive is therefore primarily an enforcement mechanism rather than a creative one: codifying in EU law what the cybersecurity community has developed and recommended for years, while bringing within its scope numerous new important entities that have often for economic, cultural, or organizational reasons limited their investments in security, resilience, supply chain security, and employee education. It imposes on them the obligation of genuine, documented implementation of these practices under penalty of sanctions. The ENISA NIS Investments 2023 report indicates that the main barriers to implementing cybersecurity best practices in entities include, among others, competence shortages, limited leadership, and weak security culture. Manifested in difficulties recruiting qualified specialists, insufficient budgets, and low levels of participation in information-sharing initiatives. Additionally, limited management engagement hinders the implementation of necessary practices and procedures. In response to these challenges, the NIS2 Directive introduces personal liability for managers, mandatory board training, and a requirement to document security plans and procedures, in order to genuinely raise the level of competence and engagement throughout the organization (Dz.U. 2026, poz. 252; ENISA, 2023; Ministerstwo Cyfryzacji, 2026; NIST, 2018; OWASP, 2021).

The aim of this article is to identify selected management challenges associated with building organizational capabilities in important entities in Poland falling within the scope of the NIS2 Directive and the uKSC. This leads to the following research question: what key management challenges do important entities face when building organizational capabilities in the field of cybersecurity in accordance with the requirements of the NIS2 Directive and the Polish transposition?

The study adopts a qualitative, conceptual research design based on regulatory desk research and a literature review, described in Section 2.

2. Research Methodology

This paper adopts a qualitative, conceptual research design based on secondary data analysis. The study does not include empirical verification at the level of individual organizations. Instead, it draws on regulatory documents, institutional guidance, normative

frameworks, and academic literature to develop a structured analytical framework of management challenges. Source selection was guided by four criteria:

1. the regulatory relevance of sources directly shaping cybersecurity obligations for important entities under EU and Polish law, including the NIS2 Directive, the uKSC amendment, GDPR, DORA, the AI Act, and the Cyber Resilience Act,
2. the institutional authority of guidance and reports published by recognized bodies, such as the Ministry of Digitization, ENISA, NIST, and OWASP,
3. the actuality of publications published or updated following the adoption of the NIS2 Directive and its transposition into Polish law in 2026, and
4. the topical relevance of academic literature on cybersecurity management, organizational resilience, and governance, with particular attention to issues related to NIS2 implementation.

The analytical procedure followed three sequential steps. First, applicable legal acts and the Ministry of Digitization's Q&A implementation guide were analyzed to identify the core obligations imposed on important entities. Second, relevant normative frameworks (NIST CSF, OWASP) and academic publications were reviewed to contextualize these obligations within broader cybersecurity governance concepts. Third, the findings were synthesized into a three-dimensional framework of challenges: identification, organizational, and operational. This structure reflects the sequential logic of NIS2 implementation. From determining regulatory status, through building internal capabilities, to maintaining ongoing compliance, and maps directly onto the main obligation clusters defined in the uKSC amendment. The framework was validated through triangulation of regulatory sources, institutional guidance, and academic literature to ensure internal consistency and completeness. The analyzed sources were coded according to clusters of responsibilities derived from NIS2/uKSC: status identification, management and accountability, competencies and outsourcing, risk management, incident reporting, monitoring, documentation, and cooperation with authorities. These codes were then grouped into three overarching analytical categories: identification, organizational and operational challenges. Since the study is conceptual in nature and relies on secondary sources, coding was used as a technique for analytical structuring rather than as a procedure for quantitative content analysis (Dyrektywa (UE) 2022/2555; Dz.U. 2026, poz. 252; ENISA, 2023; NIST, 2018).

3. NIS2 and the Polish transposition: selected scope, important entities, and the logic of obligations

The NIS2 Directive and its Polish implementation assume that cybersecurity is not merely a technological issue, but rather the foundation for ensuring the uninterrupted provision of services of social and economic significance. The recitals to the Directive state that the growing number, scale, sophistication, and impact of incidents necessitate the creation of coordinated regulatory frameworks and the definition of a catalogue of sectors and activities subject to cybersecurity and general resilience obligations. These regulations focus not so much on specifying particular protective tools as on the organization's capacity for comprehensive risk management, incident response, and the maintenance of high operational resilience. In the Polish transposition, this logic is reflected in the departure from the earlier model based on operators of essential services and its replacement with the categories of key entities and important entities. The amendment to the Act on the National Cybersecurity System explicitly states that it transposes the NIS2 Directive into domestic law (Dyrektywa (UE) 2022/2555; Dz.U. 2026, poz. 252).

Within the scope of this article, particular attention is devoted to the group of entities referred to as important entities. In accordance with Article 5(2) of the uKSC amendment, both general qualification criteria and exceptions are defined. In practice, this category refers primarily to entities operating in the sectors specified in Annex 2 to the Act, including: postal services, nuclear energy investments, waste management, production, manufacture and distribution of chemicals, production, processing and distribution of food, manufacturing, digital service providers, scientific research, and public entities. This arrangement confirms that the status of an important entity results from a combination of statutory criteria and assignment to sectors deemed significant from the perspective of the digital resilience of the state and economy. The presented arrangement indicates that obtaining the status of an important entity is not dependent solely on the size of the organization, but results from a combination of criteria concerning size, sector membership, and for certain cases a specific designation indicated in the Act (Dyrektywa (UE) 2022/2555; Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The manner of identifying this category of entities is of significant importance. The Polish model is based primarily on self-identification that is, the obligation of an organization to independently establish its own size, scope of activities, and to relate these elements to the uKSC and its annexes. According to a document published by the Ministry of Digitization, administrative decisions are applied exceptionally rather than as a rule. This concerns special cases where the authority responsible for cybersecurity may decide to bring within the scope of the Act an entity that does not meet the typical criteria but is significant from the perspective of state security, continuity of services, or existing risk (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

From the perspective of building systemic resilience, the substantive obligations of key and important entities are in principle identical. The difference concerns primarily the model of supervision and audit. The Ministry of Digitization document clearly indicates that supervision of key entities is of an *ex ante* nature, while supervision of important entities is *ex post*. Key entities conduct audits every 3 years and at the request of the competent cybersecurity authority, whereas important entities conduct audits exclusively at the request of that authority. The difference between the two categories does not result from different security requirements but from a different degree of supervision and enforcement of those obligations (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The fundamental idea underlying the obligations arising from the regulations is to ensure a uniform minimum level of organizational resilience for all entities covered by the Act. The most important is actual obligation to create and maintain an information security management system around the information systems used by entities. In accordance with Article 8 of the Act, such system must enable:

- regular risk assessment and effective risk management,
- implementation of adequate and proportionate technical and organizational measures, taking into account current knowledge, implementation costs, the entity's size, risk exposure, and the potential impact on services, systems, processes, and data integrity.

The core of this standard is therefore not merely the possession of formal documentation, but the genuine and practical implementation of cybersecurity measures based on knowledge of assets, risks, and threats, as well as the actual application of procedures in day-to-day operations. As emphasized in the Ministry of Digitization's Q&A guide, the key obligation of both key and important entities is to implement an ISMS encompassing regular risk assessment and decision-making regarding risk treatment, with technical and organizational measures tailored to the specific characteristics of the organization, including its size, the nature of the services provided, financial capacity, current technical knowledge, and current threats. Rather than imposing a universal set of safeguards, the regulations require solutions adapted to the individual needs of the specific entity. In this sense, the obligations of important entities are explicitly managerial rather than merely technical, since they require not only the implementation of security measures, but above all the building of organizational capability to maintain cybersecurity over time. This includes determining the entity's status, registration in the relevant register, connection to the S46 system, and implementation of the ISMS, while the Act also permits the use of external resources without relieving the organization of responsibility. Cybersecurity tasks may therefore be performed by internal structures or outsourced to external service providers, provided that effective execution and oversight are ensured. What remains essential is that the entity retains the capacity to coordinate, supervise, and hold accountable all actions taken in the cybersecurity domain, rather than merely purchasing security services. The detailed implications of this arrangement for organisational capability are discussed in Section 5 (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The conclusion to this section should be that an important entity must genuinely demonstrate the capacity to achieve and maintain a defined level of managerial and operational maturity in the area of cybersecurity. Merely fulfilling formal or legal requirements is not sufficient. What becomes essential is the actual implementation of effective risk management mechanisms, continuous improvement of procedures, and the building of organizational resilience to incidents. The status of an important entity thus entails the obligation to actively shape a security culture and to ensure the lasting, practical application of cybersecurity standards, which constitutes the essence of the logic of the NIS2 system and its Polish transposition.

4. State of research and research gap

Existing publications focus on the legal aspects of the NIS2 Directive and the placement of the new regulations within the EU legal system. These analyses organize the legal context, emphasizing the expansion of sectors, increased obligations in risk management, board accountability, and enforcement; however, they address to a limited degree the practical building of implementation capability in organizations (Teichmann, 2025; Vandezande, 2024).

A second group of publications focuses on practical aspects of NIS2 implementation and compliance obstacles, particularly identifying barriers such as resource constraints, competence limitations, and organizational specificity. For example, Mentzelou et al. (2025) present an analytical model of implementation difficulties without, however, addressing the specifics of national conditions or the differences between categories of entities subject to the Directive (Mentzelou et al. 2025).

A third area of research concerns cybersecurity governance, managerial accountability, and organizational resilience. It is emphasized that cybersecurity is becoming part of the organization's management system and managerial accountability, highlighting the importance of adaptation, inter-departmental collaboration, and the integration of technological and managerial resources. However, these analyses rarely refer directly to the requirements of the NIS2 Directive or the specifics of important entities (Galle, Vletter-van Dort, 2025; Dupont et al., 2023).

Institutional materials, such as the ENISA NIS2 Technical Implementation Guidance, have practical significance for implementing risk management, of a technical-operational nature, yet they do not explain the organizational costs, conditions, or barriers to implementation across different types of organizations (ENISA, 2025).

The Polish research context is less well explored. Legal and expert publications on cybersecurity for example, "Introduction to IT Security" (Securitum) is an expert publication of a technical and practical nature. Of key importance is the Ministry of Digitization document,

which explains implementation aspects and interprets the regulations in the context of the Polish transposition of NIS2 (Sajdak, 2023; Kowalski, 2023; Ministry of Digitization, 2026).

Based on the above considerations, a research gap emerges. First, most available publications on NIS2 focus on legal and compliance aspects, while organizational and managerial issues are relatively poorly described. Second, although analyses of implementation barriers, cybersecurity governance, and cyber resilience are appearing, they do not always refer directly to important entities, even though these are subject to similar requirements as key entities while often having limited resources, less formalized structures, and a smaller competence base. Third, there is a lack of detailed studies focusing on the Polish NIS2 implementation process following the amendments to the Act on the National Cybersecurity System. It therefore seems justified to shift the research focus from analysis of the regulations to examination of the most important challenges related to identification, organization, and operations, which are of key importance for the effective implementation of NIS2 by important entities.

5. Results: key challenges. the perspective of important entities

From the perspective of important entities, the implementation of NIS2 should be viewed not so much as a one-time adjustment to legal requirements, but as a new, continuous process one requiring a lasting linkage between regulatory obligations and the organization's actual mode of operation. In the Polish transposition, of particular significance is the fact that entry into the statutory regime is based on the entity's own self-identification, requiring it to relate its activities to Article 5 of the uKSC and to Annex 1 and Annex 2. Already at this stage, the organization must combine an analysis of requirements with detailed knowledge of its own organizational structure, business processes, resources, and ICT systems.

Further obligations arising from the Act extend beyond purely formal matters. According to the explanatory materials, adaptation to the requirements of the Act requires simultaneously: determining the entity's status, organizing internal accountability structures, implementing an information security management system, developing appropriate procedures, registering in the S46 system, and ensuring readiness to respond to incidents and cooperate with other institutions. For this reason, the key challenges for important entities should be analyzed from three complementary perspectives: identification, organizational, and operational. Such a division allows one to capture not merely the catalogue of obligations, but the conditions for their fulfillment within the organization (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026; UE L 333, 2022).

5.1. Identification Challenges

The first identified group of challenges faced by organizations are identification challenges. The organization must pose the following questions and attempt to find answers to them:

- is the Organization subject to the regime of the Act on the National Cybersecurity System? If so,
 - what extent do the provisions apply to it?
 - what specific implementation actions need to be planned?
 - what deadlines must be reached in the process?

The Polish implementation model is based on an active self-identification process on the organization side. As indicated in the Ministry of Digitization's materials, an entrepreneur who does not know whether they are subject to the national cybersecurity system should first establish their size, the types of activities carried out, the number of personnel employed, and the formal legal basis for conducting the activity, and then relate these findings to Article 5 of the Act and to the activities specified in Annex 1 and Annex 2 (Ministerstwo Cyfryzacji, 2026).

In this context, identification extends beyond a purely formal dimension and requires a close linking of legal criteria with the real structure and activities of the organization. According to the Ministry of Digitization document, the basis for assessment is not only registration data, but also financial statements, the number of employees, properly declared PKD (Polish Classification of Activities) codes, and official documents such as concessions, permits, or entries in registers of regulated activities. Additional complexity is introduced by the need to resolve whether, when determining the size of an enterprise, partner or affiliated entities should be taken into account. The explanatory materials emphasize that this is not merely an accounting matter, since it is also relevant whether those entities provide the same service and whether their information systems are functionally linked. Thus, the identification challenge consists not only in answering the question "am I subject to the Act?" but also "on what basis?", "to what extent?", and "taking into account what organizational relationships?" (Ministerstwo Cyfryzacji, 2026).

It is worth raising the open question here as to whether such a level of complexity in the identification process does not pose too great an organizational challenge for all organizations, especially the smaller ones or those with limited resources or competences?

A key aspect of the analyzed implementation phase is the precise determination of the substantive scope of organizational obligations, which includes the identification of services and information systems requiring coverage by further implementation procedures.

The Q&A document indicates that, following the phase of qualification of the entity's legal status, the legislator assumes the completion of another identification task: the designation of those information systems in which it will be necessary to implement an information security management system. It follows that the identification process is not limited to the legal

qualification of the enterprise but evolves toward functional qualification within which the organization is obliged to delineate the resources, processes, and systems relevant to the provision of the regulated services. This approach is consistent with the NIST concept, which treats cybersecurity as a process of shaping an organizational profile based on business requirements, acceptable risk levels, available resources, and the specifics of the organizational environment. In this context, identification constitutes a fundamental precondition for designing protective actions, being not only a preliminary legal act, but also a key element of the organization's strategic management process (Ministerstwo Cyfryzacji, 2026; NIST, 2018; NIST, 2026).

From the perspective of entities, the implementation deadlines are also of significant importance, they force the translation of identification findings into specific actions within a defined timeframe. In accordance with the Act, an application for entry in the register of key and important entities must be submitted within 6 months of the conditions for recognition as such an entity being met. The Ministry of Digitization document clarifies that other significant deadlines include:

- connection to the S46 system, and
- implementation of ISMS obligations within 12 months of the conditions for recognition as a key or important entity being met.

In this sense, identification challenges encompass not only the recognition of status itself but also the determination of the sequence of actions that must be planned on the organization's part. The S46 system itself does not yet constitute the essence of the identification challenges but is one of the first visible consequences of identification, a point of transition between the qualification phase and the organizational-operational phase (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

Challenges related to identification should be treated far more broadly than as a simple assignment of an entity to a given category. In the case of important entities, this process consists primarily in determining the scope of obligations, which requires establishing: regulatory status, sector of activity, type of activities carried out, company size, scope of services provided, and information systems, as well as indicating the key deadlines and actions initiating the next steps. Correctly completing this phase then enables the undertaking of organizational challenges, such as the allocation of responsibility, provision of appropriate resources, and creation of a compliance model, as well as operational challenges related to the day-to-day fulfillment of security requirements. Identification should therefore be regarded as a fundamental implementation phase, conditioning the course of the entire process, any errors made at this stage may negatively affect subsequent actions (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

Evidently, some tasks such as determining the type of activity carried out or the size of the company, can objectively be considered uncomplicated and requiring primarily formal analysis. However, other aspects, including establishing the organizational context or other aspects

related to the preparation of the ISMS, may pose a serious organizational challenge for entities, especially those with a complex structure or limited resources.

5.2. Organizational Challenges

The second category comprises organizational challenges, consisting in the need to create a model of organizational functioning that enables the genuine, continuous fulfillment of obligations, rather than merely their formal declaration. For at least some important entities, these challenges mean not so much the modification of already existing and mature cybersecurity structures as their construction from scratch, rationalization, or formal implementation. In this context, as mentioned above, NIS2 and the uKSC do not always introduce revolutionary changes in terms of the security standards themselves; however, they may constitute a significant turning point at the organizational level, especially for those organizations that have not previously regarded cybersecurity as a distinct managerial and operational function (Ministerstwo Cyfryzacji, 2026; Mentzelou et al., 2025).

The fundamental challenge stems from the very nature of the obligations defined by the Act. The provisions require an important entity to implement an information security management system in those information systems that have an impact on service delivery. Meaning the system must cover, among others: risk assessment, human resource protection, security and continuity assurance within the supply chain, constant monitoring, analysis of the effectiveness of applied technical and organizational solutions, and employee education. The legislator thus expects not the implementation of a single tool or procedure, but a holistic, durable organizational solution integrating managerial, technical, personnel, and relational aspects. In practice, the first organizational step is defining the internal accountability structure. The Ministry of Digitization materials indicate that the head of the entity not only approves the solutions developed, but is also responsible for the preparation, implementation, application, review, and control of the ISMS, plans an appropriate budget, delegates tasks and supervises their implementation, and promotes employee awareness of cybersecurity obligations. As a result, cybersecurity becomes embedded in the management structure of the organization as a whole. The literature emphasizes that proper cybersecurity management requires:

- clear division of responsibility,
- active communication within the organization,
- development of management competences, and
- integration of cybersecurity issues into the general enterprise management system (Dz.U. 2026, poz. 252; Galle, Vletter-van Dort, 2025; Ministerstwo Cyfryzacji, 2026).

One of the key organizational challenges is developing or acquiring appropriate executive competences. According to the Ministry of Digitization guidelines, cybersecurity tasks may be carried out in two ways:

- using internal teams, or
- entrusting some obligations to external service providers.

Outsourcing in the area of cybersecurity may cover only specific tasks, and the choice of the appropriate solution must be carefully considered to ensure the effective fulfillment of obligations. The regulations do not require the full transfer of security functions to internal structures, while at the same time not allowing outsourcing to be treated as a means of avoiding responsibility. Every organization must make a decision not only about building its own team, but also about which competences should remain in-house and which may be entrusted to external entities. In this regard, it is worth noting the approach presented in NIST, treating competence gaps and team potential as one type of organizational risk. NIST SP 1308 suggests that, depending on strategy, budget, risk level, and other available resources, an organization may consider hiring new employees, upskilling, reorganizing, or changing risk management methods. The foundation is an assessment of both internal team and external provider capabilities, incorporating these factors into decisions, and building a competence model tailored to the risk profile and scale of requirements. However, the decision to outsource cybersecurity functions carries its own set of organizational risks that important entities must manage. Dependence on a single external provider, commonly referred to as vendor lock-in, may limit the entity's ability to switch suppliers, renegotiate terms, or maintain operational continuity in the event of a provider failure or contract termination. Furthermore, standard service level agreements (SLAs) offered by security service providers are not always aligned with the specific reporting timelines and incident response obligations imposed by NIS2 and the uKSC, creating a risk of regulatory non-compliance that formally remains with the entity rather than the provider. Additional complexity arises in relation to data localization requirements under e.g. GDPR and the accessibility of systems and logs to competent cybersecurity authorities during audits or incident investigations. To mitigate these risks, important entities should ensure that outsourcing arrangements are governed by contractual provisions that explicitly address NIS2 and uKSC compliance obligations, define measurable performance indicators, and preserve the entity's right to audit, monitor, and terminate the engagement without compromising service continuity (Galle, Vlettervan Dort, 2025; Ministerstwo Cyfryzacji, 2026; NIST, 2026).

Additionally, it is worth bearing in mind that creating and maintaining an appropriate competence structure is associated with an increase in operational costs. The outcome of these actions, in accordance with the Act, should be an increase in awareness and organizational discipline. The Ministry of Digitization materials emphasize that documentation alone will not guarantee compliance if it is not applied in practice the organization should know its assets, risks, and threats, and procedures must be implemented, tested, and used. Employees should be regularly trained, and educational programs should cover both ISMS obligations and procedures, as well as specific examples of threats and incidents. In this way, organizational challenges are not limited merely to creating a security function, but also encompass

a transformation of the organization's approach to accountability, knowledge, and day-to-day practices and constitute one of the additional, permanent operational costs for enterprises (Galle, Vlettervan Dort, 2025; Ministerstwo Cyfryzacji, 2026; NIST, 2026).

The next aspect concerns the management of relations with external entities in the context of the ICT supply chain. Both the regulations and the Ministry of Digitization publications emphasize that ensuring security and continuity in the supply chain of ICT products, services, and processes is an integral part of the information security management system specifying that organizations should be aware of the structure of their supply chain, recognize risks associated with suppliers, define appropriate requirements, monitor vulnerabilities, and implement mitigation actions. In practice, the organizational challenge lies in ensuring that contracts and cooperation with suppliers are incorporated into the internal risk management system, rather than functioning outside managerial control (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026; NIST, 2018).

Concluding this part, it can be observed that the literature emphasizes that the problem discussed does not reduce to the formal compliance of organizations with the regulations, but may constitute a significant barrier to the organizational capability of entities particularly smaller ones. A lack of awareness, technical complexity, and financial constraints mutually reinforce one another, leading to weakened risk management and reduced operational resilience. It is particularly important to treat personnel shortages and limited resources not merely as a matter of headcount, but as a challenge requiring, *inter alia*, a well-considered configuration of competences, resource sharing, or the automation of repetitive tasks. This approach corresponds to the realities of important entities, which do not always have the capacity to build comprehensive cybersecurity teams, yet must ensure an appropriate capacity for oversight, coordination, and accountability for actions taken by employees, processes, and external partners. Thus, organizational challenges reduce to four fundamental questions:

- who bears responsibility?
- What competences are critical?
- Which tasks may be entrusted to external providers? and
- how to ensure that the implemented solutions function in practice?

This is where the greatest difficulties may arise for many organizations, namely, the translation of general statutory and industry security standards into specific roles, budgets, procedures, reporting lines, and supplier relationships. Consequently, organizational challenges constitute a key element linking the identification phase with the practical fulfillment of obligations (Galle, Vletter-van Dort, 2025; Mentzelou i in., 2025; NIST, 2026).

5.3. Operational Challenges

The third group comprises operational challenges, referring to difficulties associated with the ongoing fulfillment of the obligations defined in the Act in such a way as to not only meet regulatory requirements but also maintain the smooth operation of business processes and continuity of service provision. At this level, NIS2 and the uKSC exert the most direct impact on the organization, translating general statutory obligations into day-to-day activities such as monitoring, updating, documenting, reporting, communicating, responding, and cooperating with authorities and users. The legislator thereby also imposes a specific operational regime that may affect the organization's mode of operation in various ways (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The first dimension of the challenge is associated with the obligation to maintain continuous oversight of the information environment. Both the Act and the Ministry of Digitization materials indicate that the information system used to provide a service should be subject to continuous monitoring and the organization must analyze events that may constitute the cause or consequence of an incident. The Ministry's materials clarify that monitoring should cover, *inter alia*: traffic to and from the entity, system access, privileged accounts, critical configuration files, backups, security tool logs, and environmental events. In practice, this entails the need to maintain not only the technical capacity to record events, but also the capacity to interpret and prioritize them which may generate additional operational burdens (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The second dimension concerns incident management under time pressure and the need to make protective decisions that may disrupt the normal course of operations. The Ministry's materials indicate that serious incidents are reported via the S46 system, as a rule within 72 hours of their detection, together with information on the impact on the service, number of users affected, and remediation actions taken. In certain situations, further reporting obligations also arise such as an early warning, a progress report, or a final report. At the same time, the entity may be obliged to immediately limit certain technical activities, including temporarily restricting network traffic, if the protection of services and systems so requires. This means that the organization must simultaneously stabilize the operational situation, report the incident, and take decisions that may undermine current operational availability. The literature indicates that precisely operational disruptions, high reporting costs, and inadequate risk assessment are among the most significant challenges in this area. It is worth emphasizing that the potential costs associated with taking such actions, especially where they prove to be unjustified, may be particularly burdensome for the organization: leading, for example, to revenue loss, deterioration of client relations, reduced employee effectiveness, or the need to engage additional resources to restore system functionality. Accordingly, every decision to limit activities should be preceded by a thorough risk analysis and assessment of potential consequences, in order to avoid unnecessary costs and ensure the organization's operational effectiveness (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026; Mentzelou et al., 2025).

The next aspect concerns the ongoing updating of operational documentation and the continuous management of relationships with external entities. According to the Ministry's guidelines, an organization cannot limit itself to formal compliance, it should know its assets, risks, and potential threats, and should have procedures that are genuinely applied in day-to-day operations. The regulations impose an obligation to maintain documentation and records confirming the fulfillment of required activities. Additionally, an important entity is obliged to cooperate with relevant authorities, CSIRT teams, users, and suppliers, taking into account in its actions the consequences of recommendations, informing about significant events, and implementing remedial measures. From an operational perspective, this means that security becomes an integral element of day-to-day coordination, both internal and external, rather than merely a set of technical safeguards (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

The framing proposed in the literature on NIS2 implementation barriers appears apt: Mentzelou et al. indicate that operational disruptions, high reporting costs and inadequate risk assessment are among the most consequential effects of organizational pressure, absorbing the impact of earlier deficits in awareness, resources, and managerial capacity. This means that operational difficulties do not appear only at the end of the implementation process, they represent the point at which earlier identification and organizational shortcomings accumulate. NIST SP 1308 reinforces this perspective, indicating that cybersecurity management should be integrated with Enterprise Risk Management (ERM), staffing decisions, and operational planning, and that the organization should have the capacity for permanent monitoring and, where necessary, updating its risk profile and implementing corrective actions.

Consequently, the operational challenges of important entities can be viewed as difficulties associated with the day-to-day functioning of the organization under conditions of growing security requirements. They encompass the need to simultaneously maintain constant monitoring, report incidents, update systems, maintain documentation, and cooperate with supervisory institutions. While preserving operational continuity and the high quality of one's own services. It is precisely at this level that the regulations may generate the greatest tensions increasing coordination costs, slowing decision-making processes, amplifying administrative burdens, and forcing compromises between the level of security and operational efficiency. For this reason, operational challenges should be viewed not as the mere execution of statutory obligations but as a significant test of the organization's actual maturity in the area of cybersecurity (NIST, 2026; Mentzelou et al., 2025).

6. Discussion and conclusions

The analysis conducted indicates that the implementation of NIS2 requirements as expressed in the uKSC by important entities should not be framed solely as a challenge of formal-legal compliance, but as a process of building and maintaining organizational capabilities in the area of cybersecurity. Already the explanatory materials accompanying the amendment to the Act on the National Cybersecurity System indicate that the implementation of the new regulations will pose a particular challenge for the new key and important entities. This means that the regulatory burden does not reduce to the mere reading of obligations, but to the capacity to translate them into managerial, organizational, and operational practice. In this context, the distinction between identification, organizational, and operational challenges is of key importance. First, an important entity should independently determine its regulatory status, analyzing the scale and profile of its activities in relation to Article 5 of the Act and the relevant sectoral annexes. Second, the organization must create or formalize an internal system of accountability, competence, and oversight, including in the case of partial outsourcing of tasks to third parties. Third, the essential burden of regulatory implementation manifests at the operational level. Where obligations relating among other things reporting, monitoring, documentation, and cooperation with institutions should be seamlessly integrated with day-to-day organizational processes particularly in those organizations that had not previously focused on such activities (Dz.U. 2026, poz. 252; Ministerstwo Cyfryzacji, 2026).

Compared with existing studies on NIS2 and cybersecurity governance, which largely focus on legal analysis or generic implementation barriers, this paper shifts the perspective to the specific management challenges of important entities under the Polish transposition. By linking regulatory obligations with identification, organizational and operational capabilities, it offers a practice-oriented view that complements mainly doctrinal or technically driven contributions. The main contribution is the three-dimensional framework of identification, organizational and operational challenges, which integrates EU-level requirements with the concrete conditions faced by important entities in Poland. This framework can be used as a conceptual basis for assessing organizational readiness for NIS2 and for designing governance models, resource allocation and prioritization of cybersecurity investments in important entities (Teichmann, 2025; Vandezande, 2024; Mentzelou et al., 2025; Galle, Vletter-van Dort, 2025).

The conclusions of the analysis indicate that for many important entities, the provisions arising from the NIS2 Directive and the uKSC constitute not only a change of a regulatory nature but also an impulse to formalize the approach to cybersecurity at the organizational level. This phenomenon applies in particular to those institutions that had not previously possessed distinct security structures or had treated them merely as a supplement to the IT department. An important entity should therefore be understood not only as a legal concept, but as an organization from which the legislator expects the achievement of a defined level of maturity in cybersecurity management.

While a comprehensive cybersecurity maturity model goes beyond the scope of this paper, the framework proposed here suggests several baseline indicators that could serve as a starting point for assessing organizational readiness in important entities. These include:

- existence of a formally implemented ISMS covering key information systems,
- assignment of dedicated cybersecurity roles and responsibilities, like NIS2 coordinator or equivalent function,
- documented and tested incident response and reporting procedures aligned with the notification requirement, and
- evidence of regular cybersecurity training for management and staff.

The development of validated, sector-specific maturity indicators remains an important direction for future empirical research (Dz.U. 2026, poz. 252; ENISA, 2023; Ministerstwo Cyfryzacji, 2026; NIST, 2026).

The final conclusion is that the effectiveness of NIS2 implementation by important entities depends primarily on the capacity to combine the correct identification of obligations, the rational shaping of the implementation model, and the maintenance of operational efficiency under conditions of new requirements. It is at the intersection of these three dimensions that the fundamental management challenge emerges, as the ability to align legal expectations with organizational arrangements and day-to-day operations ultimately determines the maturity and resilience of the entity. From a research perspective, this justifies further analyses focused on practical models for fulfilling obligations, including support mechanisms for business in this process and the relationship between organizational maturity and the capacity to maintain operational compliance over the longer term. Future research should therefore validate this framework in selected sectors and compare important entities with key entities in terms of cybersecurity maturity and implementation costs. Quantitative studies could also develop operational indicators for organizational capabilities and workforce readiness, thereby moving beyond purely conceptual analysis.

References

1. Dacko-Pikiewicz, Z., Szczepańska-Woszczyna, K., Lis, M. (eds.) (2025). *Horyzonty sztucznej inteligencji a Przemysł 5.0*. Dąbrowa Górnicza: Akademia WSB.
2. Dupont, B., Shearing, C., Bernier, M., Leukfeldt, R. (2023). The tensions of cyber-resilience: From sensemaking to practice. *Computers & Security*, 132, 103372. doi:10.1016/j.cose.2023.103372.
3. Dyrektywa Parlamentu Europejskiego i Rady (UE) 2022/2555 z dnia 14 grudnia 2022 r. w sprawie środków na rzecz wysokiego wspólnego poziomu cyberbezpieczeństwa na terytorium Unii, zmieniająca rozporządzenie (UE) nr 910/2014 i dyrektywę (UE)

- 2018/1972 oraz uchylająca dyrektywę (UE) 2016/1148 (dyrektywa NIS 2). Dz.U. UE L 333 z 27.12.2022, p. 80.
4. ENISA (2023). *NIS Investments 2023. Cybersecurity Policy Assessment. European Union Agency for Cybersecurity*, listopad 2023. Download from: <https://www.enisa.europa.eu/sites/default/files/publications/CSPA%20-%20NIS%20Investments%20-%202023.pdf>, 10.04.2026.
 5. ENISA (2025). *NIS2 Technical Implementation Guidance. European Union Agency for Cybersecurity*, czerwiec 2025. Download from: https://www.enisa.europa.eu/sites/default/files/2025-06/ENISA_Technical_implementation_guidance_on_cybersecurity_risk_management_measures_version_1.0.pdf, 10.04.2026.
 6. Galle, A., Vletter-van Dort, H. (2025). From cybersecurity to cyber resilience in the board room: key steps for supervisory board members and non-executives. *International Cybersecurity Law Review*, 6, pp. 221-237. doi:10.1365/s43439-025-00151-7
 7. Hubbard, D., Seiersen, R. (2024). *Ryzyko w cyberbezpieczeństwie. Metody modelowania, pomiaru i szacowania ryzyka. Wydanie II*. Gliwice: Helion.
 8. Kowalski, S. (2023). *Dyrektywa NIS2. Co to jest i jak ją wdrożyć w firmie*. Download from: <https://mycompanypolska.pl/artukul/dyrektywa-nis2-co-to-jest-i-jak-ja-wdrozyc-w-firmie>, 10.04.2026.
 9. Mentzelou, K., Chountalas, P.T., Kitsios, F.C., Magoutas, A.I., Dasaklis, T.K. (2025). Identifying and Modeling Barriers to Compliance with the NIS2 Directive: A DEMATEL Approach. *Journal of Cybersecurity and Privacy*, 5(4), 97. doi:10.3390/jcp5040097
 10. Ministerstwo Cyfryzacji (2026). Ustawa z dnia 5 lipca 2018 r. o krajowym systemie cyberbezpieczeństwa po nowelizacji PYTANIA I ODPOWIEDZI. Download from: <https://www.gov.pl/attachment/4a661bd4-712c-4faf-8025-bcad437e5a29>, 10.04.2026.
 11. NIST (2018). *Framework for Improving Critical Infrastructure Cybersecurity. Version 1.1*. National Institute of Standards and Technology, 16 kwiecień 2018. Download from: <https://nvlpubs.nist.gov/nistpubs/cswp/nist.cswp.04162018.pdf>, 10.04.2026.
 12. NIST (2026). *NIST Cybersecurity Framework 2.0: Cybersecurity, Enterprise Risk Management, and Workforce Management Quick-Start Guide. NIST Special Publication 1308*. National Institute of Standards and Technology. Download from: <https://www.nist.gov/publications/nist-cybersecurity-framework-20-cybersecurity-enterpriserisk-management-and-workforce> -access date 10.04.2026
 13. OWASP (2021). *OWASP Top 10: 2021. Open Worldwide Application Security Project*. Download from: <https://owasp.org/Top10/2021>, 10.04.2026.
 14. Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2016/679 z dnia 27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchylenia dyrektywy 95/46/WE (ogólne rozporządzenie o ochronie danych). Dz.U. UE L 119 z 4.5.2016, s. 1.

15. Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2022/2554 z dnia 14 grudnia 2022 r. w sprawie operacyjnej odporności cyfrowej sektora finansowego i zmieniające rozporządzenia (WE) nr 1060/2009, (UE) nr 648/2012, (UE) nr 600/2014, (UE) nr 909/2014 oraz (UE) 2016/1011. Dz.U. UE L 333 z 27.12.2022, s. 1.
16. Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2024/1689 z dnia 13 czerwca 2024 r. w sprawie ustanowienia zharmonizowanych przepisów dotyczących sztucznej inteligencji oraz zmiany rozporządzeń (WE) nr 300/2008, (UE) nr 167/2013, (UE) nr 168/2013, (UE) 2018/858, (UE) 2018/1139 i (UE) 2019/2144 oraz dyrektyw 2014/90/UE, (UE) 2016/797 i (UE) 2020/1828 (akt w sprawie sztucznej inteligencji). Dz.U. UE L 2024/1689 z 12.7.2024.
17. Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2024/2847 z dnia 23 października 2024 r. w sprawie horyzontalnych wymagań w zakresie cyberbezpieczeństwa w odniesieniu do produktów z elementami cyfrowymi oraz w sprawie zmiany rozporządzeń (UE) nr 168/2013 i (UE) 2019/1020 i dyrektywy (UE) 2020/1828 (akt o cyberodporności). Dz.U. UE L 2024/2847 z 20.11.2024.
18. Sajdak, M. (ed.) (2023/2024). *Wprowadzenie do bezpieczeństwa IT. Tom 1 i Tom 2*. Kraków.
19. Teichmann, F. (2025). Cybersecurity of critical infrastructure in Europe: the NIS2 directive in focus. *International Cybersecurity Law Review*, 6, pp. 207-220. doi:10.1365/s43439-025- 00154-4
20. Ustawa z dnia 23 stycznia 2026 r. o zmianie ustawy o krajowym systemie cyberbezpieczeństwa oraz niektórych innych ustaw. Dz.U. 2026, poz. 252.
21. Vandezande, N. (2024). Cybersecurity in the EU: How the NIS2-directive stacks up against its predecessor. *Computer Law & Security Review*, 52, 105890. doi:10.1016/j.clsr.2023.105890

SUSTAINABLE DEVELOPMENT AND ESG FACTORS IN THE SME SECTOR: CHALLENGES AND PERSPECTIVES FOR LEADER

Irena DUDZIK-LEWICKA

University of Bielsko-Biala, Department of Marketing and Entrepreneurship; idudzik@ath.bielsko.pl,
ORCID: 0000-0002-3497-8934

Purpose: Analysis of the significance of the concept of sustainable development and environmental, social, and corporate governance (ESG) factors for leaders of Polish small and medium-sized enterprises (SMEs), presented on the example of empirical research conducted in small companies in the Silesian Voivodeship.

Design/methodology/approach: A mixed-method approach was applied: quantitative research (a survey conducted among 55 SME managers from the Silesian Voivodeship) and qualitative research (an expert interview), complemented by a literature review and analysis of EU regulations.

Research limitations/implications: The limitations of the study result from the non-random sampling method, the small sample size ($n = 55$), and the focus on a single region, which limits the generalisability of the findings.

Practical implications: The findings provide guidance for management in developing ESG strategies, preparing for data reporting within value chains, and obtaining financial support for transformation initiatives.

Social implications: Raising awareness of the role of business ethics, labor rights, and social engagement in shaping a company's image and stability.

Originality/value: The value of the article lies in combining the theoretical framework of ESG with up-to-date empirical data (April-May, 2024) concerning the SME sector at a regional level, which makes it possible to assess the level of readiness of enterprises for sustainable transformation.

Keywords: ESG, SMEs, sustainable development, non-financial reporting.

Category of the paper: research paper.

1. Introduction

The concept of sustainable development currently constitutes one of the key paradigms guiding the operation of modern business organizations. It encompasses not only the pursuit of economic efficiency, but also the necessity of integrating environmental, social, and organizational aspects into management processes. Taking these dimensions into account

is now essential for building a company's competitiveness, ensuring its long-term stability, and maintaining relationships with stakeholders. In this context, ESG factors (Environmental, Social, Governance) are gaining particular importance. Despite their non-financial nature, they are increasingly perceived as indicators of organizational maturity and institutional responsibility. Management based on these elements enables companies, among other things, to minimize operational risks, improve transparency, enhance social trust, and gain easier access to financing aligned with the principles of sustainable development. A special role in this process is played by the management team - owners and managers - who are responsible for shaping strategies, policies, and organizational culture. It is the leaders who initiate the implementation of ESG-related changes, and their awareness, competencies, and commitment determine the effectiveness of adopting sustainable management principles. For this reason, this study has significant practical relevance for decision-makers and leaders of small and medium-sized enterprises (SMEs), providing them with concrete knowledge. The presented content may serve as a starting point for strategic reflection as well as real support in decision-making at both operational and managerial levels.

The aim of this study is to analyze the importance of the concept of sustainable development and ESG factors in contemporary business, focusing on challenges and perspectives from the point of view of leaders (owners and managers) of Polish small and medium-sized enterprises (SMEs). Key aspects of ESG, regulations and reporting processes, as well as specific barriers and opportunities for the SME sector in the context of responsible business practices will be presented. The study is based on an analysis of available sources and the results of research conducted at the Faculty of Management and Transport of the University of Bielsko-Biała.

2. The Evolution and Concept of Sustainable Development

The concept of sustainable development has a long history of evolution. Although the term is believed to have been first used as early as 1713 by the German forester Hans Carl von Carlowitz in the context of rational tree harvesting - ensuring that forest development would not be disrupted and recommending new plantings to replace felled trees (Ślażyńska-Kluczek, Brzezek, 2023) - the key period for its development dates to the 1960s (Płachciak, 2011). This period is considered a turning point in the relationship between humans and the natural environment and fostered the development of the broader concept of eco-development (Płachciak, 2011). The fundamental idea of eco-development is the protection of the environment and natural resources through changes in consumption models and value systems, so that the environment is passed on to future generations in no worse condition than it was received (Zegar, 2003). The need for such an approach became particularly evident in the late

1960s, when the consequences of intensive economic growth and increasing affluence in Western societies led to mass consumption of goods (Płachciak, 2011).

Over time, the concept of sustainable development has evolved to encompass multiple aspects and dimensions, which has resulted in a variety of interpretations. The subject literature therefore presents numerous, often differing definitions that emphasize its diverse meanings. The most important definitional approaches are presented in Table 1.

Table 1.
Definitional approaches to sustainable development

Definitional approach	Key assumptions and concepts	Authors / Sources
Intergenerational perspective and meeting needs	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It emphasizes intergenerational solidarity and balancing access to environmental resources.	Brundtland Report, Environmental Protection and Management Act, Ministry of Development and Technology
Integration and balance of three spheres	A model based on harmonizing the social, economic, and environmental systems. It aims at the preventive elimination of imbalance between development and environmental conditions.	Barbara Kryk, Bazyli Poskrobko
Political, socio-economic concept or doctrine	Viewing sustainable development as a strategy of continuous growth without harming natural resources, or as a doctrine of political economy in which quality of life corresponds to the level of civilizational development.	Fifth Environmental Action Programme of the European Community, Małgorzata Rutkowska-Podołowska and Jolanta Pakulska
Application in business and the economy	Striving to conduct production activities with minimal environmental pressure, focusing on producing durable and valuable goods that meet real needs.	Marcin Nowicki
Improving quality of life and well-being	Effective improvement of the quality of life of current and future generations through shaping appropriate proportions between economic, human, and natural capital.	Barbara Piontek

Source: own elaboration based on (World Commission on Environment and Development, 1991; Environmental Protection and Management Act, 1980; Ministry of Development and Technology (2025); Kryk, 2004; Poskrobko, 2009; Ministry of Environmental Protection, Natural Resources and Forestry, 1997; Rutkowska-Podołowska, Pakulska, 2011; Nowicki, 2007; Piontek, 2010).

The contemporary understanding of sustainable development is globally reflected in the United Nations Sustainable Development Goals (SDGs), known as Agenda 2030. This document includes 169 targets focused on five key areas: people, planet, prosperity, peace, and partnership. These goals address issues such as poverty eradication, hunger reduction, access to health and education, and the promotion of equality (Ślażyńska-Kluczek, Brzezek, 2023). Within the area of prosperity, emphasis is placed on sustainable economic growth, job creation, decent working conditions, infrastructure development, industrial growth, innovation, and the reduction of inequalities between countries (Janicka, Sajnog, 2022).

In summary, sustainable development is a complex and multidimensional concept that has undergone significant evolution over the centuries. Today, it forms the foundation of policies and strategies integrating economic, social, and environmental aspects, aiming to ensure the

well-being of present generations without compromising the development opportunities of future ones, as reflected in global initiatives such as Agenda 2030.

3. Characteristics of ESG Factors

ESG factors, an acronym derived from the English terms Environmental, Social, and Governance, constitute key elements of the sustainable development concept and influence the perception of companies. They include the assessment of a company's impact on the environment, society, and governance (Wroniewska, Dudzik-Lewicka, 2024). Although they are often referred to as non-financial factors, they are no less important than financial ones. The distinguishing feature of these factors lies in the difficulty of presenting certain non-financial aspects using simple and clear metrics. All these factors are interconnected and influence one another. Their implementation ultimately translates into the financial performance of an entity (Ślażyńska-Kluczek, Brzezec, 2023). The identification of ESG factors aims to enhance the long-term value and stability of a company. ESG indicators were developed to measure the actual impact of enterprises on both external and internal stakeholders. Within management processes, such as impact assessment, risks associated with a company's operations are often divided into three main ESG categories (Barrow, 2009), corresponding to different areas of responsible business conduct. Each of these categories includes both quantitative and qualitative aspects, which increasingly influence how companies are perceived. A summary of the key issues is presented in Table 2.

Table 2.
Characteristics of ESG Factors

ESG Area	Description	Selected Assessment Aspects
E - Environmental	Assessment of a company's impact on the natural environment	• Energy consumption from renewable and non-renewable sources. • Greenhouse gas emissions. • Waste generation and disposal. • Impact on biodiversity. • Use of environmentally friendly energy sources. • Carbon footprint.
S - Social	Impact of a company on its social environment – employees, customers, and local communities	• Respect for human and labor rights. • Gender pay gap. • Diversity of management (e.g., by gender). • Workplace accident rate. • Cases of discrimination.
G - Governance	Corporate governance and management system	• Management standards and procedures. • Compliance with laws and regulations. • Accountability to stakeholders and investors. • Transparency of management structure. • Data security. • Business ethics.

Source: own elaboration based on (Ślażyńska-Kluczek, Brzezec, 2023; Biermann et al., 2017; Wroniewska, Dudzik-Lewicka, 2024; GPW, 2021).

In conclusion, ESG factors constitute a multidimensional and complementary set of criteria for assessing the sustainable performance of enterprises. They encompass the impact of business activities on the natural environment, social aspects related to relationships with employees, customers, and local communities, as well as corporate governance and management mechanisms. The integration of these elements into management strategies is essential for ensuring long-term stability and value growth of companies, complementing traditional financial indicators with non-measurable yet significant aspects from the perspective of stakeholders and the sustainability of development.

4. ESG regulations, standards and reporting process

The contemporary ESG regulatory system includes four key levels: global (e.g., the UN Agenda 2030), international (e.g., the Paris Agreement), EU-level (e.g., the CSRD Directive), and national (e.g., Poland's Strategy for Responsible Development implementing sustainable development goals). Despite their dynamic development, a major challenge remains the lack of full harmonization between systems, which makes it difficult to compare corporate performance across different jurisdictions (Wroniewska, Dudzik-Lewicka, 2024).

The first milestone in the European Union was the Non-Financial Reporting Directive (NFRD), which since 2017 has required large public-interest entities to disclose non-financial data concerning, among other things, employee issues, environmental protection, and anti-corruption measures (Janicka, Sajnóg, 2022). Over time, however, it proved insufficient in light of growing investor expectations and has therefore been modernized and is gradually being replaced by the Corporate Sustainability Reporting Directive (CSRD). The new regulation significantly expands reporting obligations both in terms of the scope of disclosed information and the number of entities required to report. Its aim is to provide stakeholders with reliable and comparable ESG information enabling informed decision-making (Siwiec, 2023; UHY ECA Poland, 2025). The technical foundation of CSRD is the European Sustainability Reporting Standards (ESRS), which focus on strategy and performance measurement based on the principle of double materiality, requiring analysis of both the company's impact on its environment and the impact of external factors on the company (Krajowa Izba Gospodarcza, 2024; UHY ECA Poland, 2025).

This system is complemented by the Sustainable Finance Disclosure Regulation (SFDR), which requires financial market participants to disclose how they integrate sustainability considerations into investment decisions (Michalski, 2022), as well as the EU Taxonomy, which classifies environmentally sustainable economic activities based on six environmental objectives (Redqueen, 2023). In addition to legal regulations, companies voluntarily implement international reporting standards such as the Global Reporting Initiative (GRI) guidelines,

the industry-specific standards of the Sustainability Accounting Standards Board (SASB), the ISO 26000 standard, and the principles of the United Nations Global Compact (UN Global Compact) (Wroniewska, Dudzik-Lewicka, 2024).

The ESG reporting process itself is a structured sequence of activities. According to the Warsaw Stock Exchange (GPW), it begins with defining the report's objectives and audience, followed by a materiality analysis aimed at identifying key ESG areas considering the business model, risks, and stakeholder expectations. The next step is assessing compliance with minimum sustainability standards, including EU Taxonomy requirements, then selecting appropriate indicators - general, sector-specific, and company-specific - and finally preparing the report based on collected data (Redqueen, 2023).

Another approach presents a broader eight-stage model, starting with developing an ESG strategy aligned with the company's business strategy, followed by assessing environmental and social impacts and identifying risks, conducting a materiality analysis, establishing a baseline through initial measurements and benchmarking, setting measurable ESG targets, developing an action plan, implementing it while monitoring key performance indicators (KPIs), and ending with regular - usually annual - ESG reporting aimed at building stakeholder trust (Witkowska, 2023).

Although SMEs are usually not directly subject to these regulations, they become part of the system through the value chains of larger contractors (Brzózek, 2025; Krajowa Izba Gospodarcza, 2024; UHY ECA Poland, 2025), who require suppliers to provide data such as carbon footprint information. For leaders of smaller firms, this creates significant challenges, including the complexity of regulations, rising operating costs, and limited human resources needed to prepare reliable reports (Zieliński, 2023).

5. Strategic benefits of responsible business conduct

Sustainable development and ESG indicators are becoming increasingly important elements of the business strategies of modern companies. The key benefits for enterprises resulting from environmental actions and the integration of ESG factors can be divided into two groups: external and internal - relating respectively to the impact on the environment and the functioning of the organization.

External benefits:

- Increased competitiveness and market position: pro-environmental and sustainability-oriented activities contribute to enhancing a company's competitiveness and strengthening its market position (Mazur-Wierzbicka, 2007a; Mazur-Wierzbicka, 2007b). In highly developed countries, companies perceive environmental regulations and other protection mechanisms not as constraints imposed by the state, but as a source of competitive advantage (Zuzek, Mickiewicz, 2014).

- Building a positive image and stronger brand recognition: environmental initiatives contribute to shaping a positive corporate image in the external environment (Mazur-Wierzbicka, 2007a; Mazur-Wierzbicka, 2007b), improving corporate reputation (Polska Agencja Rozwoju Przedsiębiorczości, 2024), and increasing brand recognition (Ślazińska-Kluczek, Brzezek, 2023). Improving image is often one of the main motivations for adopting sustainability and corporate social responsibility practices (Gadomska-Lila, Wasilewicz, 2016).
- Improved customer relations and access to new markets: a better perception by customers may translate into customer loyalty and the acquisition of new clients. Incorporating ESG factors increases customer interest (Gadomska-Lila, Wasilewicz, 2016) and may open new business opportunities, including access to new markets (Mazur-Wierzbicka, 2007a; Mazur-Wierzbicka, 2007b). There is also existing or anticipated market demand for environmentally beneficial innovations (Polska Agencja Rozwoju Przedsiębiorczości, 2024).
- Effective stakeholder engagement and social acceptance: implementing ESG principles enables effective cooperation with stakeholders, generating positive outcomes for both companies and society (Gadomska-Lila, Wasilewicz, 2016). It helps meet stakeholder expectations and build trust. Engagement in social activities and support for local communities is recommended and increases social acceptance (Ślazińska-Kluczek, Brzezek, 2023).
- Access to capital and financing opportunities: effective ESG risk management can positively influence the cost of capital and facilitate access to financing. Companies may benefit from European Union financial support, including green loans and EU funds (Wroniewska, Dudzik-Lewicka, 2024), which represent an important opportunity for development and modernization (Polska Agencja Rozwoju Przedsiębiorczości, 2024).
- Increased attractiveness to potential employees: companies that consider social and environmental factors are perceived as more attractive workplaces (Redqueen, 2023).
- Improved relationships within the value chain: companies, especially SMEs that are part of larger value chains, are increasingly encouraged to align with ESG standards to maintain and develop business relationships. Knowledge and competencies in ESG can significantly strengthen cooperation with larger enterprises that require compliance with sustainability principles (Wroniewska, Dudzik-Lewicka, 2024).
- Compliance with regulatory requirements: adapting to legal requirements is one of the key drivers of environmental actions (Zuzek, Mickiewicz, 2014). Incorporating ESG factors supports companies in preparing for increasingly stringent regulations such as the CSRD Directive, ESRS standards, or the EU Taxonomy (Redqueen, 2023). Understanding and correctly interpreting these complex EU regulations is becoming a crucial element of every modern business strategy.

Internal benefits:

- Financial and economic benefits (cost reduction): implementing ESG factors can contribute to increased corporate profits (Ślażyńska-Kluczek, Brzezek, 2023). Environmental initiatives often lead to lower operating costs through more efficient use of energy, water, and raw materials, as well as reduced waste and wastewater (Mazur-Wierzbicka, 2007a; 2007b). More efficient resource management translates into tangible savings and improved profitability (Ślażyńska-Kluczek, Brzezek, 2023).
- Improved operational efficiency: the implementation of innovations - especially eco-innovations - can significantly enhance the efficiency of economic processes (Zuzek, Mickiewicz, 2014). ESG principles support operational optimization, and effective management in this area reflects operational excellence and a modern management approach.
- Better risk management and increased resilience: incorporating ESG factors reduces corporate risk. International studies indicate that ESG integration reduces risks related to social costs and environmental responsibility (Gangi, Daniele, Varrone, 2020). Companies that effectively manage ESG aspects are perceived by the market as more stable and less risky (Ślażyńska-Kluczek, Brzezek, 2023). A proactive approach increases readiness to respond to unforeseen events and facilitates long-term financial planning (Redqueen, 2023).
- Enhanced innovation capacity (Mazur-Wierzbicka, 2007a; 2007b).
- Organizational benefits (increased employee motivation): lower staff turnover and higher productivity may result from greater employee satisfaction with working conditions (Redqueen, 2023). Supporting employee competence development is a key benefit of ESG implementation (Wroniewska, Dudzik-Lewicka, 2024). Additionally, preventing unfair labor practices and ensuring safe working conditions are integral elements of due diligence within ESG (Redqueen, 2023).
- Improved quality of management: ESG analysis, particularly in the area of corporate governance (G), provides additional insights into management quality. Corporate governance includes internal systems of supervision and control, with key values such as ethical and transparent management and the prevention of corruption and unethical practices. Regulatory requirements oblige companies to integrate sustainability due diligence into governance structures, strategy, and business models, as well as to document ESG management processes. Strong corporate governance reduces risk and is increasingly seen as a benchmark of operational excellence (Redqueen, 2023).
- Facilitated reporting and compliance: adopting unified reporting standards such as ESRS significantly simplifies reporting processes and enables comparability between entities. Additionally, alignment with the EU Taxonomy requires meeting minimum safeguards regarding social standards and business ethics (Redqueen, 2023). Overall, integrating ESG factors into corporate strategy streamlines reporting processes and supports compliance with EU regulations.

Adopting a strategy that incorporates ESG factors brings numerous benefits to companies, both external (e.g., increased competitiveness, improved reputation, access to capital) and internal (e.g., financial gains, better risk management, improved management quality). This holistic approach positively impacts multiple areas of business activity.

6. SME sector in Poland and the challenges of sustainable development

The SME sector constitutes a key pillar of the Polish economy - accounting for 99.8% of all enterprises, generating over 45% of GDP, and employing nearly 7 million people, which represents 55.5% of all employees in the enterprise sector. Among them, microenterprises dominate, making up as much as 97.2% of this group, concentrated mainly in services and trade (Instytut Przedsiębiorczości Społecznej, 2025; Polska Agencja Rozwoju Przedsiębiorczości, 2024). This structure gives SMEs their specific characteristics, highlighting both their potential and their limitations in the context of the transition toward a sustainable economy.

In recent years, regulatory and social pressure to incorporate environmental, social, and governance (ESG) aspects into business operations has increased significantly. Although many regulations - such as the CSRD directive or ESRS standards - do not directly apply to the smallest firms, SMEs are increasingly being integrated into non-financial reporting processes by larger partners within the value chain, for example through the requirement to provide data on carbon footprint. This means that even non-listed companies will have to adapt to new reporting requirements (Polska Agencja Rozwoju Przedsiębiorczości, 2024).

However, Polish SMEs face numerous challenges in implementing sustainable development principles. The most frequently cited barriers include unclear, inconsistent, and frequently changing legal regulations, difficulties in accessing financing, limited availability of skilled personnel, as well as a low level of awareness and knowledge regarding environmental issues. Despite the declared lack of staffing constraints in general surveys, when asked about specific pro-environmental activities, more than one-third of SMEs admit to significant competency gaps. Moreover, environmental actions are still perceived as less demanding than, for example, digitalization, which may indicate an insufficient diagnosis of needs and capabilities in this area (Polska Agencja Rozwoju Przedsiębiorczości, 2024).

Comparative data from EU countries indicate that Polish SMEs lag significantly behind the European average in areas such as waste reduction, recycling, efficient energy and material management, and the use of renewable energy sources. In 2021, only 13% of Polish companies in this sector declared having a strategy to reduce their carbon footprint, compared to 24% of the EU average. Additionally, the declared impact of eco-innovations on environmental protection is often limited, while the COVID-19 pandemic and the war in Ukraine have further weakened companies' capacity to invest in eco-innovation. The greatest actual environmental

contributions concern activities such as reducing the use of fossil fuels (9.8%) and waste recycling (8.1%); however, their scale remains limited, especially in small service companies.

At the same time, positive trends and growing support opportunities are observable. Motivations for implementing ESG activities increasingly stem from pragmatism - the desire to reduce production costs, improve reputation, and comply with environmental regulations (Polska Agencja Rozwoju Przedsiębiorczości, 2024). These motivations are reinforced by supportive initiatives such as funds from the National Recovery Plan (KPO), activities of the Polish Agency for Enterprise Development (PARP), and programs promoting the circular economy.

In the coming years, the transition toward sustainable development and investments in eco-innovation will be a key direction for the SME sector. However, their effectiveness will depend on companies' ability to overcome systemic, organizational, and competency-related barriers, as well as on consistent support from public institutions, the market, and business partners.

7. Implementation of Sustainable Development and ESG Principles in SMEs - A Case Study of Small Enterprises in the Silesian Voivodeship

7.1. Methodological Foundations of the Study

The subjects of the study were small enterprises operating in the Silesian Voivodeship, while the respondents consisted of business owners and members of the management staff of these enterprises. The research focused on the challenges faced by small enterprises in the context of sustainable development, with particular emphasis on ESG aspects, and was conducted by the author of this paper in collaboration with Agnieszka Wroniewska (Wroniewska, Dudzik-Lewicka, 2024).

To achieve the research objectives, a mixed-method approach was applied, combining both quantitative and qualitative methods. This made it possible to collect both numerical data and in-depth opinions and experiences of the respondents. In the quantitative part, a survey technique was used, with a questionnaire as the research tool, containing questions related to the research topic as well as a demographic section including data such as age, gender, and the type and size of the enterprise. The qualitative research was conducted using the interview technique, with an interview questionnaire as the tool. It took the form of a semi-structured conversation aimed at obtaining as objective a picture of the studied phenomena as possible, rather than relying solely on a strictly formalized set of questions.

The sampling method was non-random, due to organizational constraints and time limitations. It should be noted that results obtained from a non-random sample may not be fully representative of the entire population of small enterprises in the region. The survey was conducted in April 2024 using a Google Forms questionnaire and was distributed electronically.

A total of 55 correctly completed questionnaires were obtained. The interview was conducted on May 6, 2024, with Ms. Katarzyna Hiller - an expert in the field of ESG.

7.2. Respondent Profile

The survey study, conducted in April 2024, covered a group of 55 owners and members of the management staff of small enterprises operating in the Silesian Voivodeship. In the demographic structure of the surveyed population, women predominated, accounting for 55% of respondents (30 individuals), compared to 45% men (25 individuals). The participants were characterized by a relatively high level of education, with the largest share represented by individuals holding higher education degrees (42%) and secondary education (36%), while a smaller percentage consisted of those with vocational or primary education.

The analysis of the business profile of the surveyed entities revealed a clear dominance of the service sector, in which as many as 71% of enterprises operate, with a significantly smaller share of trade (24%) and only marginal representation of production and other forms of activity. In terms of organizational size, the sample structure was based primarily on micro-enterprises (76%), supplemented by small companies accounting for 24% of the total. The most common legal form chosen by the surveyed leaders was sole proprietorship, indicated by 71% of respondents, ahead of partnerships (18%), capital companies (9%), and professional partnerships.

The synthetic profile of the average survey participant indicates a woman with higher education, managing a service-oriented micro-enterprise registered as a sole proprietorship in the Silesian Voivodeship. An important complementary element to the collected quantitative data was an in-depth interview conducted with an ESG expert, Ms. Katarzyna Hiller, which allowed for a broader perspective on the analyzed managerial issues.

7.3. Key research findings

The following conclusions constitute a synthetic summary of the research results, based on both survey data and interview findings, grouped according to key thematic areas:

- Challenges related to sustainable development (ESG).
Sustainable development in its environmental, social, and governance (ESG) dimensions was identified as a significant challenge for small businesses. This view was expressed by the majority of respondents (56%). A considerable proportion (40%) did not take a clear position, which may indicate a low level of awareness or lack of experience in this area. From the perspective of the expert interview with Katarzyna Hiller, an ESG specialist, implementing ESG standards poses real and significant challenges for small enterprises (mainly due to costs, lack of resources, and knowledge), although ESG itself represents an opportunity for growth and increased competitiveness.

- **Key constraints and barriers to the development of small enterprises in Poland.**
The results indicate that the development of small enterprises is hindered by multiple obstacles. Respondents most frequently pointed to complex tax and administrative procedures (26% overall, 58% among microenterprises) and limited financial resources (25% overall, 62% among microenterprises, 44% among women). Difficulties in finding new markets were indicated by 15% of respondents. Other barriers included lack of ESG implementation knowledge (14%), shortage of specialized staff (9%), flawed development strategies (9%), lack of time, frequent legal changes, social security burdens, and high labor costs (2%). Katarzyna Hiller confirmed the relevance of financial and regulatory barriers and additionally highlighted market competition, workforce challenges, taxes, and legal instability as key constraints, often linked to limited knowledge and competencies.
- **Awareness of sustainable development and ESG regulations.**
Most respondents (56%) had not heard of the concept of sustainable development in the context of ESG. Awareness was slightly higher among small enterprises (18% “Yes”) compared to microenterprises (25% “Yes”). Knowledge of specific regulations (NFRD, EU Taxonomy, CSRD, ESRS) was very low. According to the expert, ESG awareness in the SME sector is increasing but remains fragmented and is often driven by regulatory or contractor requirements. Understanding ESG and related regulations remains a major challenge.
- **Awareness of reporting obligations.**
A large majority of respondents (78%) are not aware of reporting obligations related to ESG disclosures, while only 22% declared such awareness. The expert noted that awareness in SMEs is still developing and often reactive, driven by external requirements rather than proactive understanding.
- **Business relationships with larger entities and ESG adoption.**
Relationships with larger companies play an important role in shaping SMEs’ approach to ESG. Among respondents, 47% declared existing or planned cooperation with larger firms. Such relationships were more common among small enterprises (20%) than microenterprises (27%). Legal form and education level also influenced this tendency. As emphasized by Katarzyna Hiller, ESG interest in SMEs is often driven by expectations from larger business partners.
- **Knowledge of ESG standards in business cooperation.**
53% of respondents believe ESG knowledge “may help” in business relations, while 15% believe it will “definitely help.” Small enterprises more often indicated strong benefits than microenterprises. According to the expert, cooperation with larger firms is a key driver of ESG interest and knowledge development.

- **ESG strategy.**

A vast majority (93%) of respondents do not have an ESG strategy in place; only 7% have implemented one. Among those without a strategy, 27% plan to adopt one, while 73% do not. Small enterprises showed slightly greater willingness to implement ESG strategies. The expert confirmed that although interest exists, companies often abandon implementation due to high costs and complexity.
- **Awareness of benefits of sustainable practices.**

Awareness of ESG benefits remains moderate. Only 45% of respondents declared knowledge of potential benefits, while 55% did not. Awareness was higher among small enterprises and individuals with higher education. The expert noted that awareness is often limited and focused mainly on environmental aspects, with ESG perceived more as an obligation than an opportunity.
- **Most significant benefits (according to aware respondents).**

Among respondents aware of ESG benefits, the most frequently indicated were waste reduction and segregation (32%), reduced water and energy consumption (30%), and the use of eco-friendly materials (25%). The expert emphasized that these are primarily environmental actions and that ESG should also include social and governance aspects. She views ESG as an opportunity that supports development, process optimization, cost reduction, and profitability.
- **Social engagement.**

SMEs show limited involvement in local environmental and social initiatives. The largest group (35%) declared no engagement, while 18% were unaware of the need for such involvement. Only 9% actively participate in environmental projects, and another 9% offer employee volunteering. Notably, none of the small enterprises reported a complete lack of engagement. The expert highlighted that CSR initiatives are less popular among SMEs and are often perceived as obligations rather than sources of tangible benefits.
- **Key challenges in implementing ESG metrics.**

Respondents most frequently identified difficulties in understanding ESG regulations (20%), non-financial reporting (16%), and rising energy costs (13%) as major challenges. Men more often pointed to energy costs as a key issue (31%). The expert noted that while regulatory complexity is expected, rising energy costs can also create opportunities, such as access to funding for renewable energy. She identified high costs and lack of human resources as the most significant barriers to ESG implementation.

8. Strategic recommendations and implementation guidelines for leaders and organizations in the SME sector

For owners and/or managers of small businesses, a conscious approach to sustainable development (ESG) is becoming increasingly important - both in the context of growing market expectations and long-term competitiveness. In light of the research findings and the expert opinion of Katarzyna Hiller, key areas requiring action and support have been identified, representing an attempt to operationalize the sustainable development paradigm within the realities of small enterprises:

- **Systematic knowledge acquisition and closing the competency gap.**
A key imperative for leaders is to actively increase awareness across all three ESG pillars (environmental, social, and governance), as current knowledge is often insufficient. Regular participation in specialized educational activities, such as training sessions and workshops, is recommended to enable accurate interpretation of complex regulatory requirements (e.g., CSRD or the EU Taxonomy).
- **Integration of ESG factors into the overall organizational strategy.**
It is essential to align non-financial objectives with the company's mission and business model. A strategy based on measurable goals and priorities supports the development of long-term competitive advantage and enhances organizational resilience in a changing environment.
- **Proactive adaptation to value chain requirements.**
Companies should promptly implement processes for collecting non-financial data, such as carbon footprint metrics. This is driven by increasing pressure from larger contractors who, being subject to reporting obligations, require ESG-related data from their suppliers as a condition for continued cooperation.
- **Optimization of management processes and transparency (Governance).**
It is recommended to implement ethical corporate governance based on transparent procedures and anti-corruption mechanisms. Such an approach reduces operational risks and strengthens the company's institutional credibility among investors and business partners.
- **Leveraging sustainable financing mechanisms.**
Leaders should incorporate ESG criteria into investment planning, as this can improve access to capital from banks and financial institutions. Actively seeking external funding—such as EU funds for renewable energy (RES) investments—is advisable, as it enables both modernization and operational cost optimization.

- Building social and reputational capital.
An important element of strategy is strengthening relationships with the local community and ensuring employee well-being. This contributes to increased employer attractiveness and lower staff turnover, while also creating a “social license to operate” that supports business development within its environment.
- Implementation of monitoring systems (KPIs).
Effective transformation requires the establishment of key performance indicators (KPIs) and regular evaluation of results. Consistent monitoring enables ongoing optimization of activities and supports transparent communication with stakeholders.
- Human resource management through delegation and outsourcing.
Given the complexity of ESG issues and the commonly identified shortage of specialized staff, managers should invest in developing employee competencies or consider outsourcing analytical and reporting tasks to external experts.

In conclusion, the implementation of the presented recommendations should enable leaders of the SME sector to effectively operationalize the ESG paradigm, thereby facilitating the transformation of increasing regulatory requirements into a sustainable competitive advantage. A holistic approach, combining systematic competence development with managerial transparency and active monitoring of non-financial data, constitutes an essential foundation for building a modern and crisis-resilient organization.

9. Conclusions

In conclusion, this study provides a multidimensional analysis of the importance of the concept of sustainable development and ESG factors in the operational context of the SME sector. The conducted empirical research, combining a quantitative approach ($n = 55$) with a qualitative expert interview, enabled the identification of key barriers, but above all the strategic benefits resulting from responsible business conduct. Despite certain methodological limitations, such as the non-random sampling method, the collected data provide a reliable picture of the current awareness among surveyed leaders of small enterprises in 2024. These findings are particularly relevant in an era of increasing regulatory and market pressure, where ESG is no longer the domain of large corporations only, but is becoming a prerequisite for maintaining sustainable relationships within value chains. The horizon of future changes is shaped by planned European Union regulations aimed at simplifying and better aligning reporting obligations with the specific characteristics of smaller entities. This issue remains the subject of an active public debate - voices advocating the protection of entrepreneurs from excessive bureaucracy, as well as the need for a flexible approach to implementing ESG standards, emphasize that the success of the transformation depends on finding a balance

between formal requirements and the actual capabilities of the SME sector. In this context, the developed guidelines may serve leaders not only as support in adapting to new regulations, but above all as a foundation for building modern, resilient organizations capable of transforming the challenges of sustainable development into tangible market success.

References

1. Barrow, C. (2009). *Zarządzanie finansami w małej firmie*. Gliwice: Helion.
2. Biermann, F., Kanie, N., Kim, R. (2017). Global governance by goal-setting: The novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, 26-27, pp. 26-31, doi:10.1016/j.cosust.2017.01.010
3. Brzózka, S. (2025). *Raport ESG: Niemiecka ustawa o należytej staranności w łańcuchu dostaw będzie oddziaływać także na polskie firmy*. Retrieved from: <https://raportcsr.pl/slalomir-brzozek-niemiecka-ustawa-o-nalezytej-starannosci-w-lancuchu-dostaw-będzie-oddziaływać-także-na-polskie-firmy/>, 18.05.2025.
4. Gadomska-Liła, K., Wasilewicz, J. (2016). Zrównoważony rozwój i społeczna odpowiedzialność z perspektywy biznesowej. *Studia i Prace WNEiZ US*, 46, pp. 299-310, doi:10.18276/sip.2016.46/1-23
5. Gangi, F., Daniele, L.M., Varrone, N. (2020). How do corporate environmental policy and corporate reputation affect risk-adjusted financial performance? *Business Strategy and the Environment*, 29(5), pp. 1975-1991, doi: 10.1002/bse.2482
6. Instytut Przedsiębiorczości Społecznej (2025). *Podsumowanie raportu PARP o stanie sektora MŚP w Polsce w 2024*. Retrieved from: <https://fips.pl/podsumowanie-raportu-parp-o-stanie-sektora-msp-w-polsce-w-2024>, 18.05.2025.
7. Janicka, M., Sajnog, A. (2022). Finanse zrównoważone w ujęciu globalnym. In: M. Janicka, T. Miziolek (eds.), *Finanse zrównoważone ESG - Przedsiębiorstwa - Sektor finansowy* (pp. 45-47). Warszawa: PWE.
8. Krajowa Izba Gospodarcza (2024). *ESRS nie tylko dla MŚP - retransmisja z webinaru*. YouTube. Retrieved from: <https://www.youtube.com/watch?v=BfH8miztnSo&t=1200s>, 11.09.2024.
9. Kryk, B. (2004). Ekorozwój jako przyjęta koncepcja rozwoju społeczno-ekonomicznego a inwestycje ekologiczne. In: D. Kopycińska (ed.), *Problemy mikroekonomii menedżerskiej* (pp. 5-16). Szczecin: Wydawnictwo Naukowe Uniwersytetu Szczecińskiego.
10. Mazur-Wierzbicka, E. (2007a). Wpływ zachowań proekologicznych na konkurencyjność przedsiębiorstw. In: T. Bernat (ed.), *Przedsiębiorstwo i państwo – wybrane problemy konkurencyjności* (pp. 30-37). Szczecin: Print Group Daniel Krzanowski.

11. Mazur-Wierzbička, E. (2007b). Zarządzanie proekologiczne – ważny czynnik sukcesu rynkowego przedsiębiorstwa. In: D. Kopyciński (ed.), *Zachowania rynkowe w teorii i praktyce* (pp. 62-69). Szczecin: Wydawnictwo Uniwersytetu Szczecińskiego.
12. Michalski, D. (2022). *Finanse Zielonej Transformacji*. Warszawa: Difin.
13. Ministerstwo Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa (1997). Piąty program działania Wspólnoty Europejskiej w dziedzinie ochrony środowiska. In: *Prawo ochrony środowiska Wspólnoty Europejskiej. Suplement I. Zagadnienia ogólne. Powietrze*. Warszawa: MOŚZNiL.
14. Ministerstwo Rozwoju i Technologii (2025). *Zrównoważony rozwój*. Retrieved from: <https://www.gov.pl/web/rozwoj-technologia/zrownowazony-rozwoj>, 18.05.2025.
15. Nowicki, M. (2007). Lokalne bieguny wzrostu. *Pomorski Przegląd Gospodarczy*, 4.
16. Piontek, B. (2010). Współczesne uwarunkowania rozwoju społeczno-gospodarczego (ujęcie systematyczne). *Problemy Ekorozwoju*, 5(2), pp. 117-124.
17. Płachciak, A. (2011). Geneza idei rozwoju zrównoważonego. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu. Ekonomia*, 17(214), pp. 231- 248.
18. Polska Agencja Rozwoju Przedsiębiorczości (2024). *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce 2024*. Warszawa: PARP.
19. Poskrobko, B. (2009). *Zrównoważony rozwój gospodarki opartej na wiedzy*. Białystok: Wydawnictwo Wyższej Szkoły Ekonomicznej w Białymstoku.
20. Redqueen, S. (2023). *Wytyczne do raportowania ESG: Przewodnik dla spółek*. Retrieved from: https://www.gpw.pl/pub/GPW/ESG/Wytyczne_do_raportowania_ESG.pdf, 23.09.2023.
21. Rogowski, W., Lipski, M. (2022). Znaczenie informacji niefinansowej w świetle wymogów zrównoważonego rozwoju oraz turbulentnego otoczenia. *Kwartalnik Nauk o Przedsiębiorstwie*, 64(2), pp. 33-44, doi: 10.33119/KNoP.2022.64.2.3
22. Rutkowska-Podołowska, M., Pakulska, J. (2011). *Zrównoważony rozwój w gospodarce opartej na wiedzy*. Warszawa: Oficyna Wydawnicza SGH.
23. Siwiec, K. (2023). *Sprawozdawczość ESG*. Warszawa: C.H. Beck.
24. Ślazińska-Kluczek, D., Brzezek, M. (2023). Czynniki ESG jako elementy zrównoważonego rozwoju wpływające na postrzeganie przedsiębiorstw przez konsumentów. *Kwartalnik Nauk o Przedsiębiorstwie*, 70(4), pp. 73-90, doi: 10.33119/KNoP.2023.70.4.5
25. UHY ECA Poland (2025). *ESG – raportowanie niefinansowe według nowych wytycznych UE*. YouTube. Retrieved from: <https://www.youtube.com/watch?v=uJE8CmnV4-E&t=922s>, 18.05.2025.
26. Ustawa z dnia 31 stycznia 1980 r. o ochronie i kształtowaniu środowiska (Dz.U. 1994, nr 49, poz. 196 z późn. zm.).
27. Witkowska, N. (2023). *Raport ESG krok po kroku*. Warszawa: Fundacja im. XBW Ignacego Krasickiego.

28. Wroniewska, A., Dudzik-Lewicka, I. (2024). *Małe przedsiębiorstwa wobec wyzwań zrównoważonego rozwoju w obszarze ESG na przykładzie województwa śląskiego* (niepublikowana praca). Bielsko-Biała: Uniwersytet Bielsko-Bialski, Wydział Zarządzania i Transportu.
29. Zegar, J.. (2003). *Kierowanie zrównoważonym rozwojem społeczno-gospodarczym (ekorozwojem)*. Warszawa: Oficyna Wydawnicza SGH.
30. Zieliński, D. (2023). ESG a wyzwania dekarbonizacyjne przedsiębiorstw działających w Polsce. *Studia BAS*, 74(2), pp. 133-140, doi:10.31268/StudiaBAS.2023.15
31. Zuzek, D.K., Mickiewicz, B. (2014). Aktywność przedsiębiorstw w kontekście wdrażania zasad zrównoważonego rozwoju w województwie małopolskim. *Optimum. Studia Ekonomiczne*, 1(67), pp. 197-206, doi:10.15290/ose.2014.01.67.14

READINESS FOR ADAPTATION IN THE CONTEXT OF ARTIFICIAL INTELLIGENCE IMPLEMENTATION IN PRODUCTION PLANNING

Michał FERTSCH^{1*}, Łukasz HADAŚ²

¹ Poznan University of Technology, Faculty of Management Engineering, michal.fertsch@put.poznan.pl,
ORCID: 0000-0001-8438-7975

² Poznan University of Technology, Faculty of Management Engineering, lukasz.hadas@put.poznan.pl,
ORCID: 0000-0001-9271-8738

* Correspondence author

Purpose: The purpose of this paper is to explore the readiness of production planning employees to adapt to the implementation of artificial intelligence (AI) in decision-making processes. The study investigates the roles that AI should perform in the company, employees' willingness to reorganize decision-making structures, and the alignment between expectations toward AI and the acceptance of organizational change.

Findings: The findings reveal that most respondents see AI as a supportive tool rather than an autonomous decision-maker. While there is a general openness to redefining individual roles in decision-making processes, there is significantly less support for changes in organizational hierarchies. Strategic planners are more open to AI integration than operational planners. Experience and familiarity with AI tools positively influence acceptance of changes.

Research limitations/implications: The study is limited to a sample of 104 professionals from the production planning sector, which may not be representative of all industries. Further research could explore broader sectors and analyze longitudinal changes in readiness over time. Additionally, deeper investigation into the causes of resistance to structural changes is recommended. These results are consistent with broader patterns in AI readiness observed in European manufacturing firms (Müller et al., 2023; Schroeder, Kinkel, 2022), highlighting both individual adaptability and organizational inertia.

Social implications: The study suggests that while AI is welcomed for its analytical capabilities, there is still societal hesitation regarding its decision-making autonomy. Addressing these concerns may improve public trust in AI technologies and support broader societal acceptance of AI-driven business transformations.

Originality/value: This paper provides a novel analysis of readiness for AI integration specifically within production planning. By distinguishing between strategic and operational planners, it adds value to the understanding of AI's impact on organizational roles and decision-making structures. The study offers practical insights for business leaders considering AI-driven changes in planning and management.

Keywords: Artificial Intelligence, Production Planning, Decision-Making Structures, Organizational Readiness, Human-AI Interaction.

Category of the paper: Research paper.

Introduction

This paper explores the readiness of production planning employees to adapt to the implementation of artificial intelligence (AI) in decision-making processes. Drawing on a survey of 104 industry professionals, the study investigates the roles defined by respondents that AI should perform in the company their willingness to reorganize decision-making structures, and the consistency between expectations toward AI and the acceptance of organizational change. The results reveal a strong preference for AI as a supportive tool rather than an autonomous decision-maker. While most respondents are open to redefining their roles, far fewer support structural changes in organizational hierarchies. Strategic planners exhibit more openness to AI integration than operational planners. The findings are discussed in light of current literature, highlighting areas of alignment and divergence, and offering practical recommendations for AI implementation in manufacturing environments. This article is structured as follows: following the introduction, Section 2 reviews relevant literature. Section 3 outlines the methodology, followed by results in Section 4, discussion in Section 5, and conclusions in Section 6. The importance of this topic stems from the accelerating deployment of AI in production environments and the growing need to understand human-AI collaboration dynamics. Despite growing interest in AI integration, relatively little is known about how employees in production planning perceive and respond to such changes. This constitutes a clear research gap.

Literature Review

A frequently addressed issue in the literature is how AI is perceived by its users. As Glikson and Woolley (2020) indicate, a key factor determining the effectiveness of AI implementation is employees' trust in its recommendations and belief in its competence. This trust is built on algorithm transparency, controllability, and positive user experiences. Janiesch et al. (2021) distinguish three levels of AI integration in decision-making processes: decision support, joint decision-making, and full autonomy. Each of these levels generates different organizational and competence requirements. At the decision-support level, AI serves as an analytical tool assisting humans in decision-making. In the joint decision-making model, humans and AI cooperate and share responsibility. Full autonomy assumes decisions are entirely made by AI, which raises the most controversy and resistance. In manufacturing enterprises, there are high expectations of AI focused on improving decision-making speed, scenario analysis, and schedule optimization. As Dwivedi et al. (2021) note, while employees often express positive attitudes towards technology, they are less willing to accept changes in their professional roles. Gursøy

et al. (2019) confirm these findings, pointing out the lack of correlation between the desire to use new technology and readiness to change roles in the decision-making process. The literature also references demographic and professional factors influencing readiness to adopt AI. Other factors such as professional experience, position in the organizational structure, and prior exposure to AI technologies also affect acceptance levels and perceived risks and benefits (Lichtenthaler, 2020). Numerous studies describe AI implementations in manufacturing enterprises and their impact on organizational structures. Zhang et al. (2022) discuss changes in decision-making structures in Chinese factories following the adoption of AI systems. New roles emerged, combining technological and managerial skills—positions like “AI Coordinator” or “Production Data Analyst”. Bibby and Dehe (2018) also observed that employee readiness increases when implementation occurs gradually and involves end users. Heimberger et al. (2024) conducted a comprehensive review of factors influencing AI adoption in production systems, identifying both organizational and technological drivers. Similarly, Müller et al. (2023) proposed a conceptual approach for assessing AI-readiness in German manufacturing firms. Their frameworks are instrumental in shaping structured implementation strategies. Schroeder & Kinkel (2022) empirically linked AI-readiness to organizational resilience, providing insight into how companies can improve adaptability through structured AI deployment. Carutasu & Palade (2021) offer a model of organizational readiness that aligns with digital maturity frameworks. Many studies, including those by Ransbotham et al. (2020), MIT Sloan Management Review, and BCG, indicate that organizational barriers and employee attitudes are significant obstacles to AI implementation. Middle management attitudes, in particular, play a crucial role in the success of AI adoption.

Research Methodology

This study aimed to determine how employees in production planning perceive the role of AI in decision-making structures and how ready they are to reorganize their responsibilities and positions in light of potential AI implementation. An essential part of the study was recognizing how respondents view the role of AI in their tasks and their willingness to accept AI’s involvement in decision-making.

The following research questions were posed:

- RQ1: What AI roles and functions are considered most desirable by employees in production planning?
- RQ2: How ready are employees to delegate decision-making responsibility to AI in various contexts?
- RQ3: What changes in decision-making and organizational structures are acceptable to the respondents?

The study used a questionnaire targeting professionals involved in production planning. It included closed-ended questions, where respondents assessed various proposals using a Likert scale across three areas: anticipated AI functions, level of acceptance of AI decision-making autonomy, and readiness for organizational changes. The questionnaire also included questions about job position, work experience, and familiarity with AI tools.

The survey was conducted online, and participation was voluntary and anonymous. The sample consisted of 104 respondents with varying levels of responsibility and experience in operational and strategic planning. During the study, incomplete and incorrectly filled out answers were rejected. Data were analyzed using descriptive and comparative statistics.

The survey method was chosen due to its suitability in capturing subjective attitudes and readiness assessments across a diverse population. Participants were recruited through professional networks and mailing lists targeting industry professionals. Data collection spanned eight weeks. Although the sample is not statistically representative of all industries, it provides meaningful insights into production planning contexts.

Research Results

The results show a wide range of attitudes toward AI. This variation concerns both the role AI should play in production planning and the readiness for change in workplace

Respondents had different levels of work experience and varying degrees of previous AI exposure. Operational planners tended to be more cautious—preferring AI to be limited to data collection, analysis, and scenario generation, with human verification. Those in higher roles were more open to joint decision-making and AI recommendations for long-term planning.

Work experience also influenced responses: more experienced individuals were more skeptical of full AI autonomy, while less experienced employees were more open to relinquishing some decision-making authority. Respondents with prior AI experience were more ready for changes and more trusting of AI-generated outcomes. They were also more willing to work in teams where AI systems handle analytical tasks.

The majority believed AI should play a supporting and analytical role—generating scenarios, aiding in scheduling, and identifying deviations. Only a minority supported decision-making roles, especially fully autonomous ones. About 70% were open to using AI in an advisory capacity, while only 15% accepted AI making independent decisions in typical operations. The distribution of the above-mentioned responses is presented in Figure 1.

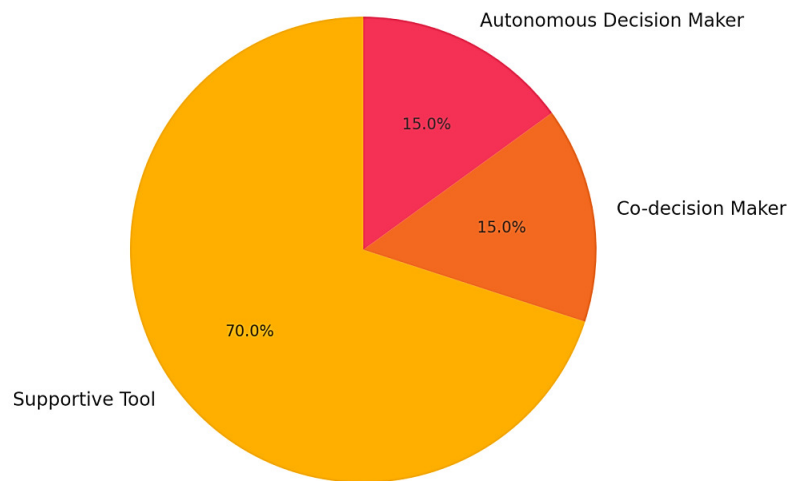


Figure 1. Preferred AI Roles in Decision Processes.

Source: Author's own study.

Readiness to introduce changes in decision-making structures varied: 62% accepted redefining planner roles (e.g., transferring analytical tasks to AI), but only 28% supported changes in formal organizational structures (e.g., creating dedicated AI cooperation teams). Managers were more open to structural changes than non-managerial staff. The distribution of the above-mentioned responses is presented in Figure 2.

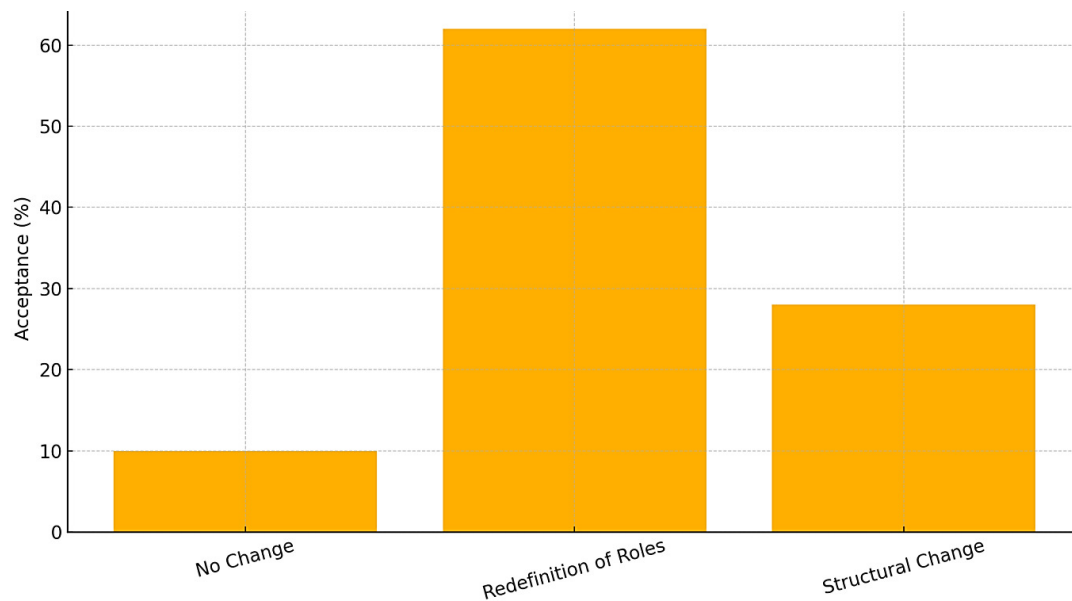


Figure 2. Readiness for Organizational Changes.

Source: Author's own study.

The discrepancy between expectations of AI and readiness for organizational change suggests respondents are attached to existing decision-making models. While they saw AI's value in forecasting and optimization, they were reluctant to change their roles or submit to AI decisions without human oversight.

Given that the largest groups of respondents were operational and strategic planners, a detailed comparison of their responses was conducted. Table 1 presents the distribution of responses from these survey groups in the context of the expected role that AI should play in the enterprise and their willingness to introduce changes in the decision-making structure. The differences between different planners were shown in Table 1.

Table 1.
Differences Between Operational and Strategic Planners

Planner Type	AI as Support (%)	AI as Co-Decider (%)	AI as Autonomous (%)	Role Redefinition Acceptance (%)	Structural Change Acceptance (%)
Operational Planner	78	15	7	55	20
Strategic Planner	65	25	10	70	40

Source: Author's own study.

Operational planners were more skeptical about AI autonomy and less inclined to accept changes in decision-making structures. Strategic planners were more open to shared decision-making and organizational restructuring. Nearly 80% of operational planners saw AI as a decision support tool, while only 7% allowed for full autonomy. In contrast, 25% of strategic planners supported joint decision-making and accepted the possibility of organizational change. More experienced respondents and those previously exposed to AI were more positively inclined toward adopting changes.

Discussion

The findings show a gap between the desire to reap AI benefits and the readiness to alter roles in planning decision-making processes. While participants recognize AI's decision-support potential, they remain wary of autonomous AI decision-making. Readiness to adapt depends on experience, job role, and prior AI exposure. This suggests a state of "adaptive caution", where employees are open to using AI under the condition of maintaining control. This confirms earlier research on the importance of building trust in AI systems (Glikson, Woolley, 2020; Jarrahi, 2018). Compared to previous studies, this research confirms that trust and task clarity are pivotal for AI acceptance. However, unlike Glikson & Woolley (2020), we observed a sharper contrast between openness to AI support and reluctance toward structural reorganization. This may reflect sector-specific conservatism in production planning. Future studies should investigate sectoral variability more deeply. To systematically cultivate trust in AI systems, organizations could implement a multi-stage trust-building framework, involving transparency measures, participatory design, continuous feedback loops, and formal AI training programs. Such structured approaches may bridge the gap between acceptance and active collaboration with AI. The results align with other studies regarding the importance of

trust but also reveal new challenges—high expectations from AI without a corresponding willingness to accept necessary structural changes.

Conclusions

The study revealed a generally positive attitude toward the use of artificial intelligence (AI) in production, especially in roles that enhance and support human decision-making. Most respondents preferred AI as a tool for data analysis, scenario generation, or identifying deviations, rather than as an autonomous decision-maker. This reflects a cautious openness to AI, rooted in a desire to maintain human oversight and control. While participants expressed interest in leveraging AI to improve efficiency, they showed greater willingness to adjust their individual roles than to support structural changes at the organizational level. Redefining responsibilities—such as delegating analytical tasks to AI—was more acceptable than introducing new formal roles or departments dedicated to AI cooperation. Differences in attitudes were also observed based on professional position and experience. Strategic planners were more receptive to integrating AI into long-term decision-making processes, whereas operational planners tended to be more sceptical and preferred clear human control over day-to-day execution. Additionally, individuals with previous exposure to AI systems demonstrated higher trust and readiness for adaptation. Although expectations toward AI were generally high, many respondents hesitated to support deeper transformations that would shift decision-making power or reorganize planning teams. This highlights a gap between the technological potential of AI and the social and organizational readiness for its full integration. Addressing this tension will require not only technical implementation but also active involvement of users, communication, and capacity-building within production environments. The presented research highlights a significant readiness gap in structural transformation related to AI use. While individual-level adaptation is relatively well accepted, systemic organizational change remains a challenge. These findings are relevant not only to production managers but also to AI system designers, who must consider organizational inertia. Limitations include the sample's size and scope. Further research should consider longitudinal tracking of AI-related adaptation across roles and sectors. These findings are reinforced by recent literature, which emphasizes that AI-readiness—both technical and cultural—is crucial for achieving resilience and long-term gains from AI implementation (Heimberger et al., 2024; Carutasu, Palade, 2021).

Acknowledgements

Publication funded by Poznan University of Technology, Faculty of Engineering Management - project number 0812/SBAD/4244.

References

1. Bibby, L., Dehe, B. (2018). Defining and assessing industry 4.0 maturity levels – case of the defence sector. *Production Planning & Control*, 29(12), 1030-1043. <https://doi.org/10.1080/09537287.2018.1503355>
2. Carutasu, G., Palade, M. (2021). Organizational readiness for artificial intelligence adoption. *Scientific Bulletin of Politehnica University of Timișoara, Transactions on Engineering and Management*, 7(1-2), 30-45.
3. Dwivedi, Y.K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., ... & Williams, M.D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 57, 101994. <https://doi.org/10.1016/j.ijinfomgt.2019.08.002>
4. Glikson, E., Woolley, A.W. (2020). Human trust in artificial intelligence: Review of empirical research. *Academy of Management Annals*, 14(2), 627-660. <https://doi.org/10.5465/annals.2018.0057>
5. Gursoy, D., Chi, O.H., Lu, L., Nunkoo, R. (2019). Consumers acceptance of artificially intelligent (AI) device use in service delivery. *International Journal of Information Management*, 49, 157-169. <https://doi.org/10.1016/j.ijinfomgt.2019.03.008>
6. Heimberger, H., Horvat, D., Schultmann, F. (2024). Exploring the factors driving AI adoption in production: A systematic literature review and future research agenda. *International Journal of Information Management*.
7. Janiesch, C., Zschech, P., Heinrich, K. (2021). Machine learning and deep learning. *Electronic Markets*, 31, 685-695. <https://doi.org/10.1007/s12525-021-00475-2>
8. Jarrahi, M.H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, 61(4), 577-586. <https://doi.org/10.1016/j.bushor.2018.03.007>
9. Lichtenthaler, U. (2020). Extremes of acceptance: Employees' responses to artificial intelligence. *Journal of Business Strategy*, 41(6), 13-21. <https://doi.org/10.1108/JBS-12-2019-0259>

10. Müller, F., Hoffmann, A., Weber, C. (2023). Assessing AI-readiness in production—A conceptual approach. *Journal of Manufacturing Technology Management*, 34(2), 123-145.
11. Ransbotham, S., Kiron, D., Gerbert, P., Reeves, M. (2020). The cultural benefits of artificial intelligence in the enterprise. *MIT Sloan Management Review and Boston Consulting Group*. <https://sloanreview.mit.edu/projects/the-cultural-benefits-of-artificial-intelligence-in-the-enterprise/>
12. Schroeder, U., Kinkel, S. (2022). AI-readiness and production resilience: Empirical evidence from European manufacturers. *International Journal of Production Research*, 60(10), 2885-2902.
13. World Economic Forum (2020). *The Future of Jobs Report 2020*. World Economic Forum. <https://www.weforum.org/reports/the-future-of-jobs-report-2020/>
14. Zhang, Q., Yang, L., Portillo, J. (2022). The evolving role of AI-enabled production planners in smart factories: A case from China. *Journal of Manufacturing Systems*, 62, 221-230. <https://doi.org/10.1016/j.jmsy.2021.11.008>

SYNTHETIC KNOWLEDGE AS SYSTEMIC CAPITAL IN THE GOVERNANCE OF GENERATIVE ARTIFICIAL INTELLIGENCE

Marcin GERYK

Jagiellonian University; marcin.geryk@uj.edu.pl, ORCID: 0000-0002-5164-0716

Purpose: The diffusion of generative artificial intelligence signals a structural transformation in the architecture of the knowledge economy. While prior research has focused primarily on automation and augmentation (Raisch, Krakowski, 2021; Shrestha et al., 2019), the systemic implications of generative systems for knowledge as capital remain insufficiently theorized. This paper aims to conceptualize synthetic knowledge as systemic capital and to explain its implications for organizational quality, governance and sustainability.

Design/methodology/approach: This paper conceptualizes synthetic knowledge as systemic capital, that is, algorithmically generated cognitive content produced within concentrated digital infrastructures and mobilized within organizations. Unlike traditional knowledge capital, held by identifiable members of a firm and integrated through processes the firm controls, synthetic knowledge is externally generated, infrastructurally mediated, and materially constrained. Drawing on the knowledge-based view of the firm (Grant, 1996), socio-technical transition theory (Geels, 2002; Markard et al., 2012), and recent scholarship on foundation models and the governance of artificial intelligence (Bommasani et al., 2021, 2024; Burkhardt, Rieder, 2024), the study identifies key structural dynamics of synthetic knowledge production.

Findings: The study identifies three structural tensions: cognitive efficiency versus epistemic autonomy, decentralized access versus infrastructural concentration, and digital productivity versus environmental sustainability.

Research limitations/implications: This study is conceptual in nature and does not rely on primary empirical data; the framework requires validation across sectors and organizational forms.

Practical implications: The findings highlight the need for organizations to develop governance mechanisms for managing synthetic knowledge and epistemic dependencies.

Social implications: The study emphasizes the broader societal importance of responsible governance of artificial intelligence and of attention to sustainability.

Originality/value: The article develops a conceptual framework linking infrastructural concentration, epistemic asymmetry, organizational quality, environmental externalities, and regulatory governance, including the European Artificial Intelligence Act. It argues that generative artificial intelligence should be understood not as a neutral tool but as a reorganization of cognitive capital embedded in infrastructural and ecological constraints.

Keywords: synthetic knowledge; generative artificial intelligence; epistemic asymmetry; organizational quality; governance; sustainability.

Category of the paper: Conceptual paper.

1. Introduction

The contemporary knowledge economy is undergoing a structural transformation driven by the diffusion of generative artificial intelligence. Large language models and foundation models increasingly support decision-making, innovation, and knowledge-intensive work (Bommasani et al., 2021; Dwivedi et al., 2023). Yet management research continues to interpret artificial intelligence primarily through automation, augmentation, and algorithmic control (Raisch, Krakowski, 2021; Shrestha et al., 2019; Kellogg et al., 2020). Less attention has been paid to how generative artificial intelligence reshapes the architecture of knowledge as capital.

Within the knowledge-based view of the firm, the firm is an institution for integrating the specialized knowledge held by its individual members (Grant, 1996), while a second line within the same literature admits the collective knowledge of social groups and treats knowledge as a process (Spender, 1996). Competitive advantage derives from integrating competencies, routines, and learning processes, while organizational learning theories emphasize reflexivity and adaptation as foundations of quality and long-term development (Argyris, Schön, 1978; Senge, 1990; Nonaka, 1994). Knowledge capital, in this perspective, remains largely subject to managerial governance.

Generative artificial intelligence disrupts this configuration. Synthetic knowledge, algorithmically recombined content produced within large-scale computational infrastructures, originates outside the firm and is integrated into internal processes. Knowledge production becomes partially externalized: instead of emerging primarily through collective learning, it is accessed through prompts and platform-mediated interfaces. The locus of cognitive production shifts from organizational practice to infrastructural systems operating at planetary scale.

For the purposes of this article, synthetic knowledge is understood as algorithmically generated and organizationally mobilized cognitive content produced by generative artificial intelligence systems on the basis of large-scale model architectures, training data, optimization procedures, and user prompts. Unlike ordinary digital information or automated data processing, it produces linguistically intelligible, context-sensitive and decision-relevant outputs that can be incorporated into organizational reasoning, planning, communication, innovation, and quality governance. This understanding is consistent with recent research on artificial knowledge generation, which shows that generative artificial intelligence introduces a machine-mediated dimension into knowledge management and challenges traditional models of knowledge creation (Alavi, Leidner, Mousavi, 2024; Cerchione, Liccardo, Passaro, 2026). Synthetic knowledge is therefore not knowledge in the classical epistemological sense of justified true belief. Setting truthfulness aside as the defining attribute is not new to organization theory: Nonaka (1994) invoked that classical definition only to shift its emphasis toward justification, understood as a process of convergence and screening carried out within

an organization. Synthetic knowledge is a functional organizational resource: a probabilistic, model-mediated cognitive output that becomes knowledge-like when used within managerial and institutional decision processes.

This shift aligns with analyses of platform capitalism and data-driven accumulation (Srnicek, 2017; Zuboff, 2019). Platforms function as organizational forms oriented toward data extraction and infrastructural control, while foundation models mediate access to computationally generated cognition (Burkhardt, Rieder, 2024). Organizations thus rely on outputs whose training regimes and optimization logics remain only partially transparent. Such dependence generates epistemic asymmetry and redistributes cognitive authority beyond firm boundaries.

At the same time, synthetic knowledge is materially grounded. Training and deploying large-scale models require energy-intensive data centers and global hardware supply chains (Strubell et al., 2019; Patterson et al., 2021). From a socio-technical transition perspective (Geels, 2002; Markard et al., 2012), generative artificial intelligence is embedded in socio-technical regimes that include energy supply rather than standing apart from them. Cognitive efficiency coexists with material expansion and environmental cost.

These dynamics coincide with a regulatory turn. The European Artificial Intelligence Act (European Union, 2024) introduces a risk-based governance architecture focused on transparency and accountability. Scholarship increasingly links artificial intelligence risks to institutional responsibility (Wirtz et al., 2022), while policy debate on foundation models turns on how the manner of model release affects competition and the innovation ecosystem (Bommasani et al., 2024). Synthetic knowledge cannot be treated as a neutral productivity tool; it embeds organizations in infrastructures characterized by concentration, opacity, and environmental impact.

Despite growing scholarship, the transformation of knowledge as capital under conditions of infrastructural concentration and ecological constraint remains theoretically fragmented. Automation, digital transformation, governance, and sustainability are often examined separately. Their interdependence has yet to be theorized in systemic terms.

Although recent literature has increasingly addressed generative artificial intelligence in knowledge management, foundation model governance and digital transformation, these debates remain only partially integrated from the perspective of management and quality sciences. Existing studies identify the disruptive role of generative artificial intelligence in knowledge processes and emphasize the need for further conceptual models and empirical research (Strelau, 2025; Cerchione, Liccardo, Passaro, 2026). However, the literature still insufficiently explains how generative systems transform knowledge capital when cognitive outputs are produced outside the firm, within concentrated computational infrastructures, and then incorporated into organizational decision-making under conditions of epistemic opacity and environmental constraint. This article addresses this gap by conceptualizing synthetic knowledge as systemic capital.

The aim of this article is to conceptualize synthetic knowledge as systemic capital and to explain its implications for organizational quality, governance and sustainability under conditions of infrastructural concentration and epistemic asymmetry.

The article addresses three research questions:

RQ1: How does generative artificial intelligence transform knowledge from an organizational resource into infrastructurally mediated systemic capital?

RQ2: How does epistemic asymmetry emerge under conditions of dependence on foundation model infrastructures?

RQ3: How do infrastructural concentration, governance and environmental constraints interact in shaping synthetic knowledge?

This paper argues that generative artificial intelligence represents a structural reconfiguration of knowledge production and mobilization. When knowledge is generated within concentrated computational infrastructures and accessed through platform-mediated architectures, organizations do not simply extend their capabilities; they become embedded in external systems whose material and political conditions exceed their direct control.

2. Methodological Approach

This article is conceptual in nature and follows a theory-building approach based on integrative literature synthesis. In the terms proposed by Jaakkola (2020), the design corresponds to theory synthesis, in which concepts drawn from separate literatures are integrated to account for a phenomenon that none of them explains on its own. It does not test empirical hypotheses through primary data collection. Instead, it develops a conceptual framework by analytically integrating three research streams: the knowledge-based view of the firm and organizational learning, socio-technical transition theory, and recent scholarship on foundation models, artificial intelligence governance and sustainability. Such an approach is justified when the aim of the study is not to measure an already stabilized phenomenon, but to clarify emerging constructs, identify relationships between fragmented debates and propose a theoretical model for future empirical testing. Conceptual articles are particularly relevant when emerging phenomena require theoretical clarification before mature indicators and standardized measurement procedures can be developed (Gilson, Goldberg, 2015; Jaakkola, 2020).

The analysis proceeded in three stages. First, the article reviewed foundational contributions on knowledge as an organizational resource and source of competitive advantage. Second, it examined contemporary research on generative artificial intelligence, foundation models, algorithmic governance, infrastructural concentration and environmental externalities. Third, it synthesized these strands into a multi-layered conceptual model linking infrastructural

production, epistemic mediation, organizational quality, systemic externalities and regulatory governance. The value of this approach lies not in statistical generalization, but in conceptual integration, theoretical clarification and the formulation of propositions that may guide future empirical research. The limits of the procedure are those of any conceptual design and are stated in section 13.2.

3. Knowledge as Capital in Management and Quality Sciences: From Organizational Resource to Systemic Architecture

Within management and organization theory, knowledge has long been treated as a strategic organizational resource. The knowledge-based view of the firm posits that sustainable competitive advantage derives from the integration and application of the specialized knowledge held by individual members, coordinated through rules and directives, sequencing, routines, and group problem solving (Grant, 1996). Each of these mechanisms presupposes common knowledge, among them shared language, shared meaning and mutual recognition of one another's knowledge domains, which together allow specialists to combine what they know without transferring it in full. Kogut and Zander (1992) held that what firms do better than markets is the sharing and transfer of the knowledge of their members, and proposed an account of firm boundaries that does not appeal to opportunism. Together, these contributions established knowledge as a central explanatory variable in strategic management and positioned the firm as the primary locus of cognitive coordination.

Importantly, knowledge was never regarded as static. Nonaka's (1994) theory of knowledge creation emphasized the dynamic interplay between tacit and explicit knowledge, highlighting dialogue and shared experience as drivers of innovation. Dynamic capabilities theory further argued that competitiveness rests on distinctive processes for coordinating and combining resources, on the asset positions a firm holds, among them its portfolio of difficult-to-trade knowledge assets, and on the evolution paths it has inherited (Teece, Pisano, Shuen, 1997). In this tradition, knowledge capital is inseparable from learning, reflexivity, and internal governance. Whether the firm is held to generate its cognitive assets or chiefly to apply them, it is the firm that stewards them.

The assumption that knowledge is created and governed primarily within organizational boundaries has shaped management and quality research. Continuous improvement and organizational excellence are typically conceptualized as internally coordinated processes. Even within networks or ecosystems, ultimate responsibility for knowledge integration remains anchored at the firm level.

The diffusion of generative artificial intelligence introduces a structural shift. Artificial intelligence has often been framed as automation or augmentation (Raisch, Krakowski, 2021), yet its deeper significance lies in the relocation of knowledge production itself. Increasingly, cognitive inputs integrated into organizational processes are generated within external computational infrastructures rather than cultivated through internal learning cycles. Large language models produce synthetic outputs incorporated into planning and strategy without being embedded in organizational experience. The firm is no longer the exclusive site of cognitive production.

Research on artificial intelligence capability defines such a capability as the ability of a firm to select, orchestrate and leverage its own artificial intelligence resources (Mikalef, Gupta, 2021). Once the decisive resource is a model that the firm neither trains nor owns, the same logic must be applied to an asset lying beyond its boundary. Algorithmic systems influence decision structures, evaluation criteria, and control mechanisms (Kellogg et al., 2020), shaping how knowledge is interpreted and operationalized. Knowledge capital thus becomes partially infrastructuralized: generated at scale within concentrated computational systems and deployed within organizational contexts.

This infrastructuralization redefines knowledge mobilization. Organizations increasingly mobilize synthetic outputs trained on globally aggregated data rather than solely transforming internally generated insights. The boundary between internal and external knowledge becomes porous, and validation is mediated through platform architectures. The conditions under which knowledge is produced and governed extend beyond the firm into broader socio-technical systems.

This transformation is consequential for management and quality sciences. If knowledge production is partially externalized, organizational autonomy and quality governance can no longer rely exclusively on internal routines. Quality becomes tied to the governance of interfaces between organizations and algorithmic infrastructures. Transparency, reliability, bias, and systemic dependency move to the center of strategic concern. The knowledge-based view remains analytically powerful, but it requires expansion to incorporate the systemic dimension of cognitive capital in digitally mediated and infrastructurally concentrated environments.

Knowledge as capital must therefore be reconsidered not only as an internal strategic asset but as part of a distributed socio-technical architecture in which production, validation, and valorization span organizational and infrastructural domains. This reconfiguration provides the theoretical basis for conceptualizing synthetic knowledge as systemic capital, that is, as capital whose value and control are shaped not solely by firm-level capabilities but also by the political economy and material conditions of digital infrastructures.

4. Synthetic Knowledge and the Transformation of Value Creation in Knowledge-Intensive Systems

Synthetic knowledge differs fundamentally from expert or experiential knowledge embedded in organizational routines. It does not arise from situated practice, tacit understanding, or cumulative institutional memory. Instead, it is generated through large-scale probabilistic modeling across distributed data corpora (Bommasani et al., 2021). Unlike the knowledge creation processes described in classical organizational theory (Nonaka, 1994), it does not emerge from social interaction or tacit–explicit conversion, but from computational recombination at infrastructural scale.

This ontological distinction reshapes value creation. In the knowledge-based view, firms generate value by integrating internally developed knowledge resources (Grant, 1996). Competitive advantage stems from distinctive combinations of skills and learning processes that are difficult to replicate. Under generative artificial intelligence, however, value increasingly depends on the capacity to mobilize externally generated synthetic outputs. The source of cognitive input shifts from organizational memory toward platform-mediated computation. Value creation moves from knowledge integration toward knowledge interface management.

Research on human–algorithm collaboration indicates that generative systems do more than automate tasks (Raisch, Krakowski, 2021; Dwivedi et al., 2023). They shape strategic framing, structure interpretive horizons, and influence decision alternatives (Shrestha et al., 2019). The architecture of value creation becomes co-produced by organizational actors and algorithmic infrastructures. The firm's role evolves from primary producer of knowledge to orchestrator of distributed cognitive resources.

Foundation models operate as infrastructural platforms whose governance structures shape how knowledge is produced, accessed, and updated (Burkhardt, Rieder, 2024). Epistemic authority is increasingly mediated by algorithmic architectures rather than professional communities or hierarchical expertise. The locus of validation shifts toward infrastructural systems that remain only partially transparent to their users.

This shift generates a structural decoupling between knowledge production and responsibility. Organizations may rely on synthetic outputs without controlling training data regimes, optimization logics, or update cycles. Research on algorithmic management shows how such opacity reshapes authority and accountability (Kellogg et al., 2020). Responsibility for outcomes remains internal, while cognitive processes are externally generated and only partially observable.

Competitive advantage therefore rests less on proprietary knowledge assets and more on epistemic capability, that is, the ability to evaluate, contextualize and govern synthetic knowledge flows. Assessing reliability, detecting bias, and aligning outputs with organizational

objectives become core competencies. In knowledge-intensive systems, managing the interface between human judgment and synthetic cognition becomes central to sustained value creation.

The environmental dimension further complicates this transformation. Synthetic knowledge production is computationally intensive and materially embedded in energy-consuming infrastructures (Strubell et al., 2019; Patterson et al., 2021). The apparent immateriality of digital cognition conceals its dependence on hardware, electricity grids, and global supply chains. Efficiency gains may coexist with infrastructural expansion and ecological externalities.

Synthetic knowledge thus reconfigures not only how value is generated but how it is distributed and externalized. The shift from internally embedded knowledge to infrastructurally mediated outputs restructures knowledge-intensive systems across organizational, infrastructural, and ecological domains. Competitive advantage becomes intertwined with platform governance and environmental constraint. This systemic transformation provides the conceptual bridge toward understanding synthetic knowledge as systemic capital.

5. Concentration of Cognitive Capital as a Structural Risk

The expansion of generative language models has not only transformed knowledge production; it has intensified the concentration of cognitive infrastructure. Traditional knowledge resources were dispersed across firms, universities and professional communities, whereas the development and operation of large-scale generative models require substantial computational capacity, proprietary datasets, and advanced engineering expertise. These requirements can be met by only a limited number of globally dominant actors (Bommasani et al., 2021). The material foundations of synthetic knowledge are therefore structurally centralized.

This concentration reflects broader dynamics of platform capitalism. Control over data, models, and computational infrastructures generates asymmetries between infrastructure providers and dependent organizational users (Srnicsek, 2017; Kenney, Zysman, 2016). Foundation models function as infrastructural platforms that shape downstream innovation ecosystems and redistribute value toward model owners (Burkhardt, Rieder, 2024). Organizations may integrate synthetic outputs into their operations, yet they remain positioned downstream within hierarchies of infrastructural control.

From a management perspective, this development redefines the locus of cognitive capital. In the classical knowledge-based view, competitive advantage derived from firm-specific capabilities and internally embedded knowledge (Grant, 1996). Under the generative paradigm, critical components of cognitive capital reside outside the organization, within proprietary infrastructures operating at global scale. The firm becomes an integrator of cognitive resources rather than their primary producer.

This relocation produces epistemic asymmetry. Organizations may access synthetic outputs but lack meaningful influence over training data regimes, optimization parameters, update cycles, and embedded assumptions. Unlike classical information asymmetry (Akerlof, 1970), which concerns unequal access to information, epistemic asymmetry concerns unequal control over the architectures that generate and structure knowledge. The asymmetry is procedural and infrastructural.

Epistemic asymmetry can be analytically distinguished from information asymmetry along four dimensions. First, it is architectural rather than transactional: the asymmetry concerns control over model design, training data, optimization objectives and update cycles, rather than unequal possession of information alone. Second, it is procedural rather than episodic: it affects the conditions under which outputs are generated before they enter organizational decision-making. Third, it is interpretive rather than merely informational: it shapes what becomes visible, plausible, prioritized or excluded in organizational cognition. Fourth, it is infrastructural rather than interpersonal: it is embedded in platform architectures and computational infrastructures rather than only in relations between buyers and sellers or principals and agents. Recent research on generative artificial intelligence and epistemic justice similarly indicates that these systems mediate access to knowledge, epistemic agency and knowledge hierarchies across institutional and infrastructural contexts (Olaniyan, Martins, Al Maqrashi, 2026).

Dependence of this kind strains governance structures. Automated decision-making removes the human decision-maker to whom a judgment could previously be appealed, leaving fewer points at which an outcome can be contested (Kellogg et al., 2020). Responsibility remains internal while epistemic control does not.

Technological scaling dynamics reinforce this pattern. Performance improvements in large models often follow power-law relationships with respect to model size, data volume, and computational resources, and a compute-optimal allocation of a fixed budget directs most of any increase toward model size rather than toward data volume or training time (Kaplan et al., 2020). Scaling of this kind privileges actors capable of financing and maintaining very large infrastructures. Concentration thus appears less as a market outcome than as a structural feature of the technological architecture itself.

The resulting configuration is layered. Generative infrastructures occupy an upper tier defined by capital intensity, scale, and platform governance, while organizations operate as downstream integrators of synthetic outputs. This architecture reshapes epistemic authority and the capacity to define legitimate or actionable knowledge. Epistemic pluralism may narrow as dominant architectures standardize interpretive frames, since the defects, biases and blind spots of a small number of upstream models propagate to every application built on them (Bommasani et al., 2021).

Concentration also intersects with environmental constraints. Large-scale training and inference infrastructures require continuous energy inputs (Strubell et al., 2019; Patterson et al., 2021). As computational scale expands, so does reliance on energy-intensive ecosystems.

Concentration therefore entails not only control over knowledge production but also control over resource-intensive infrastructures that shape long-term sustainability trajectories.

Concentration of cognitive capital thereby introduces a new form of dependency. Organizational autonomy can no longer be defined solely in terms of internal capabilities. It must extend to cognitive autonomy, meaning the capacity to evaluate and govern synthetic knowledge within infrastructurally concentrated and environmentally constrained systems.

Recognizing concentration as a structural risk does not imply technological determinism. A technological path frames the choices available without settling in advance which trajectory will be followed (Kenney, Zysman, 2016). What concentration underscores is the need for governance capable of balancing efficiency gains with epistemic plurality, competitive fairness and sustainability. This recognition prepares the ground for a deeper analysis of epistemic asymmetry and cognitive value redistribution.

6. Epistemic Asymmetry and the Redistribution of Cognitive Value

The concentration of generative infrastructures restructures not only knowledge production but also the distribution of cognitive value. As organizations increasingly rely on synthetic outputs in strategic and operational decisions, the processes generating these outputs remain external and only partially transparent. Epistemic asymmetry thus becomes a mechanism of value redistribution.

The asymmetry described in the preceding section operates here as a mechanism of distribution rather than of production. Organizations may access model-generated outputs, yet they do not govern data selection regimes, optimization logics, or scaling strategies (Burkhardt, Rieder, 2024). Cognitive authority is progressively decoupled from organizational boundaries and relocated to infrastructural providers.

This relocation reshapes competitive advantage. In the knowledge-based tradition, firms created value through proprietary capabilities and asset positions accumulated along paths competitors could not easily retrace (Grant, 1996; Teece et al., 1997). Under synthetic knowledge production, value increasingly depends on the capacity to orchestrate externally generated cognitive outputs. Competitive differentiation shifts from knowledge ownership to epistemic governance.

A set of meta-capabilities emerges accordingly: evaluating algorithmic outputs, detecting bias, ensuring contextual alignment, and embedding synthetic knowledge within accountable governance structures. Risk and guideline frameworks developed for the governance of artificial intelligence supply part of the ground for such capabilities (Wirtz et al., 2022), while the range of concerns raised across disciplines indicates how wide the required competence has become (Dwivedi et al., 2023). Epistemic capability becomes a core organizational

competence. Firms compete less through accumulation of knowledge assets than through their ability to critically manage synthetic knowledge flows.

At the systemic level, cognitive value is co-produced yet asymmetrically appropriated. Organizations contribute data, usage patterns, and contextual expertise to generative infrastructures, often without commensurate influence over model development or value capture. Infrastructure providers consolidate value through ownership, access control, and platform positioning (Burkhardt, Rieder, 2024). This dynamic reflects broader patterns of data-driven accumulation in platform economies (Zuboff, 2019).

Epistemic asymmetry also affects interpretive diversity. Reliance on similar foundation models may narrow strategic framings and reduce epistemic plurality, constraining innovation trajectories (Bommasani et al., 2021).

The environmental dimension adds further complexity. Economic and strategic benefits of synthetic knowledge are widely distributed, while environmental costs of large-scale training and inference remain concentrated within infrastructural ecosystems (Strubell et al., 2019; Patterson et al., 2021). Accountability becomes blurred as cognitive value and ecological burden are allocated differently.

Epistemic asymmetry is, on this reading, a governance problem rather than a technical one. Quality must include the capacity to preserve interpretive autonomy, critically evaluate synthetic outputs, and align algorithmic integration with transparent and responsible practices.

Synthetic knowledge therefore reconfigures not only who produces knowledge, but how cognitive value is generated, appropriated, and externalized. Epistemic asymmetry emerges as a defining characteristic of contemporary knowledge systems, demanding new organizational capabilities and governance frameworks oriented toward competitive fairness, sustainability, and cognitive plurality.

7. Organizational Quality and Development under Conditions of Epistemic Asymmetry

The concentration of cognitive infrastructure and the redistribution of synthetic knowledge reshape not only competitive dynamics but also the foundations of organizational quality. In classical management thought, quality was associated with internal learning, feedback loops, and continuous improvement (Deming, 1986; Sousa, Voss, 2002). Organizational development presupposed coherence: knowledge production, decision authority, and accountability were embedded within the same institutional boundaries.

Under conditions of synthetic knowledge, this coherence becomes partially decoupled. Organizations integrate externally generated cognitive outputs into strategic and operational processes, while the epistemic conditions of their production remain external. The locus of

knowledge generation and the locus of responsibility no longer fully coincide. This structural misalignment introduces new challenges for quality governance.

Organizational quality can no longer be defined solely in terms of procedural compliance or internal efficiency. It must incorporate epistemic capability, exercised within decision processes. Research on algorithmically mediated organizations emphasizes human oversight and structured validation, and distinguishes three structures in which human and machine decisions can be combined: full delegation, hybrid sequential arrangements, and aggregation of human and machine judgments (Shrestha et al., 2019; Wirtz et al., 2022). Synthetic outputs cannot replace internal expertise; they must be embedded within reflexive governance architectures.

From the perspective of dynamic capabilities theory, the processes through which a firm coordinates and combines its knowledge assets increasingly require meta-governance capacities; those assets were characterized as difficult to trade (Teece et al., 1997), whereas an asset rented from an external provider is not. Organizations must not only deploy synthetic knowledge but also assess its reliability, bias structures, and contextual limitations. Competitive advantage becomes tied to the governance of interfaces between human judgment and algorithmic systems.

Algorithmic mediation further reshapes organizational control. Studies of algorithmic management show how decision authority may drift toward data-driven systems, weakening accountability and narrowing interpretive diversity (Kellogg et al., 2020). In this context, quality management must address transparency, auditability, and responsibility for algorithmically supported decisions.

The challenge intensifies when synthetic knowledge informs strategic direction. If multiple organizations rely on similar foundation models, convergence of interpretive frames may reduce epistemic diversity across sectors. Homogenized cognitive inputs increase the risk of correlated errors and systemic fragility. Resilience literature highlights diversity, redundancy, and continuous learning as foundations of adaptive capacity (Duchek, 2020). Under epistemic asymmetry, resilience must extend beyond operational robustness toward epistemic resilience, meaning the capacity to preserve interpretive autonomy despite infrastructural dependence.

These dynamics intersect with sustainability. Generative infrastructures are materially embedded in energy-intensive systems (Strubell et al., 2019; Patterson et al., 2021). Organizational development cannot be evaluated solely through cognitive efficiency or innovation speed; it must account for environmental externalities and infrastructural lock-in effects. Long-term quality includes the material conditions under which knowledge is generated.

Under epistemic asymmetry, organizational development becomes a multidimensional governance challenge. It requires balancing cognitive efficiency with interpretive autonomy, infrastructural dependency with internal capability development, and digital productivity with

environmental responsibility. Quality management thus evolves from an operational function into a systemic governance capacity embedded in organizational strategy.

8. Governance Implications: Cognitive Capital and the European Regulatory Turn

The concentration of synthetic knowledge infrastructures and the resulting epistemic asymmetry raise fundamental governance questions. When organizations depend on cognitive resources generated within highly concentrated infrastructures, quality and development can no longer be governed exclusively at the firm level. Governance becomes multi-layered, spanning organizational, infrastructural, and institutional domains.

Contemporary scholarship emphasizes that artificial intelligence governance must integrate transparency, accountability, and risk management at systemic levels (Wirtz et al., 2022). AI systems are not isolated tools but components of socio-technical ecosystems marked by dependency and power asymmetry (Burkhardt, Rieder, 2024). Governance therefore cannot be reduced to procedural compliance; it must address the structural conditions under which knowledge is generated, distributed, and mobilized.

The European Artificial Intelligence Act (European Union, 2024) exemplifies this regulatory turn. By introducing a risk-based framework and obligations concerning documentation, transparency, and human oversight, the Act seeks to reassert institutional control over increasingly autonomous systems. For management theory, this marks a shift: organizations are not passive users of technology but accountable participants in distributed knowledge infrastructures.

However, the European Artificial Intelligence Act should not be interpreted as a complete solution to the structural tensions identified in this article. Its risk-based architecture strengthens transparency, documentation and human oversight, but it remains primarily oriented toward the regulation of systems and uses rather than toward the political economy of cognitive infrastructure itself. Recent analyses of the European model of artificial intelligence governance note that the Act joins risk regulation to the protection of fundamental rights, set within objectives of market harmonization (Hulok, 2025). Its practical operation depends on institutional design, including the European AI Office and codes of practice for general-purpose models, and on its interaction with the General Data Protection Regulation, the Data Act, the Digital Services Act and the Digital Markets Act (Graux et al., 2025). From the perspective developed here, regulatory compliance is necessary but insufficient. Organizations may formally comply with regulatory requirements while still remaining dependent on opaque, concentrated and environmentally intensive infrastructures of synthetic knowledge production.

Debates on foundation model governance reinforce this transformation. Central to policy discussion is the manner in which models are released, and the uneven bearing of regulatory proposals on open and closed models and therefore on competition (Bommasani et al., 2024). Because generative models function as infrastructural platforms, governance must address both downstream applications and upstream architectures. Cognitive capital is embedded within layered regimes of ownership, access, and control.

For management and quality sciences, this development redefines organizational responsibility. Synthetic knowledge cannot be treated as a neutral input into decision-making. Firms must institutionalize governance mechanisms ensuring transparency in the integration of generative outputs, traceability of algorithmically supported decisions, structured human oversight, and alignment with sustainability objectives. Governance thus becomes integral to quality architecture rather than an external compliance requirement.

Regulatory compliance also reshapes competitive dynamics. The ability to embed governance standards within organizational routines may become a source of legitimacy, resilience, and strategic differentiation. Governance capability itself emerges as a dimension of cognitive capital.

These institutional transformations are inseparable from environmental considerations. Generative infrastructures depend on energy-intensive data center architectures (Strubell et al., 2019; Patterson et al., 2021). If governance seeks to rebalance power and accountability in knowledge production, it must also address the material conditions under which synthetic knowledge is sustained. The governance of cognitive capital therefore extends to resource use, energy intensity, and infrastructural sustainability.

In this systemic sense, governance functions as a balancing mechanism for the tensions identified throughout this study: between cognitive efficiency and epistemic autonomy, decentralized access and infrastructural concentration, and digital productivity and environmental sustainability. The European regulatory turn illustrates how public policy can reshape the architecture of cognitive capital and influence the conditions under which knowledge is mobilized and valorized.

The central question is not only who controls cognitive capital, but under what governance and environmental constraints it can be legitimately and sustainably deployed.

9. Environmental Footprint of Synthetic Knowledge: Sustainability as a Structural Constraint

The environmental footprint of synthetic knowledge challenges the narrative of digital dematerialization. Generative systems are often portrayed as weightless cognitive tools, yet their operation depends on energy-intensive data centers, high-performance computing

clusters, specialized hardware, and global supply chains. The training and deployment of large language models require substantial electricity consumption and generate measurable carbon emissions (Strubell et al., 2019; Patterson et al., 2021). The later of these two studies also identifies considerable scope for improvement: large but sparsely activated networks can consume less than a tenth of the energy of dense networks without loss of accuracy. It revises, moreover, the most widely cited earlier estimate downward by a large factor, once the actual hardware, data center and proxy task are taken into account (Patterson et al., 2021). Estimates in this area are therefore provisional, which is itself an argument for the reporting requirements both studies propose. Synthetic knowledge is materially embedded in energy systems rather than detached from them.

Environmental implications extend beyond direct electricity use. Assessment must weigh direct effects against indirect ones, among them the influence such systems exert on environmental research, on education and on public understanding (Rillig et al., 2023). From a sustainability transition perspective, technological innovation unfolds within socio-technical systems shaped by infrastructures and resource flows (Geels, 2002; Markard et al., 2012). Generative infrastructures represent an expanding layer within this architecture, intensifying electricity demand and potentially conflicting with decarbonization trajectories.

This creates a structural tension in knowledge-intensive systems. Generative artificial intelligence enhances cognitive efficiency and accelerates information processing, yet efficiency gains at the informational level may coincide with rising aggregate energy demand. Rebound effects are plausible: improved model performance can stimulate broader adoption and further infrastructural expansion. Digital productivity does not automatically reduce material intensity.

The environmental dimension is closely linked to infrastructural concentration. Actors controlling large-scale generative infrastructures also control energy-intensive computational architectures. As cognitive capital centralizes, environmental externalities concentrate within the same nodes. Governance of synthetic knowledge therefore requires not only oversight of epistemic processes but also scrutiny of energy use, carbon intensity, and infrastructural sustainability.

Taxonomies of risks and guidelines for the governance of artificial intelligence are organized around technological, data-related and analytical dimensions among others (Wirtz et al., 2022); material and energy-related risk has so far occupied a marginal position in them. If generative infrastructures become integral to organizational cognition, environmental accountability cannot remain peripheral. Sustainability becomes a structural constraint on the mobilization and commercialization of synthetic knowledge.

Organizational development cannot, in this light, be evaluated solely through productivity gains. It must incorporate environmental performance indicators associated with digital infrastructures, in the spirit of assessment across economic, social and environmental dimensions (Elkington, 1997). Quality, in this expanded understanding, encompasses epistemic

robustness, governance integrity, and environmental responsibility as interdependent dimensions.

Synthetic knowledge thus possesses a dual character: it is simultaneously cognitive and energetic. Its informational advantages are inseparable from material and ecological costs. Recognizing this duality is essential for governance frameworks seeking to reconcile efficiency, epistemic autonomy, competitive dynamics, and sustainability.

Read alongside infrastructural concentration and epistemic asymmetry, the environmental dimension confirms that these processes are structurally interdependent. Synthetic knowledge operates within a layered architecture linking computational scale, value redistribution, governance regimes, and material constraints. The analytical task is therefore integrative rather than fragmentary.

10. Synthetic Knowledge as Systemic Capital: Toward an Integrated Framework

The preceding analyses show that generative artificial intelligence is not simply a technological innovation but a reconfiguration of cognitive capital. Synthetic knowledge is generated within concentrated infrastructures, mobilized within organizations, and shaped by governance regimes and environmental constraints that extend beyond firm boundaries. Its production and valorization unfold across infrastructural, organizational, and institutional layers.

To capture these dynamics, synthetic knowledge can be conceptualized as systemic capital. The term is used here in a sense already available within the knowledge-based literature. Spender (1996) observes that systems theory bridges two levels of analysis, the functioning system and its components, and that systemic properties arise from the activities between them. Identical systemic characteristics, he notes, can be produced from components of different kinds. When the component supplying cognition changes from a human specialist to a model, the system may continue to display much the same properties while what produces them has changed entirely. Unlike traditional knowledge capital, which resides in the people and processes of a single organization, systemic cognitive capital is externally generated, infrastructurally mediated, and materially constrained. Its value depends not only on internal capabilities but on the architecture of infrastructures, governance arrangements, and ecological limits within which it operates.

Three interdependent dimensions define this configuration:

- First, infrastructural concentration. Synthetic knowledge is produced within centralized architectures characterized by capital-intensive infrastructures, proprietary datasets, and large-scale computational capacity. Control over these infrastructures shapes access to cognitive resources and structures value distribution.
- Second, epistemic asymmetry. Organizations integrate synthetic outputs into decision-making without governing the conditions of their production. Interpretive authority shifts toward infrastructural platforms, redistributing cognitive power.
- Third, environmental constraint. The production and scaling of synthetic knowledge depend on energy-intensive infrastructures, embedding cognitive capital within material and ecological boundaries. Knowledge creation is inseparable from resource use and sustainability trade-offs.

These dimensions are mutually reinforcing. Concentration amplifies epistemic asymmetry by centralizing control over model development. Asymmetry increases reliance on governance mechanisms designed to ensure transparency and accountability. Governance frameworks increasingly incorporate sustainability criteria, while ecological constraints influence infrastructural investment and scaling strategies. Synthetic knowledge capital thus emerges as a relational system shaped by feedback between technological scale, institutional governance, and ecological limits.

From a management and quality perspective, this configuration requires a strategic shift. Organizational development cannot be reduced to internal capability accumulation. Firms must cultivate epistemic capability while embedding governance standards and sustainability considerations into decision-making. Organizational quality becomes inseparable from responsible participation in infrastructurally concentrated and environmentally constrained systems.

The theoretical contribution of this framework lies in reframing generative artificial intelligence as a reorganization of cognitive capital within a layered socio-technical architecture. Conceptualizing synthetic knowledge as systemic capital integrates management theory, governance scholarship, and sustainability transition research into a unified explanatory model. The analytical focus moves from firm-level knowledge possession to system-level knowledge orchestration under conditions of concentration and ecological constraint.

Reconceptualizing synthetic knowledge in this way also alters its valuation. Unlike traditional intellectual capital, largely detached from material intensity, synthetic knowledge capital is intrinsically tied to computational infrastructures whose scale determines both competitive advantage and environmental burden. Its assessment must incorporate infrastructural dependency and ecological externalities as structural parameters. A balanced development model therefore requires alignment between organizational quality management and sustainability governance.

This integrated framework provides the basis for articulating a formal systemic model of synthetic knowledge capital, specifying the relational architecture linking infrastructural concentration, epistemic asymmetry, organizational quality, governance mechanisms, and environmental constraints.

11. Results of the Conceptual Analysis

The conceptual analysis conducted in this study leads to three key findings: synthetic knowledge is produced within concentrated infrastructures, it generates epistemic asymmetry in organizational use, and it remains materially constrained by environmental externalities. On this basis, the model below translates these three findings into five interdependent layers. Rather than treating infrastructure, epistemic mediation, organizational quality, externalities, and governance as separate variables, the model conceptualizes them as elements of a single architecture, one that produces cognition, redistributes authority, and redefines responsibility.

Layer 1: Infrastructural production. Synthetic knowledge is generated within concentrated computational architectures characterized by large-scale data aggregation, advanced engineering capacity, and energy-intensive infrastructures (Bommasani et al., 2021), where performance follows power-law relationships with model size, data volume and computing resources (Kaplan et al., 2020). This layer establishes the material and economic conditions of cognitive production and scaling.

Layer 2: Epistemic mediation. Organizations integrate model-generated outputs into decision processes without controlling training regimes, optimization logics, or update cycles. The result is epistemic asymmetry: interpretive authority shifts toward infrastructural platforms while generative processes remain partially opaque (Burkhardt, Rieder, 2024).

Layer 3: Organizational integration and quality governance. Synthetic outputs are mobilized in strategy and operations. Organizational quality depends on epistemic capability, supported by validation routines, human oversight, and safeguards for interpretive autonomy (Shrestha et al., 2019; Wirtz et al., 2022). Resilience becomes tied to the governance of the human–algorithm interface.

Layer 4: Systemic externalities. The synthetic knowledge regime generates effects beyond firm boundaries: infrastructural dependency, risks of epistemic homogenization, and environmental costs associated with computational scaling (Strubell et al., 2019; Patterson et al., 2021). These externalities shape competition, sustainability trajectories, and systemic stability.

Layer 5: Regulatory and sustainability governance. Institutional frameworks, including the European Union’s Artificial Intelligence Act, seek to rebalance asymmetries through transparency, oversight, and accountability requirements (European Union, 2024; Hulok, 2025;

Graux et al., 2025). Governance reconnects infrastructural production with responsibility, including environmental accountability.

The model is relational rather than sequential. Infrastructural concentration shapes epistemic mediation; asymmetry conditions organizational quality; externalities trigger governance responses; and regulatory interventions influence infrastructural investment and platform design. Synthetic knowledge operates as systemic capital because its production, deployment, and stabilization are distributed across these mutually reinforcing layers.

Compared with traditional intellectual capital, synthetic knowledge differs in three respects: its production is infrastructurally centralized, its use is organizationally distributed yet epistemically mediated, and its valorization generates material and environmental externalities requiring multi-level governance. Cognitive capital thus becomes inseparable from infrastructural concentration, ecological constraint, and institutional regulation.

The model contributes by extending the knowledge-based view to account for infrastructural externalization, formalizing epistemic asymmetry as a governance-relevant variable, and integrating sustainability constraints into the theory of cognitive capital. By shifting attention from generative artificial intelligence as a tool to generative artificial intelligence as an architecture of cognitive capital, it establishes a structured agenda for empirical research on infrastructural dependency, epistemic capability, governance integration, and environmental impact in knowledge-intensive systems.

The model also provides a foundation for future empirical research by identifying key analytical dimensions that can be operationalized and tested across different organizational contexts, including variations in epistemic capability, infrastructural dependency, and governance integration.

12. Discussion: Conceptual Model of Synthetic Knowledge as Systemic Capital

The proposed model extends previous research in three important ways. First, while the knowledge-based view treats the firm as an integrator of knowledge held by identifiable individuals (Grant, 1996), the present study demonstrates its infrastructural externalization. Second, whereas prior research on generative artificial intelligence has focused on automation and augmentation (Raisch, Krakowski, 2021), this article identifies a deeper transformation of cognitive capital. Third, recent studies order the field at the level of challenges to adoption (Strelau, 2025; Cerchione, Liccario, Passaro, 2026), whereas the present framework addresses what happens to knowledge capital itself once the cognitive resource is produced outside the firm.

These findings also indicate important differences between prior research and the present study. While earlier studies focused primarily on efficiency gains and technological capabilities, the present model highlights structural dependencies, epistemic constraints and environmental externalities. This shift suggests that future research should move beyond firm-level analyses and incorporate system-level perspectives on cognitive capital and governance. Synthetic knowledge should therefore be analyzed not only as a technological phenomenon, but as a structural transformation of cognitive capital embedded in broader socio-technical systems.

Two boundaries of the argument deserve statement. The framework is analytical rather than predictive: it specifies relations among layers without asserting the strength or the direction of any particular effect. The empirical material on which it draws is also uneven, since evidence on energy consumption is more developed than evidence on epistemic dependency inside organizations, and the latter has yet to be measured directly.

13. Summary

13.1. Conclusions

The argument advanced here treats generative artificial intelligence as a structural transformation of cognitive capital rather than as an enhancement of organizational tools. Conceptualizing synthetic knowledge as systemic capital enables management and quality sciences to integrate three interrelated dimensions: infrastructural concentration, epistemic asymmetry, and environmental constraint.

Three conclusions follow, one for each of the research questions posed above:

- First, knowledge production is increasingly externalized. It is generated within concentrated infrastructures and subsequently integrated into organizational processes, challenging the assumption that cognitive capital is primarily cultivated through firm-level routines and internal learning.
- Second, concentration generates epistemic asymmetry. Organizations mobilize synthetic outputs without controlling the architectures that produce them. Competitive advantage shifts from knowledge ownership toward epistemic capability exercised within accountable decision structures.
- Third, cognitive capital is materially grounded. Synthetic knowledge depends on energy-intensive infrastructures and produces environmental externalities. Knowledge is no longer purely informational; it is simultaneously cognitive and energetic, shaped by ecological constraints and regulatory frameworks.

These three arguments support a reconceptualization of knowledge capital as infrastructurally mediated, governance-dependent, and environmentally constrained. The proposed model shifts analytical attention from generative artificial intelligence as a discrete technology to generative artificial intelligence as a system-level architecture of cognitive capital embedded in infrastructural and ecological constraints.

The model contributes on three counts: it carries the knowledge-based view beyond the firm so that externalized production falls within its scope, gives epistemic asymmetry a definite place among the variables that governance has to address, and brings material constraint inside the theory of cognitive capital.

This reconceptualization challenges traditional management perspectives that treat knowledge as an internally governed resource and instead positions cognitive capital within broader infrastructural and ecological systems. As a result, management research must extend its analytical focus beyond firm-level capabilities toward system-level dependencies, governance mechanisms, and sustainability constraints shaping knowledge production.

13.2. Limitations

This study is conceptual and does not rely on primary empirical data. The model therefore requires empirical validation across sectors and organizational forms. Future research should operationalize epistemic capability through measurable indicators capturing how organizations evaluate, contextualize, and govern synthetic outputs in practice. Comparative research across corporations, public institutions and knowledge-intensive small and medium-sized enterprises would clarify variations in governance routines, procurement strategies, audit practices, and sustainability reporting linked to foundation model integration.

Further empirical work should examine infrastructural dependency, including contractual lock-in, switching costs, and value capture between organizations and infrastructure providers. Although environmental externalities are documented in existing literature, this study does not quantify the impacts of generative infrastructures. Interdisciplinary research combining management studies with energy systems analysis and environmental economics is needed to assess carbon intensity, energy transparency, and rebound effects more precisely.

Future empirical research may operationalize epistemic asymmetry through indicators such as transparency of model documentation, access to information about training data, the organization's ability to audit or contest outputs, dependence on a limited number of providers, contractual restrictions on model use, switching costs, and the existence of internal validation routines. These indicators build on features the literature already identifies: the bearing of release practice on what can be inspected (Bommasani et al., 2024), the mediating role of platform architectures (Burkhardt, Rieder, 2024), and unequal epistemic agency among those who depend on such systems (Olaniyan, Martins, Al Maqrashi, 2026). Together they would allow future studies to move from conceptual diagnosis toward measurable assessment of epistemic dependency in organizations using generative artificial intelligence.

Given the rapid evolution of generative technologies and regulatory regimes, the model should be treated as provisional and open to refinement as architectures, market structures, and sustainability constraints evolve. Even so, it offers a structured foundation for future research at the intersection of organizational quality, infrastructural governance, and sustainability transformation, and invites a rethinking of cognitive capital under conditions of systemic technological dependence.

Acknowledgements

This research received no external funding.

This study is conceptual in nature and does not rely on proprietary research instruments or externally owned analytical tools.

The author declares no conflict of interest.

References

1. Akerlof, G.A. (1970). The market for “lemons”: Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, Vol. 84, Iss. 3, pp. 488-500, doi: <https://doi.org/10.2307/1879431>
2. Alavi, M., Leidner, D.E., Mousavi, R. (2024). A knowledge management perspective of generative artificial intelligence. *Journal of the Association for Information Systems*, Vol. 25, Iss. 1, pp. 1-12, doi: 10.17705/1jais.00859
3. Argyris, C., Schön, D.A. (1978). *Organizational learning: A theory of action perspective*. Reading, MA: Addison-Wesley.
4. Bommasani, R., Hudson, D.A., Adeli, E., Altman, R., Arora, S., von Arx, S., Bernstein, M., Bohg, J., Bosselut, A., Brunskill, E., Brynjolfsson, E., Buch, S., Card, D., Castellon, R., Chatterji, N., Chen, A., Creel, K., Davis, J.Q., Demszky, D., ... Liang, P. (2021). *On the opportunities and risks of foundation models*. arXiv. Retrieved from: <https://doi.org/10.48550/arXiv.2108.07258>
5. Bommasani, R., Kapoor, S., Klyman, K., Longpre, S., Ramaswami, A., Zhang, D., Schaake, M., Ho, D.E., Narayanan, A., Liang, P. (2024). Considerations for governing open foundation models. *Science*, Vol. 386, Iss. 6718, pp. 151-153, doi: <https://doi.org/10.1126/science.adp1848>

6. Burkhardt, S., Rieder, B. (2024). Foundation models are platform models: Prompting and the political economy of AI. *Big Data & Society*, Vol. 11, Iss. 2, doi: <https://doi.org/10.1177/20539517241247839>
7. Cerchione, R., Liccardo, G., Passaro, R. (2026). Artificial knowledge generation: investigating the revolutionary role of generative AI in knowledge management. *Journal of Innovation & Knowledge*, Vol. 11, 100866, doi: 10.1016/j.jik.2025.100866
8. Deming, W.E. (1986). *Out of the crisis*. Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study.
9. Duchek, S. (2020). Organizational resilience: a capability-based conceptualization. *Business Research*, Vol. 13, pp. 215-246, doi: 10.1007/s40685-019-0085-7
10. Dwivedi, Y.K., Kshetri, N., Hughes, L., Slade, E.L., Jeyaraj, A., Kar, A.K., Baabdullah, A.M., Koohang, A., Raghavan, V., ... Wright, R. (2023). Opinion Paper: “So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, Vol. 71, p. 102642, doi: <https://doi.org/10.1016/j.ijinfomgt.2023.102642>
11. Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st century business*. Oxford: Capstone.
12. European Union (2024). Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act). *Official Journal of the European Union, OJ L*, 2024/1689, 12.7.2024.
13. Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case study. *Research Policy*, Vol. 31, Iss. 8-9, pp. 1257-1274, doi: [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8)
14. Gilson, L.L., Goldberg, C.B. (2015). Editors’ comment: So, what is a conceptual paper? *Group & Organization Management*, Vol. 40, Iss. 2, pp. 127-130, doi: 10.1177/1059601115576425
15. Grant, R.M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, Vol. 17, Iss. S2, pp. 109-122, doi: <https://doi.org/10.1002/smj.4250171110>
16. Graux, H., Garstka, K., Murali, N., Cave, J., Botterman, M. (2025). Interplay between the AI Act and the EU digital legislative framework. Study PE 778.575, publication for the Parliament's Committee on Industry, Research and Energy (ITRE). Luxembourg: Policy Department for Transformation, Innovation and Health, European Parliament, doi: 10.2861/4863883
17. Hulok, M. (2025). The EU model of AI governance: regulating artificial intelligence through law and policy. *ERA Forum*, Vol. 26, pp. 527-547, doi: 10.1007/s12027-025-00869-1
18. Jaakkola, E. (2020). Designing conceptual articles: four approaches. *AMS Review*, Vol. 10, pp. 18-26, doi: 10.1007/s13162-020-00161-0

19. Kaplan, J., McCandlish, S., Henighan, T., Brown, T.B., Chess, B., Child, R., Gray, S., Radford, A., Wu, J., Amodei, D. (2020). *Scaling laws for neural language models*. arXiv. Retrieved from: <https://doi.org/10.48550/arXiv.2001.08361>
20. Kellogg, K.C., Valentine, M.A., Christin, A. (2020). Algorithms at work: The new contested terrain of control. *Academy of Management Annals*, Vol. 14, Iss. 1, pp. 366-410, doi: <https://doi.org/10.5465/annals.2018.0174>
21. Kenney, M., Zysman, J. (2016). The rise of the platform economy. *Issues in Science and Technology*, Vol. 32, Iss. 3, pp. 61-69.
22. Kogut, B., Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, Vol. 3, Iss. 3, pp. 383-397, doi: <https://doi.org/10.1287/orsc.3.3.383>
23. Markard, J., Raven, R., Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, Vol. 41, Iss. 6, pp. 955-967, doi: <https://doi.org/10.1016/j.respol.2012.02.013>
24. Mikalef, P., Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information & Management*, Vol. 58, Iss. 3, 103434, doi: [10.1016/j.im.2021.103434](https://doi.org/10.1016/j.im.2021.103434)
25. Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, Vol. 5, Iss. 1, pp. 14-37, doi: <https://doi.org/10.1287/orsc.5.1.14>
26. Olaniyan, Y.D., Martins, M.O., Al Maqrashi, R.H. (2026). Generative artificial intelligence and epistemic (in)justice: perspectives from higher education students in the Global North and South. *Frontiers in Human Dynamics*, Vol. 8, 1790324, doi: [10.3389/fhumd.2026.1790324](https://doi.org/10.3389/fhumd.2026.1790324)
27. Patterson, D.A., Gonzalez, J.E., Le, Q.V., Liang, C., Munguia, L.-M., Rothchild, D., So, D.R., Texier, M., Dean, J. (2021). *Carbon emissions and large neural network training*. arXiv. Retrieved from: <https://doi.org/10.48550/arXiv.2104.10350>
28. Raisch, S., Krakowski, S. (2021). Artificial intelligence and management: The automation–augmentation paradox. *Academy of Management Review*, Vol. 46, Iss. 1, pp. 192-210, doi: <https://doi.org/10.5465/amr.2018.0072>
29. Rillig, M.C., Ågerstrand, M., Bi, M., Gould, K.A., Sauerland, U. (2023). Risks and benefits of large language models for the environment. *Environmental Science & Technology*, Vol. 57, Iss. 9, pp. 3464-3466, doi: <https://doi.org/10.1021/acs.est.3c01106>
30. Senge, P.M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday.
31. Shrestha, Y.R., Ben-Menahem, S.M., von Krogh, G. (2019). Organizational decision-making structures in the age of artificial intelligence. *California Management Review*, Vol. 61, Iss. 4, pp. 66-83, doi: <https://doi.org/10.1177/0008125619862257>

32. Sousa, R., Voss, C.A. (2002). Quality management re-visited: a reflective review and agenda for future research. *Journal of Operations Management*, Vol. 20, Iss. 1, pp. 91-109, doi: [https://doi.org/10.1016/S0272-6963\(01\)00088-2](https://doi.org/10.1016/S0272-6963(01)00088-2)
33. Spender, J.-C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, Vol. 17, Iss. S2, pp. 45-62, doi: <https://doi.org/10.1002/smj.4250171106>
34. Srnicek, N. (2017). *Platform capitalism*. Cambridge: Polity Press.
35. Strelau, R. (2025). Challenges of applying generative AI in knowledge management: Insights from a systematic literature review. *Organizacja i Kierowanie (Organization and Management)*, No. 2(198), pp. 57-75. Retrieved from: <https://econjournals.sgh.waw.pl/OiK/article/view/4404>
36. Strubell, E., Ganesh, A., McCallum, A. (2019). Energy and policy considerations for deep learning in NLP. In: *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics* (pp. 3645-3650), doi: <https://doi.org/10.18653/v1/P19-1355>
37. Teece, D.J., Pisano, G., Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, Vol. 18, Iss. 7, pp. 509-533, doi: [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509:AID-SMJ882>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509:AID-SMJ882>3.0.CO;2-Z)
38. Wirtz, B.W., Weyerer, J.C., Kehl, I. (2022). Governance of artificial intelligence: A risk and guideline-based integrative framework. *Government Information Quarterly*, Vol. 39, Iss. 4, 101685, doi: <https://doi.org/10.1016/j.giq.2022.101685>
39. Zuboff, S. (2019). *The age of surveillance capitalism: The fight for a human future at the new frontier of power*. New York: PublicAffairs.

THE RELATIONSHIP BETWEEN EMPLOYEES' MENTAL RESILIENCE AND JOB INSECURITY IN THE HARD COAL MINING INDUSTRY IN POLAND

Adam GUMIŃSKI^{1*}, Adam BOSOWSKI², Marzena PISARSKA³

¹ Silesian University of Technology; adam.guminski@polsl.pl, ORCID: 0000-0001-8250-7101

² University of Economics and Human Sciences; a.bosowski@vizja.pl, ORCID: 0000-0001-6631-0608

³ Silesian University of Technology; pisarskamarzena@wp.pl

*Correspondence author

Purpose: The article presents the research results concerning the relationship between subjectively experienced job insecurity, anxiety as a trait, and mental resilience of hard coal industry workers in Poland. It is mainly focused on the role of mental resilience as a mediating individual resource and its importance during the critical situation in the sector of early 2026.

Design/methodology/approach: The objectives of the research were achieved by combining methods. Especially, the authors applied a cross-sectional, exploratory study conducted using an anonymous online survey (Google Forms). Research tools included the Anxiety Scale – Trait (SL-C), the SPP-25 Mental Resilience Scale, and specific items from the Copenhagen Psychosocial Questionnaire (COPSOQ) to measure job insecurity.

Findings: The research enables the verification of a few hypotheses regarding the negative correlation between anxiety as a trait and mental resilience. It was found that resilience is a mediating mechanism that buffers the impact of subjectively perceived job insecurity on the emotional functioning and activity of employees.

Practical implications: The results obtained have important practical implications for both analysed coal companies and for specialists dealing with psychological support for employees exposed to chronic job insecurity. The research results suggest that mental resilience is a key factor in buffering organizational stressors. This provides a basis for the development of psychological support and social protection programs (e.g., miners' leave) to protect the mental health of employees in sectors affected by inevitable restructuring.

Originality/value: The value of the research is up to date, it raises important issues in crisis, specifically in hard coal mining in Poland. The authors provide a contextual analysis on the importance of the psychological effects of the mining crisis in Poland in early 2026, with particular emphasis on comparing the situation of employees of Jastrzębska Spółka Węglowa (JSW) and Polska Grupa Górnicza (PGG).

Keywords: job insecurity, mental resilience, trait anxiety, hard coal mining.

Category of the paper: research paper.

1. Introduction

At the beginning of 2026, the situation of the mining industry in Poland is described as critical. The sector is suffering significant financial losses and is undergoing a process of successive liquidation of mining units. Polish strategic companies such as Polska Grupa Górnicza (PGG) and Jastrzębska Spółka Węglowa (JSW) require deep restructuring to avoid bankruptcy, which forces the companies to make changes in their operational and financial activities.

The mining industry is facing key challenges:

- deepening unprofitability: high costs of mining activities make it difficult for the mining sector to compete with imported raw materials and constantly developing renewable energy sources,
- dependence on state aid: the sector relies heavily on public support mechanisms,
- personnel and social problems: the closure of the coal industry is accompanied by the need to provide social protection, such as severance pay or mining leave,

Jastrzębska Spółka Węglowa is struggling with the biggest financial crisis in years. As a key producer of coking coal in the EU, JSW is in a deep restructuring phase. The company's financial results after three quarters of 2025 amount to nearly PLN 2.9 billion in net loss, the main reason for which is the drastic drop in coking coal prices with constantly rising mining costs. In connection with the company's difficult situation, the Management Board of JSW SA signed an annex to the Collective Agreement of 31 March 2021, which gave employees a guarantee of employment until 2031. As a result of the signing of the annex, certain groups of employees were excluded from the employment guarantee, which puts employees in a precarious professional situation (jsw.pl, 2025). The situation of Polska Grupa Górnicza at the beginning of 2026 also remains tense, and the company operates based on financial support from the state budget.

Despite extensive literature on the negative impact of job insecurity on mental health, there is a significant lack of empirical research focusing on the Polish coal industry during the 2025-2026 financial crisis. Specifically, current research fails to account for how individual psychological resources, such as mental resilience, mediate the relationship between macro-economic precariousness and trait anxiety in workers. Furthermore, there is a lack of comparative analysis between differently funded mining entities (JSW vs. PGG), leaving a void in our understanding of how corporate stability models influence worker psychology.

The aim of this study was to examine the relationship between subjectively experienced job insecurity, anxiety as a trait and mental resilience among coal industry workers in Poland. Attention was paid to the role of mental resilience as an individual resource related to the emotional functioning of employees in conditions of occupational risk.

An additional objective of the study was to compare the employees of two main mining groups – Jastrzębska Spółka Węglowa (JSW) and Polska Grupa Górnicza (PGG) – in terms of the level of job insecurity, anxiety as a trait and mental resilience.

Based on the aim of the study, the following research questions were formulated:

1. What is the level of subjectively experienced job insecurity, anxiety as a trait and mental resilience among coal industry workers?
2. Are there significant relationships between job insecurity and anxiety as a feature in coal industry workers?
3. Are mental resilience and its individual dimensions significantly related to anxiety as a trait?
4. Does mental resilience mediate the relationship between job insecurity and anxiety as a trait?
5. Do JSW and PGG employees differ in terms of the level of job insecurity, anxiety as a trait and mental resilience?

2. Description of issues concerning the research problems

2.1. Anxiety as a trait

Trait anxiety is one of the key concepts in personality psychology and emotional psychology, referring to the relatively constant disposition of an individual to react with tension, fear and increased emotional arousal in a wide range of life situations. Unlike anxiety as a condition, which is transient and situationally conditioned, anxiety as a trait reflects a persistent pattern of emotional functioning, associated with individual differences in susceptibility to experiencing danger (Spielberger, 1983).

The classic distinction between anxiety and anxiety as a trait was introduced within Spielberger's concept that anxiety-state refers to the current, subjective experience of tension and anxiety, while anxiety-trait refers to the tendency to experience such states frequently and intensely in response to a wide range of stimuli perceived as threatening (Spielberger, Gorsuch, Lushene, 1970; Spielberger, 1983). People with a high level of anxiety show increased alertness to potential threats, a tendency to interpret ambiguous situations as threatening, and a lowered threshold for reacting with anxiety.

From a cognitive perspective, anxiety as a trait is associated with persistent cognitive patterns and information processing style, conducive to selectively directing attention to negative or potentially dangerous stimuli. Research indicates that people with high levels of anxiety-traits are more likely to experience difficulties in regulating emotions, show elevated levels of tension even in objectively neutral situations, and tend to anticipate the negative consequences of future events (Eysenck, Derakshan, Santos, Calvo, 2007; Endler, Kocovski, 2001).

Anxiety as a trait is also considered to be a relatively stable component of the personality structure, exhibiting moderate to high temporal stability. Although the level of anxiety-trait may change under the influence of long-term life experiences or psychological interventions, it remains much less susceptible to short-term situational fluctuations than anxiety-state (Spielberger, 1983). The literature emphasizes that anxiety-trait has a predisposing function – it increases the likelihood of stronger anxiety reactions in stressful situations, but it is not a direct reaction to a specific stressor.

In the context of professional functioning, anxiety as a trait is sometimes associated with reduced mental well-being, a higher level of burnout and greater susceptibility to the negative consequences of work stress. At the same time, research indicates that the relationship between anxiety-trait and occupational stressors is often indirect and is modified by personal resources, such as mental resilience, resilience or a sense of control (Sverke et al., 2002; Cheng, Chan, 2008). This means that anxiety as a trait does not have to be a simple function of the current professional situation but rather reflects the way in which the individual interprets, and lives experiences related to uncertainty and threat.

For this reason, anxiety as a trait is often used in research on psychosocial determinants of mental health as an indicator of relatively permanent emotional functioning, allowing to distinguish situational reactions from deeper-rooted individual predispositions. This study adopts this understanding of anxiety as a trait, treating it as a stable emotional disposition, potentially modified by the individual's adaptive resources, rather than a direct effect of subjectively perceived job insecurity.

2.2. Mental resilience

Mental resilience is a construct widely described in health psychology, personality psychology, and work and organizational psychology, referring to an individual's ability to function effectively, adapt, and return to relative mental balance in the face of stress, adversity, and potentially traumatic experiences. In the literature on the subject, resilience is understood both as a relatively permanent personality disposition and as a dynamic adaptation process, shaped in the interaction of individual characteristics with the requirements of the environment (Masten, 2001; Fletcher, Sarkar, 2013).

One of the most influential approaches to mental resilience emphasizes its role as a protective resource that enables an individual not only to survive difficult experiences, but also to maintain a relatively stable level of emotional and behavioural functioning (Bonanno, 2004). In this sense, resilience does not mean the lack of emotional reactions to stress, but the ability to regulate them and adapt flexibly to changing conditions. People with a high level of resilience can regain mental balance more quickly, use available resources more effectively, and treat difficulties as developmental challenges rather than just threats.

In terms of personality, mental resilience is understood as a relatively stable set of traits and competences conducive to adaptive coping with stress. Such an approach has been adopted, *m.in.*, in the Polish concept of mental resilience operationalized by the SPP-25 Mental Resilience Scale, which includes dimensions related to perseverance in action, openness to experience, personal competence, tolerance of failures and an optimistic attitude to life (Ogińska-Bulik, Juczyński, 2008). The authors emphasize that resilience acts as a resource conducive to maintaining mental health in conditions of prolonged stress, increasing the individual's ability to mobilize and respond flexibly.

From the perspective of Hobfoll (2002) resource conservation theory, mental resilience can be treated as a key personal resource that enables the protection of other resources (e.g. a sense of control, emotional well-being) and reduces the negative effects of environmental stressors. In situations of chronic risk, such as job insecurity, people with high levels of resilience are more likely to adopt active coping strategies, reinterpret stressful situations, and maintain relatively stable emotional functioning.

Empirical studies consistently indicate that mental resilience is significantly associated with lower levels of anxiety and depressive symptoms, higher mental well-being, and better adaptation to occupational stress (Fletcher, Sarkar, 2013; Hartmann et al., 2020). Importance is given to the cognitive components of resilience, such as optimism, sense of purpose and the ability to cognitively reinterpret difficult experiences, which promote the regulation of emotions and reduce the tendency to react chronically with anxiety.

In the context of professional work, mental resilience is increasingly analyzed as a buffering factor for the negative consequences of organizational stressors, including job insecurity. The results of the study suggest that people with high resilience experience less severity of negative emotional responses even in objectively high-risk situations, indicating its important role in adaptive processes (Sverke et al., 2002; Hartmann et al., 2020). Resilience does not eliminate stress but reduces its destructive impact on emotional functioning and mental health.

For this reason, mental resilience is sometimes referred to as one of the key individual resources in research on the mental health of employees operating in conditions of long-term uncertainty and organizational change. This study adopts this understanding of mental resilience, treating it as a relatively permanent, multidimensional personal resource, potentially mediating in the relationship between subjectively experienced job insecurity and anxiety as a trait.

2.3. Job insecurity

Job insecurity is one of the key constructs in the psychology of work and organization, referring to the subjectively experienced threat to the continuity of employment and concerns related to the professional future. Unlike the objective risk of job loss, job insecurity is cognitive-emotional in nature and concerns an individual's perception of the professional situation, regardless of the actual employment status (Greenhalgh, Rosenblatt, 1984; De Witte, 2005).

The classic definition proposed by Greenhalgh and Rosenblatt (1984) describes job insecurity as a subjective feeling of powerlessness in the face of the threat of losing the desired aspects of work, in a situation where the individual perceives the possibility of negative changes, but at the same time assesses his or her ability to influence their course as limited. This approach emphasizes that the key element of job insecurity is not the threat itself, but the lack of control and predictability, which give this experience a particularly burdensome psychological character.

In the literature on the subject, a distinction between quantitative and qualitative job insecurity is commonly accepted. Quantitative uncertainty refers to the fear of losing one's job altogether, while qualitative uncertainty refers to the risk of losing important aspects of work, such as employment conditions, professional status, responsibilities or place of work (Hellgren, Sverke, Isaksson, 1999). Research indicates that both dimensions may have different psychological consequences, with qualitative uncertainty being particularly burdensome in the conditions of organizational restructuring and systemic changes.

From a cognitive perspective, job insecurity is treated as a chronic stressor that activates anticipatory processes, which consist in anticipating potentially negative events in the future. Unlike one-off stressors, job insecurity is characterized by longevity and the lack of a clearly defined end point, which promotes the persistence of emotional tension and a sense of threat (De Witte, 2005; Sverke, Hellgren, Näswall, 2002). Such a nature of the stressor makes its impact on mental functioning stronger and more debilitating than the effects of the actual loss of a job.

Empirical studies consistently indicate that job insecurity is associated with reduced mental well-being, higher levels of distress, anxiety and depressive symptoms, as well as negative attitudes towards work, such as a decrease in job satisfaction or organizational engagement (Sverke et al., 2002; Cheng, Chan, 2008). At the same time, the results of many studies suggest that these relationships are not simple and linear in nature, but are modified by individual and contextual factors, including personal resources, social support and a sense of control.

In more recent theoretical approaches, there is an increasing emphasis on the role of psychological resources in moderating and mediating the effects of job precariousness. According to Hobfoll's (2002) theory of resource conservation, job insecurity can lead to the loss or threat of loss of key resources, such as a sense of security, stability or predictability, which in turn promotes the intensification of stress reactions. At the same time, having adaptive resources such as mental resilience can reduce the negative consequences of uncertainty, allowing you to deal with the threat more flexibly and constructively.

In the context of professional work, job insecurity is particularly relevant in sectors undergoing restructuring, systemic transformations or prolonged economic pressures. In such conditions, job insecurity becomes a permanent element of the work environment, affecting not only the current functioning of employees, but also their long-term mental health and adaptation strategies (De Witte, 2005; Sverke et al., 2002). For this reason, in this study, job insecurity has been included as a subjectively experienced, cognitive dimension of occupational risk, potentially affecting the emotional functioning of employees through individual resources.

3. The research procedure

The following research hypotheses were formulated:

- H1. Subjectively experienced job insecurity is positively related to its situational indicators, such as the possibility of losing a job, the difficulty of finding a new job and the risk of unwanted relocation.
- H2. Anxiety as a trait is significantly and negatively related to mental resilience and its individual dimensions.
- H3. Mental resilience is significantly related to the level of emotional functioning of employees, with higher levels of resilience associated with lower levels of anxiety as a trait.
- H4. Mental resilience mediates the relationship between job insecurity and anxiety as a trait.
- H5. JSW and PGG employees differ in terms of selected aspects of mental resilience and perception of occupational threats.

3.1. Applied tools

Anxiety Scale – Trait (SL-C)

Anxiety as a relatively constant personality disposition was measured using the Anxiety – Trait Scale (SL-C), which is part of Spielberger's Inventory of State and Traits of Anxiety (Spielberger, 1983). This scale is used to assess an individual's persistent propensity to react with anxiety in various life and professional situations, regardless of current circumstances. The study used a Polish scale adaptation, developed by Piksa, Kosiorowska and Golonka, designed to measure anxiety as a trait in the adult populations.

Mental Resilience Scale (SPP-25)

Mental resilience was assessed using the SPP-25 Mental Resilience Scale, developed by Ogińska-Bulik and Juczyński (Ogińska-Bulik, Juczyński, 2008). This tool is used to measure relatively sustainable personal resources that are conducive to effective coping with adversity and stress.

Job insecurity

Subjective job insecurity was measured using three items from the Copenhagen Psychosocial Questionnaire (COPSOQ), which relate to key aspects of perceived occupational risk. These items concerned: (a) the possibility of losing a job (unemployment), (b) the difficulty of finding a new job in the event of losing a current job, and (c) the possibility of being directed to another job or a place where the respondent would not like to work. Respondents assessed the degree of perceived threat on an ordinal scale.

3.2. Study participants and procedure

The survey was a one-time cross-sectional study and was conducted in the form of an anonymous online survey. The participants were recruited by targeted selection through publicly available online forums and discussion groups associating employees of the coal industry in Poland, in particular employees of coal companies such as Jastrzębska Spółka Węglowa (JSW) and Polska Grupa Górnicza (PGG). Participation in the study was completely voluntary and did not involve any remuneration or gratification. The study did not require the provision of data enabling the identification of participants, and the information collected was only declarative.

The research questionnaire was carried out using the Google Form platform and included: metric questions, items measuring subjective job insecurity, Anxiety – Trait Scale (SL-C) and Mental Resilience Scale (SPP-25). The average time to complete the survey was about ... minutes. The answers were automatically saved in a secure database to which only the author of the study had access.

In the study group (number of respondents = 154), the mean age was 36 years. The median is 37, and the dominant age is 40. The most common education indicated by the respondents was secondary education (81 people) and higher education (49 people), while 25 people indicated their education at the vocational level. A much larger number of respondents (77.7%) indicated Jastrzębska Spółka Węglowa SA (JSW) as their place of employment, 17.2% indicated Polska Grupa Górnicza (PGG). 5 people indicated another mining group, while less than 2% did not want to answer this question. The average length of service of the surveyed people is over 14 years. The dominant score is 20 – this is the most common length of service of the respondents (16 people declared this age). The shortest period of work is 1 year; the longest one is 36 years.

4. Discussion of the research results

In the first stage of the analysis, descriptive statistics and correlation analyses were carried out to determine the relationships between subjective job insecurity, anxiety as a trait, and mental resilience and its dimensions. Subsequently, comparative analyses were carried out between groups of employees of various mining companies and between persons associated and non-affiliated in trade unions. In the next step, regression analyses and mediation analysis were carried out to check whether mental resilience plays the role of a mediator in the relationship between job insecurity and anxiety as a trait. Statistical analyses were performed using IBM SPSS Statistics (version 29.0.2.0). In all analyses, the statistical significance level was assumed to be $\alpha = .05$.

In the first step, the distributions of quantitative variables were tested. For this purpose, descriptive statistics were calculated along with the Shapiro-Wilk test, which examines the normality of the distribution. The results of this analysis are presented in Table 1.

Table 1.*Basic descriptive statistics with the Shapiro-Wolf test*

	M	Me	SD	SKK	K	Min	Max	W	p
Anxiety as a trait	23.34	23	8.54	.096	-.167	3.00	45.00	.994	.786
Overall Elasticity Score	92.22	96	18.12	-1.315	3.767	.00	122.00	.923	<.001
Perseverance and determination in action	19.26	20	4.01	-1.407	3.649	.00	25.00	.902	<.001
Openness to new experiences and a sense of humor	19.36	20	3.79	-1.485	3.966	.00	25.00	.894	<.001
Personal coping competence and tolerance of negative emotions	18.47	19	4.39	-1.372	2.826	.00	25.00	.937	<.001
Tolerance for failure and treating life as a challenge	18.35	19	3.94	-1.066	2.442	.00	25.00	.937	<.001
Optimistic attitude to life and the ability to mobilize in difficult situations	16.76	17	4.62	-.730	.520	.00	25.00	.960	<.001

Annotation. M - average; Me - median; SD - standard deviation; Sk. - skewness; K. - kurtosis; Min. - minimum value; Max. - maximum value; W - the result of the Shapiro-Wilk test; p - the p-value for the Shapiro-Wolf test.

The group of JSW employees (N = 122) was dominated by responses indicating a low sense of risk of losing their job. The most frequently chosen categories were "almost never" (36.1%) and "rarely" (30.3%). In total, more than two-thirds of the surveyed JSW employees (67.2%) declared that the possibility of losing their job was rare or almost never. At the same time, 18.0% of respondents in this group indicated the answer "always" and 5.7% – "often", suggesting that there is a significant minority of workers experiencing a high level of job insecurity.

In the PGG group (N = 27), the responses indicating a relatively low perception of unemployment risk also prevailed, but the distribution of responses was more diverse than in JSW. The most frequently indicated category was "almost never" (51.9%), while 11.1% of respondents indicated "rarely". At the same time, 14.8% of respondents declared that the possibility of losing their job occurs "always", and 7.4% – "often". This means that a total of 22.2% of PGG employees experience a high sense of risk of losing their jobs.

In the group of JSW employees (N = 122), the distribution of responses indicated a significant variation in the level of perceived threat, while at the same time the assessments were polarized. The most frequently chosen categories were "always" (27.9%) and "rarely" (28.7%). More than a quarter of JSW respondents declared that finding a new job would always be a problem for them if they lost their current one, while 21.3% indicated the answer "almost never". A total of 36.9% of JSW employees assessed that difficulties in finding a new job occurred frequently or always, while 50.8% of respondents considered that such a problem occurs rarely. almost never or never.

In the PGG group (N = 27), a clear discrepancy in assessments was also observed, but with a slightly different response structure. The most frequently indicated category was "always" (29.6%), which means that almost one third of the surveyed PGG employees perceived finding a new job as a permanent and significant problem. At the same time, 25.9% of respondents indicated the answer "almost never", and 18.5% – "rarely". A total of 37.0% of PGG employees declared a high level of difficulty (often or always), while 44.4% – a low level of difficulty (almost never or rarely).

In the group of JSW employees (N = 122), the responses indicated a significant variation in the level of perceived threat, while at the same time there was a clear group of respondents who felt high uncertainty in this regard. The most frequently chosen category was "always" (27.9%), which means that more than a quarter of the surveyed JSW employees declared that they were constantly referred to an unwanted place or type of work. The next frequently indicated answers were "almost never" (29.5%) and "rarely" (19.7%). A total of 50.0% of JSW respondents assessed this risk as low (never, almost never or rarely), while 49.8% indicated a moderate or high level of risk (sometimes, often or always), which indicates an almost equal distribution of grades in this group.

In the PGG group (N = 27), the distribution of responses was more even, but with a clear shift towards a higher risk perception. The most frequently indicated category was the answer "always" (25.9%), and a similar percentage of respondents indicated the answers "rarely", "sometimes" and "often" (22.2% each). Only 7.4% of PGG respondents declared the answer "almost never". A total of 70.3% of PGG employees assessed the possibility of being referred to unwanted work as occurring sometimes, often or always, suggesting a high level of subjective uncertainty in this area.

Taken together, the results suggest that at JSW the uncertainty is more diverse and selective, while at PGG it takes the form of a more global and generalized threat to the professional future.

Table 2.*Significant correlations – JSW Group*

Variable 1	Variable 2	r Pearson
a) Loss of job	Job insecurity	.659**
b) Difficulty in finding a job	Job insecurity	.677**
c) Unfavourable relocation	Job insecurity	.716**
Resilience – total	Anxiety as a trait	-.697**
Perseverance	Anxiety as a trait	-.475**
Openness	Anxiety as a trait	-.620**
Personal competences	Anxiety as a trait	-.658**
Tolerance for failure	Anxiety as a trait	-.639**
Optimism	Anxiety as a trait	-.684**

* $p < .05$, ** $p < .01$ (double-sided).**Table 3.***Significant correlations – PGG Group*

Variable 1	Variable 2	r Pearson
a) Loss of job	Job insecurity	.663**
b) Difficulty in finding a job	Job insecurity	.781**
c) Unfavourable relocation	Job insecurity	.699**
Resilience – total	Anxiety as a trait	-.497**
Personal competences	Anxiety as a trait	-.425*
Tolerance for failure	Anxiety as a trait	-.637**
Optimism	Anxiety as a trait	-.488**

* $p < .05$, ** $p < .01$ (double-sided).

In the group of JSW employees (table 2), strong and consistent relationships were found between the three indicators of situational job insecurity (the possibility of losing a job, the difficulty of finding a new job and the possibility of unwanted relocation) and the global index of job insecurity ($r = .659-.716$, $p < .001$), which confirms their validity as components of this construct. At the same time, job insecurity was not significantly associated with anxiety as a trait, while anxiety showed strong, negative correlations with the overall level of mental resilience ($r = -.697$, $p < .001$) and all its dimensions ($r = -.475$ to $-.684$, $p < .001$). This means that at JSW, anxiety as a relatively constant personality disposition is closely related to the individual's adaptation resources, and not directly to the assessment of the current professional situation. At the same time, mental resilience and its components (especially personal competence, tolerance to failure, and optimism) form a strongly correlated system of protective resources ($r = .795-.932$, $p < .001$).

In the group of PGG employees (table 3.), very strong links between the three indicators of occupational risk and job insecurity were also confirmed ($r = .663-.781$, $p < .001$), and these relationships were in places stronger than in JSW. Unlike JSW, at PGG, anxiety as a trait showed significant negative correlations with mental resilience ($r = -.497$, $p = .008$) and its key components, in particular personal competence ($r = -.425$, $p = .027$), failure tolerance ($r = -.637$, $p < .001$) and optimistic attitude ($r = -.488$, $p = .010$). As in JSW, job insecurity itself was not directly related to anxiety, but the strong integration of resilience dimensions ($r = .585-.943$, $p \leq .001$) indicates that it plays a key buffering role against negative emotional consequences.

The results obtained allow for the formulation of several important theoretical and practical conclusions, which are in line with the current of research on the psychosocial consequences of job insecurity.

The results confirmed the H1 hypothesis, pointing to strong and significant links between three situational indicators (the possibility of losing a job, the difficulty of finding a new job and the risk of unwanted relocation) and the global indicator of subjective job insecurity. The correlations obtained were high in both the JSW Group and PGG, which confirms the accuracy of the adopted operationalization of job insecurity as a cognitive construct based on the subjective perception of the threat to employment continuity (De Witte, 2005).

These results are consistent with previous studies indicating that job insecurity is not a homogeneous experience, but consists of many interrelated, though not identical, aspects, such as fear of unemployment, job degradation or forced change in working conditions (Sverke, Hellgren, Näswall, 2002; Greenhalgh, Rosenblatt, 1984). In the context of the coal industry, which has been operating under conditions of restructuring and transformational pressure for years, such a multidimensional perception of threats seems particularly justified.

One of the key results of the survey was the lack of a significant direct link between the global index of job insecurity and anxiety as a trait, both in the JSW Group and PGG. This result may seem surprising, but it remains consistent with the distinction between situational reactions and relatively permanent personality dispositions.

Anxiety as a trait, measured using the Anxiety Scale – Trait (Spielberger, 1983), refers to an individual's stable tendency to experience tension and fears in various life situations, rather than reacting to specific, current stressors. The literature emphasizes that job insecurity is more strongly associated with anxiety-state, distress or depressive symptoms, while its relationships with personality traits are weaker and often mediated by other variables, such as psychological resources or social support (Cheng, Chan, 2008; De Cuyper, De Witte, 2007).

The strongest and most consistent pattern of relationships revealed in the study were significant, negative relationships between anxiety as a trait and mental resilience – both in general terms and in relation to its individual dimensions. These results unequivocally confirm the H2 hypothesis and are consistent with numerous studies indicating that mental resilience acts as an adaptive resource, conducive to effective coping with chronic stress and regulating emotions (Ogińska-Bulik, Juczyński, 2008; Fletcher, Sarkar, 2013).

Particularly strong associations with anxiety-trait concerned such components of resilience as personal coping competence, tolerance for failure, and an optimistic attitude towards life. According to the concepts of Lazarus and Folkman (1984), these resources increase the sense of agency and control, which reduces the tendency to react chronically with anxiety. The results of the study suggest that it is the level of pressure, rather than the perception of occupational hazards itself, that differentiates the level of anxiety as a relatively constant disposition to a greater extent in coal workers.

Although the study did not find a direct relationship between job insecurity and anxiety-trait, the correlations obtained between mental resilience and both variables support the theoretical validity of the mediation model (H4 hypothesis). According to this approach, job insecurity can affect emotional functioning indirectly – by weakening the individual's adaptive resources, which in turn promotes the intensification of anxiety.

Similar mechanisms have been described in studies that have shown that personal resources (e.g., mental resilience, sense of coherence, or self-efficacy) mediate the relationship between occupational stressors and mental well-being (Hartmann et al., 2020; Hobfoll, 2002). The results suggest that mental resilience may play an analogous role in the context of job insecurity.

Comparative analyses have shown a significant difference between JSW and PGG employees only in terms of tolerance for failure and treating life as a challenge. A lower level of this dimension in the PGG Group may reflect long-term functioning in conditions of more globally perceived uncertainty, which in the long term may weaken the ability to cognitively reinterpret difficulties as challenges rather than threats.

On the other hand, membership in trade unions only differentiated the perception of the risk of unwanted relocation, with no differences in anxiety and resilience. This result can be interpreted in the light of research showing that trade unions primarily affect the sense of security in areas directly related to the protection of workers' interests, while they have a lesser impact on individual psychological resources (Sverke et al., 2002).

5. Limitations of the study and further research

Despite the significant cognitive value of the results obtained, the study has several limitations that should be considered when interpreting them. First, the study was of a cross-sectional nature, which makes it impossible to conclude about cause-and-effect relationships between the analysed variables. It is not possible to clearly determine whether a lower level of mental resilience leads to a higher level of anxiety as a trait, or whether chronically elevated anxiety hinders the development and maintenance of resilience resources. Therefore, it seems reasonable to conduct longitudinal studies that would allow us to capture the dynamics of these relationships over time.

Another limitation is the way job insecurity is measured. The use of three indicator items, although consistent with the adopted objective of the study and the literature on the subject, limits the possibilities of full psychometric analysis of this construct and testing of more complex statistical models. Future research could use full versions of tools to measure job precariousness, which would allow for a more accurate distinction between its dimensions (e.g. quantitative and qualitative precariousness).

The structure of the research sample is also a limitation. Most of respondents were men, reflecting the specificities of the mining sector, but at the same time limiting the possibility of generalising the results to populations with a different gender structure. In addition, the size of the PGG Group was significantly smaller than that of the JSW Group, which may have affected the statistical strength of the comparative analyses and the stability of the estimation of the effects. In future studies, it is useful to aim for more numerically balanced groups or to use procedures to control the impact of sample inequality.

An additional limitation is the use of only self-report methods, which is associated with the risk of errors resulting from the bias of the answers, the current emotional state of the respondents or the effects of social approval. In future studies, it would be advisable to complement the questionnaire measurements with qualitative data (e.g. interviews) or organisational indicators, such as information on actual changes in employment or relocation.

Despite the limitations, the study makes a significant contribution to understanding the psychological mechanisms of coal industry workers in conditions of job insecurity. The results underscore the importance of mental resilience as a key protective resource and provide a solid basis for further research on the interaction between occupational stressors and the relatively enduring characteristics and resources of an individual.

References

1. Baka, Ł. (2019). *Copenhagen Psychosocial Questionnaire (COPSOQ II). Manual for the Polish version of the tool*. Warsaw: Central Institute for Labour Protection – National Research Institute.
2. Bonanno, G.A. (2004). Loss, trauma, and human resilience. *American Psychologist*, 59(1), 20-28. <https://doi.org/10.1037/0003-066X.59.1.20>
3. Cheng, G.H.-L., Chan, D.K.-S. (2008). Who suffers more from job insecurity? *Applied Psychology*, 57(2), 272-303. <https://doi.org/10.1111/j.1464-0597.2007.00312.x>
4. De Cuyper, N., De Witte, H. (2007). Job insecurity in temporary versus permanent workers. *Work & Stress*, 21(1), 65-84. <https://doi.org/10.1080/02678370701229050>
5. De Witte, H. (2005). Job insecurity: Review of the international literature on definitions, prevalence, antecedents and consequences. *S.A. Journal of Industrial Psychology*, 31(4), a200. <https://doi.org/10.4102/sajip.v31i4.200>
6. Endler, N.S., Kocovski, N.L. (2001). State and trait anxiety revisited. *Journal of Anxiety Disorders*, 15(3), 231-245. [https://doi.org/10.1016/S0887-6185\(01\)00060-3](https://doi.org/10.1016/S0887-6185(01)00060-3)
7. Eysenck, M.W., Derakshan, N., Santos, R., Calvo, M.G. (2007). *Anxiety and cognitive performance: attentional control theory*, 7(2), 336-353. <https://doi.org/10.1037/1528-3542.7.2.336>
8. Fletcher, D., Sarkar, M. (2013). Psychological resilience: A review and critique of definitions, concepts, and theory. *European Psychologist*, 18(1), 12-23. <https://doi.org/10.1027/1016-9040/a000124>
9. Greenhalgh, L., Rosenblatt, Z. (1984). Job insecurity: Toward conceptual clarity. *Academy of Management Review*, 9(3), 438-448. <https://doi.org/10.5465/amr.1984.4279673>
10. Hartmann, S., Weiss, M., Newman, A., Hoegl, M. (2020). Resilience in the workplace. *Applied Psychology*, 69(3), 913-959. <https://doi.org/10.1111/apps.12191>
11. Hellgren, J., Sverke, M., Isaksson, K. (1999). A two-dimensional approach to job insecurity. *European Journal of Work and Organizational Psychology*, 8(2), 179-195. <https://doi.org/10.1080/135943299398311>
12. Hobfoll, S.E. (2002). Social and psychological resources and adaptation. *Review of General Psychology*, 6(4), 307-324. <https://doi.org/10.1037/1089-2680.6.4.307>
13. Jastrzębska Spółka Węglowa SA (2025). *JSW is reducing employment guarantees*. JSW Press Office service. Available at: jsw.pl, 03 January 2026.
14. Jastrzębska Spółka Węglowa SA (2025). *The JSW Group has published its financial results*. JSW Press Office service. Available at: jsw.pl, 01 January 2026.
15. Lazarus, R.S., Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company.

16. Masten, A.S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist*, 56(3), 227-238. <https://doi.org/10.1037/0003-066X.56.3.227>
17. Ogińska-Bulik N., Juczyński Z. (2008). Skala pomiaru prężności – SPP-25. *Nowiny Psychologiczne*, 3, 39-56.
18. Ogińska-Bulik, N., Juczyński, Z. (2008). Mental Resilience Scale (SPP-25). In: Z. Juczyński (ed.), *Tools of measurement in the promotion and psychology of health* (pp. 162-170). Warsaw: PTP.
19. Piksa, M., Kosiorowska, E., Golonka, K. (2020). *Skala Lęku – Cecha (SL-C)*. Instytut Psychologii Stosowanej, Uniwersytet Jagielloński. <https://doi.org/10.13140/RG.2.2.17148.36484/3>
20. Spielberger, C.D. (1983). *Manual for the State–Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
21. Spielberger, C.D., Gorsuch, R.L., Lushene, R.E. (1970). *Manual for the State–Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
22. Spielberger, C.D., Gorsuch, R.L., Lushene, R., Vagg, P.R., Jacobs, G.A. (1983). *Manual for the state-trait anxiety scale*. Consulting Psychologists.
23. Sverke, M., Hellgren, J., Näswall, K. (2002). No security: A meta-analysis and review of job insecurity and its consequences. *Journal of Occupational Health Psychology*, 7(3), 242-264. <https://doi.org/10.1037/1076-8998.7.3.242>

THE SAFETY CULTURE IN TEXTILE INDUSTRY COMPANIES IN POLAND

Patrycja KABIESZ^{1*}, Grażyna PŁAZA², Adam R. SZROMEK³, Tayyaba JAMIL⁴

¹ Silesian University of Technology, Faculty of Organization and Management, Department of Production Engineering, Poland; Patrycja.Kabiesz@polsl.pl, ORCID: 0000-0001-5920-7485

² Silesian University of Technology, Faculty of Organization and Management, Department of Production Engineering, Poland; Grazyna.Plaza@polsl.pl, ORCID: 0000-0001-5862-0905

³ Silesian University of Technology, Faculty of Organization and Management, Department of Economy and Informatics, Poland; Adam.Szromek@polsl.pl, ORCID: 0000-0003-4989-9785

⁴ Silesian University of Technology, Faculty of Organization and Management, Department of Production Engineering, Poland; tayyaba.jamil@polsl.pl, ORCID: 0009-0008-2928-8155

* Correspondence author

Purpose: The aim of this article is to analyse the safety culture in selected Polish textile enterprises and to understand employees' perception of occupational safety.

Methodology: The study was conducted in two Polish textile companies using three data collection methods: (1) employee surveys, (2) interviews with management and safety specialists, and (3) observations of working conditions on the production floor. The survey consisted of 50 questions, including a demographic section and questions on safety culture, assessed on a five-point Likert scale.

Findings: Data analysis revealed significant correlations between demographic variables and perceptions of safety. It was found that length of service affects awareness of hazards and compliance with safety rules. Employees' involvement in safety-related activities was strongly related to their perception of the level of safety in the workplace. Surprisingly, the level of education did not show a significant correlation with the perception of safety culture. Additionally, a relatively low sense of safety was noted among employees, which may be due to insufficient actions on the part of management or lack of access to appropriate personal protective equipment.

Originality/value: The article contributes to the development of safety culture theory by analyzing its aspects in the context of the Polish textile industry. It provides practical guidelines for companies striving to improve their safety performance, which in the long term can contribute to building a safer and more responsible work environment in this industry.

Keywords: safety culture, textile industry, work safety, occupational health and safety (OHS), safety management.

Category of the paper: Research paper.

1. Introduction

The Polish textile and clothing (T/C) industry is one of the key sectors of the national economy, providing employment to approximately 150,000 workers, mainly in small and medium-sized enterprises (SMEs). It operates under highly competitive market conditions, the consequences of which affect not only the structure of the sector but also working conditions and occupational risk. According to data from Statistics Poland (GUS) (<https://stat.gov.pl/>), around 1,200 companies operate in the T/C sector in Poland. Data from the Polish Agency for Enterprise Development (PARP) (<https://en.parp.gov.pl/>) indicate that in 2022 the fashion and modern textiles markets comprised more than 36,000 business entities. The value of the apparel market reached PLN 53.3 billion, of which 78.3% was generated through brick-and-mortar sales. In 2019, Poland was the fifteenth largest exporter of clothing and textiles worldwide, and its market is considered one of the most attractive in Central and Eastern Europe.

The structure of this sector, dominated by micro, small and medium-sized enterprises (SMEs), translates into specific characteristics of occupational safety management. Studies on the Polish T/C industry indicate that this branch is strongly integrated into international supply chains, where planning, sourcing, production, and distribution processes play a key role. The cost pressure often results in the relocation of production processes to countries with lower occupational and environmental safety standards.

T/C enterprises account for approximately 8% of companies classified within manufacturing (Section C - Manufacturing) according to the Polish Classification of Activities (PKD), which is aligned with the European NACE Rev. 2 classification system and applied by Statistics Poland. Employment in these industries represents around 7% of total employment in Section C. Women constitute the dominant group of employees, accounting for approximately 76% of the workforce. The demographic employment structure, combined with repetitive work tasks, high productivity intensity, and exposure to physical and chemical agents, highlights the importance of a systemic approach to occupational health and safety (OHS) management.

Approximately 60% of production facilities in the T/C sector are concentrated in five locations in Poland: Łódź, Poznań, Wrocław, Katowice, and the Kuyavian-Pomeranian Voivodeship. Such strong geographical concentration enables the development of specialized industrial clusters, but it may also contribute to the consolidation of specific organizational patterns and safety practices, making the analysis of safety culture in this sector particularly relevant from a systemic perspective (Jabłońska et al., 2022).

The Polish T/C industry, with its long-standing traditions and significant contribution to the economy, is currently undergoing dynamic transformation. It must adapt to contemporary challenges and market trends, including rapidly changing consumer expectations, compliance with environmental standards, technological progress, occupational safety requirements, and the development of safety culture. Digital transformation, the implementation of process

innovations, and the development of information and communication technologies (ICT) affect not only operational efficiency but also the nature of occupational hazards and the ways in which they are perceived by employees.

The specificity of T/C production processes - spinning, weaving, dyeing, and finishing - creates a complex work environment in which risk is multifactorial and cumulative. Textile workers are exposed to numerous hazards, including (Farhan et al., 2025):

1. Physical hazards, such as excessive noise, inadequate lighting, poor ventilation, exposure to high temperatures, cluttered and disorganized workstations, blocked emergency exits (especially in the event of fire), and inadequate sanitary conditions, including limited access to clean drinking water and separate sanitary or social facilities;
2. Chemical hazards, such as long-term exposure to cotton dust, toxic emissions from dyes, inhalation of textile dust and machine-generated particles, and contact with hazardous chemicals (liquids, solids, dusts, vapors, gases);
3. Biological hazards, including exposure to bacteria, viruses, infectious waste, or infestations;
4. Psychosocial hazards, such as psychological stress and mental health imbalance.

Research indicates that the most common occupational diseases in the textile sector include respiratory illnesses, followed by reproductive disorders, noise-induced hearing loss, cardiovascular and visual problems, neurotoxicity, various dermatological conditions, and psychological stress (Edwards et al., 2013). This underscores the need to integrate technical, organizational, and behavioural measures to effectively reduce occupational risk.

Numerous studies on safety culture have been published, including theoretical reviews and conceptual analyses (Uttal, 1983; Schein, 1985; Turner et al., 1989; Pidgeon, 1991; Cox, Cox, 1991; Ostrom et al., 1993; Geller, 1994; Berends, 1996; Studenski, 2000; Mearns et al., 2003; Von Thaden, Gibbons, 2008; Kocaj, 2024; Kucińska-Król et al., 2024). Safety culture - understood as a set of values, beliefs, norms, and practices shaping employees' attitudes, behaviors, and decisions in the face of occupational hazards - plays a crucial role in improving working conditions and reducing accident rates (Al-Wardi, 2017; Ben-Saed, Pilbeam, 2022). The primary objective of safety management is not merely compliance with procedures, but the development of an organizational culture in which safety becomes embedded in everyday practice and employee engagement is treated as an integral component of organizational functioning (Chan, Li, 2022; Kwon, 2020).

Particularly in the context of the Polish T/C sector, which is currently adapting to environmental standards and technological advancement, an effective safety culture is essential to ensure the protection of employees' health and lives, as well as the long-term efficiency and competitiveness of enterprises. Studies published in Safety Science indicate that safety culture influences safety outcomes both directly - by shaping safe behaviours - and indirectly, through safety climate, leadership, and organizational communication, thereby affecting safety performance (Mearns et al., 2003; Arzahan et al., 2022).

In the scientific literature, safety culture is identified as a dynamic set of beliefs, attitudes, and behaviours that shape employees' perception of workplace hazards and occupational risk. According to Guldenmund (2000), safety culture encompasses both technical and social aspects, aiming to minimize risk and actively involve employees in safety-related decision-making processes. Several theoretical models explain the mechanisms underlying safety culture formation, including the model developed by the Health and Safety Executive (HSE) (Nicholson, Roebuck, 1995; Blanc, 2022). This model emphasizes that genuine safety culture cannot be developed without organization-wide engagement in occupational safety issues and highlights the need to integrate safety culture into overall corporate strategy.

According to Truong and Lee (2025), companies seeking improved OHS performance should invest in employee competence development and awareness while fostering a culture of openness and communication regarding hazards. In the context of changes in the T/C industry, safety management should not be limited to the implementation of procedures but should focus on building a culture that supports employees and actively engages them in safety-related processes. Conceptualizing safety culture as a continuous improvement process that adapts to evolving organizational needs, technological change, and employee attitudes is therefore essential. In this context, employee education and training - combining theoretical knowledge about hazards with practical skills enabling rapid and effective responses - play a central role.

It should be noted that most empirical studies have focused on high-risk sectors such as energy, aviation, construction, and the chemical industry, whereas traditional manufacturing sectors, including T/C, remain relatively underrepresented in international research.

In studies of the Polish T/C sector, economic analyses, enterprise structure, innovation levels, and participation in global supply chains have predominated (Sadowski et al., 2021). Only few studies have simultaneously examined organizational determinants of safety culture and individual risk perception within the context of SME dominance and strong cost pressure resulting from global competition (Jurek, 2024; Zysiński, Krysiuk, 2018).

Based on the literature review, the following gaps concerns three interrelated areas were identified: (1) the insufficient number of studies on safety culture in the textile sector in Central and Eastern Europe, (2) the lack of analyses linking the organizational level (management, leadership, formal OHS systems) with the individual level (risk perception, attitudes, behaviors), and (3) the limited application of mixed-methods approaches in safety research within traditional industrial sectors.

Based on these premises, the following research questions (RQs) were formulated:

RQ1: How is the perceived managerial commitment to safety associated with the level of safety culture in the enterprise?

RQ2: What is the relationship between the level of safety culture and employees' perception of occupational risk?

RQ3: Does risk perception mediate the relationship between organizational determinants of safety culture and employees' self-reported safe behaviours?

RQ4: Do structural characteristics of the enterprise (such as size, level of procedural formalization, and degree of integration into the global supply chain) moderate the relationship between safety culture and employees' safe behaviours?

Based on these premises, the aim of this article is to conduct a detailed analysis of safety culture in selected Polish T/C enterprises and to understand how employees perceive occupational safety issues. By means of a mixed-methods design that combines quantitative survey analysis with qualitative examination of the organizational context, the study provides an in-depth exploration of the mechanisms shaping occupational safety in the T/C sector characterized by relatively low technological intensity and substantial exposure to physical and chemical hazards.

The findings are significant both theoretically - by expanding the body of knowledge on safety culture in the textile and clothing (T/C) sector, and practically, as they offer evidence-based recommendations for enterprises.

2. Methodology

2.1. Research Design

The study was conducted using a mixed-methods research approach, integrating quantitative and qualitative components. This design enabled the identification of determinants shaping safety culture at the organizational level, as well as individual risk perception and self-reported safety behaviours among employees. The study had a cross-sectional design.

To enhance the robustness and credibility of the findings, methodological triangulation was applied, including: (1) an employee survey, (2) semi-structured interviews with managers and occupational health and safety (OHS) specialists, and (3) systematic workplace observations conducted on the production floor. This approach enabled data triangulation and cross-validation of findings derived from multiple sources, thereby strengthening the interpretative depth of the analysis.

2.2. Sampling and Research Procedure

An invitation to participate in the study was sent to 21 textile and clothing (T/C) enterprises in Poland using purposive sampling, ensuring variation in company size and type of economic activity. In the end, only two enterprises agreed to participate in the study.

Surveys were administered directly at the workplace under conditions ensuring full anonymity and confidentiality. Supervisors were not involved in the administration process, thereby minimizing potential response bias and social desirability effects.

Semi-structured interviews were conducted with members of top management and OHS specialists to obtain an in-depth understanding of the existing safety management systems and to identify organizational barriers affecting safety performance.

Observational research was conducted in a non-participatory manner and focused primarily on workstation organization, use of personal protective equipment (PPE), compliance with OHS procedures, and adherence to safety signage and regulations.

2.3. Research Instruments

The quantitative component was based on a structured questionnaire consisting of two sections: (1) control variables - demographic and occupational characteristics (gender, age, level of formal education, job position, length of service); (2) main variables - 50 statements measuring dimensions of safety culture, including perceived management commitment to safety, compliance with OHS procedures, hazard communication, employee involvement in safety-related activities, and subjective sense of workplace safety.

Respondents evaluated each statement using a five-point Likert scale:

- 1 - strongly disagree,
- 2 - rather disagree,
- 3 - neutral / no opinion.
- 4 - rather agree,
- 5 - strongly agree.

For the purposes of this article, eight items (V1-V8) were selected from the original 50-item pool to operationalize key components of safety culture and safety perception (see Table 1).

Table 1.
Question database

Symbol	Question
V1	In our workplace, everyone places great importance on continuously improving health and safety standards.
V2	In our workplace, safety and hygiene are just as important as production and quality.
V3	Employees and supervisors have the necessary knowledge to work safely.
V4	Employees are always actively involved in decision-making regarding their health and safety.
V5	I receive timely information about work-related hazards.
V6	I feel safe as an employee.
V7	I participate in activities aimed at improving safety, such as serving on committees, analyzing accidents, or developing safety rules and occupational health and safety training.
V8	My workplace is safe.

Internal consistency reliability was assessed using Cronbach's alpha, which reached 0.87, indicating high internal consistency. Additionally, the correlational structure of the items was examined to confirm their alignment with the assumed theoretical framework and the adequacy of construct operationalization.

Semi-structured interviews followed a predefined interview guide covering: (1) organization of the safety management system, (2) the role of leadership in shaping safety culture, (3) challenges related to compliance with OHS regulations, (4) preventive and training activities.

Complementary workplace observations were conducted on the production floor to identify potential hazards related to work organization and compliance with safety procedures. Observations enabled the identification of safety issues that may not have been fully captured through survey responses or interviews but have a direct impact on employee safety.

2.4. Research Model

The study employed a multilevel conceptual model (Fig. 1), enabling analysis of relationships between variables at both the organizational (company) and individual (employee) levels.

Organizational level (company): (1) safety culture - perceived safety values and norms within the enterprise; (2) management commitment - active managerial support for OHS initiatives; (3) safety communication - effectiveness of information flow regarding hazards, procedures, and incidents. Organizational-level outcomes include safety results, such as the number of incidents and procedural violations.

Individual level (employee): (1) safety perception - perceived protection and risk at the workplace; (2) safety behaviour - self-reported and observed OHS-related behaviours.

The final outcome variable is safety performance, encompassing both individual safety behaviours and objective safety indicators at the organizational level. This multilevel framework allows for the examination of direct and indirect relationships between organizational determinants and employee-level outcomes, supporting the subsequent testing of mediation and moderation effects within a structural modelling approach.

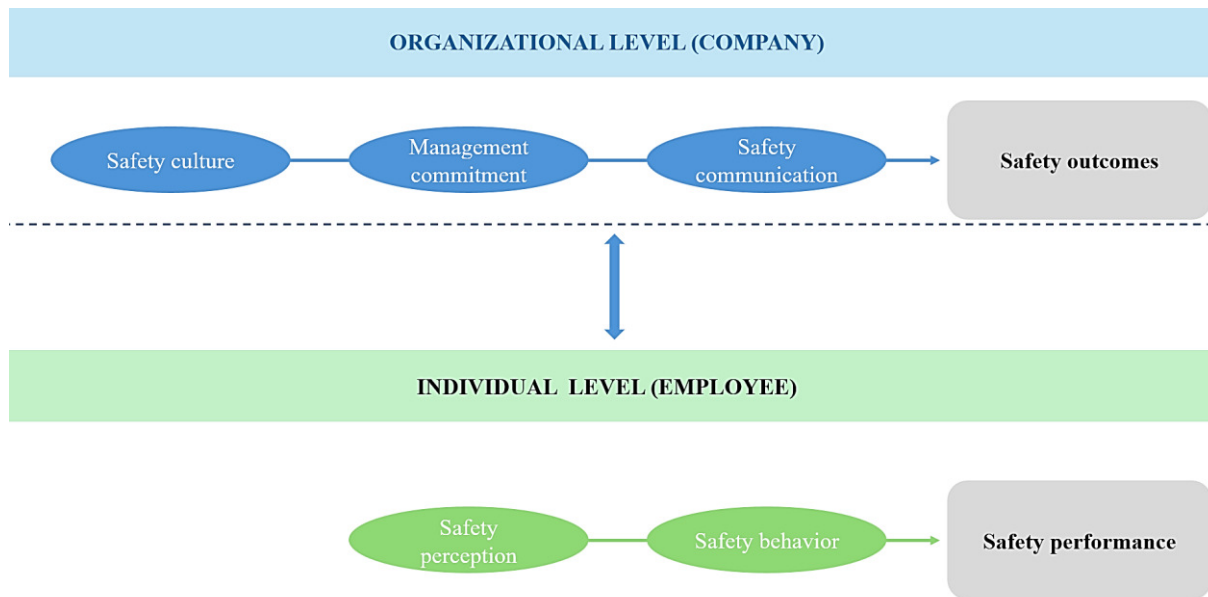


Figure 1.1 Hierarchical model of occupational safety.

Source: Own study.

2.5. Data Analysis

Quantitative data were subjected to statistical analysis using STATISTICA 13 software and included: (1) descriptive statistics - mean and standard deviation, (2) correlation analysis between variables, and (3) multilevel modelling - examining relationships between variables at the organizational and individual levels.

Qualitative data (interviews and observations) were analysed using content and thematic analysis, which enabled the identification of recurring patterns and a more in-depth interpretation of the results.

The integration of quantitative and qualitative data was carried out at the interpretation stage, allowing for a more comprehensive understanding of the relationships identified within the studied enterprises.

2.6. Ethical Considerations

Each participant was informed about the anonymous nature of the study, the confidentiality of their responses, and the fact that the collected data would be used exclusively for scientific purposes.

3. Results

The study involved 110 people, and the participants were only women, which means that in Poland, the textile industry is mainly staffed by women. The analysis of demographic data have indicated that the majority of respondents were middle-aged. The largest proportion belonged to the 46-50 age group (51.8%), followed by those aged 41-45 (46.4%). In contrast, only 1.8% of participants were between 31 and 35 years old. The vast majority of the survey participants have professional experience in the textile industry. Half of the respondents have been working in the company for over 14 years, 47.3% of the respondents have 12 to 14 years of experience. Only 1.8% of people have 3 to 5 years of experience, and 0.9% - 6 to 8 years. Based on the analysis, it results that the textile industry in Poland is dominated by employees with long service

In terms of education, the majority of the study participants have completed primary school (60.9%), vocational school (34.5%), secondary school (3.6%) and higher education (0.9%), which may indicate the practical nature of work in the textile industry and a lower demand for higher education in this industry. The demographic profile of the respondents is presented in Table 2.

Table 2.
Demographic characteristics of the respondents

Demographic factor	Demographic relationships			
Gender	Male 0	Female 110 (100 %)		
Age	31-35 2 (1.8 %)	41-45 51 (46.4 %)	46-50 57 (51.8 %)	
Professional experience	3-5 2 (1.8 %)	6-8 1 (0.9 %)	12 -14 52 (47.3 %)	14 and more 55 (50%)
Education level	Primary education 38 (34.5 %)	Vocational education 67 (60.9 %)	High School 4 (3.6 %)	Bachelor/ Master and above 1 (0.9 %)

Then, due to the qualitative data obtained from the conducted survey questionnaire, the values of Spearman's rank correlation coefficients were estimated along with the p coefficient value defining the significance of the obtained results ($p < 0.05$). At the beginning, however, the data were ranked and then calculations were performed using STATISTICA 13 software. The following designations were adopted: AR - age range, LoE - level of education, PE - professional experience. The remaining variable designations (V1-V8) denote the statements from Table 1. For example, V1 denotes the first statement: *In our workplace, everyone attaches great importance to the continuous improvement of occupational health and safety standards*. The results of all correlations are presented in Table 3, while Table 4 has been limited to selected categories.

Table 3.
Spearman's Rank Order Correlation

Variable	AR	LoE	PE	V1	V2	V3	V4	V5	V6	V7	V8
AR	1	-0.034	0.038	-0.113	-0.014	-0.112	-0.130	-0.095	-0.107	0.022	0.037
LoE	-0.034	1	0.028	0.080	0.092	-0.150	0.014	-0.231	-0.18	-0.139	-0.097
PE	0.038	0.028	1	0.055	-0.029	-0.154	-0.072	-0.039	-0.112	0.130	0.203
V1	-0.113	0.08	0.055	1	0.307	0.290	0.222	0.170	0.143	0.138	0.120
V2	-0.014	0.092	-0.029	0.307	1	0.047	-0.107	0.056	0.037	-0.089	0.013
V3	-0.112	-0.150	-0.154	0.290	0.047	1	0.377	0.308	0.347	0.013	0.084
V4	-0.130	0.014	-0.072	0.222	-0.107	0.377	1	0.441	0.425	0.285	0.183
V5	-0.095	-0.231	-0.039	0.17	0.056	0.308	0.441	1	0.481	0.079	0.02
V6	-0.107	-0.180	-0.112	0.143	0.037	0.347	0.425	0.481	1	0.084	-0.026
V7	0.022	-0.139	0.130	0.138	-0.089	0.013	0.285	0.079	0.084	1	0.350
V8	0.037	-0.097	0.203	0.120	0.013	0.084	0.183	0.02	-0.026	0.350	1

Table 4.
Spearman's Rank Order Correlation

Variable	AR	LoE	PE	V1	V2	V3	V4	V5	V6	V7	V8
AR	1.000	-0.034 (0.725)	0.038 (0.697)	-0.113 (0.239)	-0.014 (0.884)	-0.112 (0.243)	-0.130 (0.176)	-0.095 (0.322)	-0.107 (0.267)	0.022 (0.817)	0.037 (0.704)
LoE	-0.034 (0.725)	1.000	0.028 (0.772)	0.080 (0.405)	0.092 (0.337)	-0.150 (0.119)	0.014 (0.886)	-0.231 (0.015)	-0.180 (0.060)	-0.139 (0.147)	-0.097 (0.316)
PE	0.038 (0.697)	0.028 (0.772)	1.000	0.055 (0.568)	-0.029 (0.763)	-0.154 (0.107)	-0.072 (0.455)	-0.039 (0.682)	-0.112 (0.246)	0.130 (0.177)	0.203 (0.034)
V1	-0.113 (0.239)	0.080 (0.405)	0.055 (0.568)	1.000	0.307 (0.001)	0.290 (0.002)	0.222 (0.020)	0.170 (0.077)	0.143 (0.135)	0.138 (0.150)	0.120 (0.213)
V2	-0.014 (0.884)	0.092 (0.337)	-0.029 (0.763)	0.307 (0.001)	1.000	0.047 (0.624)	-0.107 (0.266)	0.056 (0.563)	0.037 (0.700)	-0.089 (0.357)	0.013 (0.893)
V3	-0.112 (0.243)	-0.150 (0.119)	-0.154 (0.107)	0.290 (0.002)	0.047 (0.624)	1.000	0.377 (0.000)	0.308 (0.001)	0.347 (0.000)	0.013 (0.896)	0.084 (0.382)
V4	-0.130 (0.176)	0.014 (0.886)	-0.072 (0.455)	0.222 (0.020)	-0.107 (0.266)	0.377 (0.000)	1.000	0.441 (0.000)	0.425 (0.000)	0.285 (0.003)	0.183 (0.055)
V5	-0.095 (0.322)	-0.231 (0.015)	-0.039 (0.682)	0.170 (0.077)	0.056 (0.563)	0.308 (0.001)	0.441 (0.000)	1.000	0.481 (0.000)	0.079 (0.412)	0.020 (0.836)
V6	-0.107 (0.267)	-0.180 (0.060)	-0.112 (0.246)	0.143 (0.135)	0.037 (0.700)	0.347 (0.000)	0.425 (0.000)	0.481 (0.000)	1.000	0.084 (0.381)	-0.026 (0.784)
V7	0.022 (0.817)	-0.139 (0.147)	0.130 (0.177)	0.138 (0.150)	-0.089 (0.357)	0.013 (0.896)	0.285 (0.003)	0.079 (0.412)	0.084 (0.381)	1.000	0.350 (0.000)
V8	0.037 (0.704)	-0.097 (0.316)	0.203 (0.034)	0.120 (0.213)	0.013 (0.893)	0.084 (0.382)	0.183 (0.055)	0.020 (0.836)	-0.026 (0.784)	0.350 (0.000)	1.000

There are only a few statistically significant correlations between the traits, among them a negative correlation ($r_s = -0.231$, $p = 0.015$) between the level of education and the answer to the statement (V5) "I receive information on work-related hazards in a timely manner". The result suggests that a higher level of education (LoE) may be associated with lower agreement with this opinion (V5). In turn, a positive correlation ($r_s = 0.203$, $p = 0.034$) occurred between work experience and the answer to the question (V8) "My workplace is safe". It follows that the greater the employee's experience (PE), the greater the perceived safety at work (V8).

As well as significant and positive correlations are observed between the answers to the questions in Table 1:

- V1 vs. V2 ($r_s = 0.307$, $p < 0.001$) - the higher the agreement with the opinion that everyone attaches great importance to continuous improvement of occupational health and safety standards, the greater the agreement with the opinion that health and safety are as important as production and quality.
- V1 vs. V3 ($r_s = 0.290$, $p = 0.002$) - the higher the agreement with the opinion that everyone attaches great importance to continuous improvement of occupational health and safety standards, the greater the agreement with the opinion that employees and supervisors have the necessary knowledge to work safely.
- V1 vs. V4 ($r_s = 0.222$, $p = 0.020$) - the higher the agreement with the opinion that everyone attaches great importance to the continuous improvement of occupational health and safety standards, the greater the agreement with the opinion that employees are always actively involved in making decisions concerning their health and safety.

In addition, significant and positive correlations are observed between the statements:

- V3 vs. V4 ($r_s = 0.377$, $p < 0,001$).
- V3 vs. V5 ($r_s = 0.308$, $p < 0,001$).
- V3 vs. V6 ($r_s = 0.347$, $p < 0,001$).
- V4 vs. V5 ($r_s = 0.441$, $p < 0,001$).
- V4 vs. V6 ($r_s = 0.425$, $p < 0,001$).
- V4 vs. V7 ($r_s = 0.285$, $p = 0,003$).
- V5 vs. V6 ($r_s = 0.481$, $p < 0,001$).
- V7 vs. V8 ($r_s = 0.350$, $p < 0,001$).

The highest correlation coefficient value concerns opinions V5 vs. V6 ($r_s = 0.481$, $p < 0.001$), which suggests that opinions that respondents receive timely information about work-related hazards and feel safe as employees are correlated.

It should be noted, however, that correlation does not mean causality, therefore the analyzed factors may be non-causally correlated with respect to a third variable, e.g. a common cause or mediator.

4. Discussion

Based on the results of the survey research on safety culture in Polish T/C sector enterprises, several aspects can be identified that significantly influence the shaping of working conditions and employees' perception of safety. The findings should be interpreted in relation to the four research questions (RQ1-RQ4) presented in the introduction, which were grounded in the assumption that the relationships between organizational determinants, risk, and employees' safe behaviours are complex and multilevel in nature. This approach is consistent with

multilevel models of safety culture and safety climate developed in the Safety Science literature (Mearns et al., 2003; Arzahan et al., 2022).

With regard to RQ1, which concerns the relationship between perceived managerial commitment to safety and the level of safety culture within the enterprise, the analysis revealed significant and positive correlations between variables related to the prioritization of safety (V1), the balance between safety and production (V2), and competence in safe work practices (V3). These relationships form a coherent pattern. In this context, employees' perceptions of organizational norms appear internally consistent and mutually reinforcing, indicating a meaningful association between managerial commitment and the overall level of safety culture.

The above results are consistent with models presented in the literature, which indicate that safety leadership and visible managerial commitment constitute the foundation of safety culture (Mearns et al., 2003; Neal, Griffin, 2006; Dothang Truong, Lee, 2025; Pratama, Caponecchia, 2025; Smolarek, Sułkowski, 2020). In T/C enterprises, managerial commitment appears to play a norm-setting role, shaping the perception that safety is an organizational value rather than merely a formal requirement.

These findings suggest that safety culture does not function solely as an abstract organizational construct; rather, it translates into the way employees interpret workplace hazards. The results therefore indicate that specific components of safety culture, particularly communication and participation, are significantly associated with the subjective assessment of workplace safety.

From a theoretical perspective, this may be interpreted as confirmation that safety climate functions as a cognitive framework through which employees evaluate the level of risk (Neal, Griffin, 2006; Pidgeon, 1991). This is consistent with Guldenmund's (2000) proposition that safety culture encompasses both technical and social aspects. Similar conclusions were drawn by Mearns et al. (2003), who demonstrated that safety climate influences individual risk assessments and safe behaviours.

With reference to RQ3, which addressed the potential mediating role of perceived risk between organizational determinants of OHS culture and employees' self-reported safe behaviours, the observed pattern of correlations suggests the possible existence of a chain of relationships. Although confirmation of mediation effects requires more than correlation analysis alone, the results indicate that hazard communication (V5) may influence perceived safety (B6), which in turn may affect engagement in OHS activities (V7), ultimately influencing the assessment of workplace safety (V8).

In this case, a significant relationship was observed between V7 and V8, suggesting that engagement in OHS-related activities may be associated with an improved level of safety. These findings point to a potential mediating mechanism consistent with the logic of RQ3. However, its verification would require the application of Structural Equation Modelling (SEM), within which the proposed mediational pathways could be formally tested, in line with

established research approaches in safety climate studies. The results also confirm previous findings regarding the influence of organizational support and safety climate on the development of safe behaviours through cognitive and motivational processes (Neal, Griffin, 2006).

With regard to RQ4, which concerns the role of structural characteristics of the enterprise as moderators of the relationship between safety culture and safe behaviours, empirical verification was limited due to the small number of analyzed entities, only two T/C enterprises were included in the study. Nevertheless, qualitative findings suggest that factors such as the level of procedural formalization and management style may differentiate the ways in which hazards are communicated and employees are engaged.

These observations indicate that structural characteristics may influence the manner in which safety culture affects employee behaviour. To adequately assess the assumptions of RQ4, a comparative analysis of a larger number of companies representing diverse structural profiles would be required.

In the T/C sector, where SMEs operate under strong cost pressure, structural constraints may limit the potential for investment in systematic safety management, thereby influencing the extent to which safety culture affects employee behaviour.

The results also indicate that certain demographic characteristics are associated with the level of perceived safety. Metaphorically speaking, the longer an individual works in a particular workplace, the more strongly they perceive a certain level of safety. This may suggest that employees “mature” within a specific work environment, developing their own coping strategies and experiential knowledge. The lack of a clear relationship between formal education and the level of safety culture perception may indicate that, in the T/C sector, practical experience and everyday learning play a more significant role than formally acquired knowledge.

Overall, the study provides partial support for the proposed theoretical model and indicates the existence of a multilevel safety culture mechanism in the T/C sector linking organizational norms, risk perception, and employee behaviour.

From a theoretical perspective, the study addresses a research gap by empirically linking organizational and individual level determinants in the T/C sector, which remains underrepresented in international research.

From a practical perspective, the findings confirm the assumption that an effective strategy for enhancing safety levels in T/C enterprises should integrate four key elements: visible managerial commitment, open and transparent hazard communication, employee engagement, and the development of safety-related competencies. At the same time, the cross-sectional nature of the study limits the possibility of drawing causal inferences.

Future research should focus on longitudinal study designs and the application of Structural Equation Modelling. In particular, it would be valuable to examine the mediating and moderating mechanisms described in RQ3 and RQ4.

The conclusions emphasize that the development of safety culture in the Polish textile industry requires a multidimensional approach, encompassing both education and training as well as the active involvement of employees and management in the continuous improvement of working conditions. Further research should also consider the impact of technological changes and environmental requirements on occupational safety in this sector, which may contribute to a more comprehensive approach to improving employment conditions.

5. Conclusion

The results of the study on safety culture in the textile industry confirm a clear relationship between demographic characteristics and the perception of safety culture. The findings indicate that longer job tenure is associated with greater hazard awareness and better compliance with occupational health and safety regulations. Participation in training and practical engagement in safety-related activities also have a positive impact. An interesting result is that the level of formal education does not show a significant correlation with the perception of safety culture, suggesting that practical experience may be more important than formal qualifications. However, the relatively low sense of safety reported by employees points to the need for improved communication and stronger managerial commitment. The study's conclusions highlight the necessity of a multidimensional approach to enhancing safety culture, encompassing education as well as the active involvement of both employees and managers in occupational safety processes.

In conclusion, the findings emphasize that the development of safety culture in the Polish textile industry requires a multidimensional approach encompassing education and training, as well as active involvement of both employees and managers in the continuous improvement of working conditions.

Future research should focus on the impact of technological and environmental changes on occupational safety in the textile industry in order to fully understand and improve working conditions in this sector.

Acknowledgements

This paper was financed from the project no. BK-259/ROZ3/2025 (13/030/BK_25/0089) and 13/030/BKM_24/0085 (BKM-630/ROZ3/2024) by the Department of Production Engineering (ROZ3), Faculty of Organization and Management, Silesian University of Technology.

References

1. Al-Wardi, Y. (2017). Arabian, Asian, western: A cross-cultural comparison of aircraft accidents from human factor perspectives. *International Journal of Occupational Safety and Ergonomics*, 23(3), 366-373.
2. Arzahan, I.S.N., Ismail, Z., Yasin, S.M. (2022). Safety culture, safety climate, and safety performance in healthcare facilities: A systematic review. *Safety Science*, 147, 105624.
3. Ben-Saed, M., Pilbeam, C. (2022). The effect of an embargo, sanctions and culture on safety climate: A qualitative view from aviation maintenance in the MENA region. *Journal of Safety Research*, 81, 259-269.
4. Berends, J.J. (1996). *On the Measurement of Safety Culture*. Eindhoven: Eindhoven University of Technology.
5. Blanc, F., Ottimofiore, G., Myers, K. (2022). From OSH regulation to safety results: Using behavioral insights and a “supply chain” approach to improve outcomes - The experience of the Health and Safety Executive. *Safety Science*, 145, 105491.
6. Chan, W.T.K., Li, W.C. (2022). Cultural effects on the selection of aviation safety management strategies. *Lecture Notes in Computer Science*, 13200, 245-252.
7. Cox, S., Cox, T. (1991). The structure of employee attitudes to safety: A European example. *Work and Stress*, 5(2), 93-106.
8. Edwards, P., Mainiero, L., Barnes, F. (2013). Safety culture in industrial organizations: A review of literature and perspectives. *Journal of Safety Research*, 44(2), 107-119.
9. European Commission (2021). *Data on the EU Textile Ecosystem and its Competitiveness. Final Report*. Luxembourg: Publications Office of the European Union.
10. Farhan, A., Ambarwati, R., Dedy. (2025). The role of safety leadership in shaping safety culture: The mediating role of communication and commitment. *Jurnal Manajemen Bisnis*, 12(2), 216-239.
11. Geller, E.S. (1994). Ten principles for achieving a Total Safety Culture. *Professional Safety*, 39(9), 18-24.

12. Główny Urząd Statystyczny (2025). *Dane statystyczne*. Retrieved from: <https://stat.gov.pl/>, 03.03.2025.
13. Guldenmund, F.W. (2000). The nature of safety culture: A review of theory and research. *Safety Science*, 34(1-3), 215-257.
14. Jabłońska, M., Ławińska, K., Wysokińska, Z. (2022). Overview of EU and global conditions for the transformation of the TCLF industry on the way to a circular and digital economy: Case studies from Poland. *Comparative Economic Research. Central and Eastern Europe*, 25(1).
15. Jurek, K. (2024). Wpływ innowacji na efektywność operacyjną w sektorze transportu i logistyki. *Zarządzanie Publiczne*, 1-2(61), 1-14.
16. Kocaj, A. (2024). Spatial transformations in the clothing industry in Poland: From a traditional to a creative sector. *AUTEX Research Journal*, 24(1), Article 20240005.
17. Kucińska-Król, I., Festinger, N., Walawska, A., Kulczycka, J. (2024). Study of Lodz society's knowledge of the circular economy in the textile and clothing industry. *Fibres & Textiles in Eastern Europe*, 32(3), 10-20.
18. Kwon, Y. (2020). Perceptions of the west and the east and national culture on the human factors. *Proceedings of the International Conference on Human Factors 2020*. London, UK.
19. Ma, G., Zhang, Y., Jiang, S., Pan, X., Wu, Z. (2025). Fostering resilient safety culture to boost safety performance of young construction workers: Insights from empirical and simulation studies. *International Journal of Industrial Ergonomics*, 105, 103687.
20. Mearns, K., Whitaker, S.M., Flin, R. (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science*, 41(8), 641-680.
21. Neal, A., Griffin, M.A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents. *Journal of Applied Psychology*, 91(4), 946-953.
22. Nicholson, C.E., Roebuck, B. (1995). The investigation of the Hillsborough disaster by the Health and Safety Executive. *Safety Science*, 18(4), 249-259.
23. Ostrom, L., Wilhelmsen, C., Kaplan, B. (1993). Assessing safety culture. *Nuclear Safety*, 34(2), 163-172.
24. Pidgeon, N.F. (1991). Safety culture and risk management in organisations. *Journal of Cross-Cultural Psychology*, 22(1), 129-140.
25. Polska Agencja Rozwoju Przedsiębiorczości (2025). *Informacje o przedsiębiorczości w Polsce*. Retrieved from: <https://en.parp.gov.pl/>, 10.03.2025.
26. Pratama, G.B., Caponecchia, C. (2025). Examining the influence of national culture on aviation safety: A systematic review. *Journal of Safety Research*, 92, 317-330.
27. Sadowski, A., Dobrowolska, B., Skowron-Grabowska, B., Bujak, A. (2021). Polish textile and apparel industry: Global supply chain management perspective. *AUTEX Research Journal*, 21(3), 262-276.
28. Schein, E.H. (1985). *Organizational culture and leadership*. San Francisco: Jossey-Bass.

29. Smolarek, M., Sułkowski, Ł. (2020). Job satisfaction among SMEs employees in fibres & textiles of the CEE countries. *Economics and Sociology*, 13(2), 181-209.
30. Studenski, R. (2000). Kultura bezpieczeństwa pracy w przedsiębiorstwie. *Bezpieczeństwo Pracy. Nauka i Praktyka*, 9, 2-6.
31. Truong, D., Lee, S.-A. (2025). Developing a new safety culture framework for aviation maintenance: Preliminary results. *Safety Science*, 183, 106729.
32. Turner, B.A., Pidgeon, N.F., Blockley, D.I., Toft, B. (1989). *Safety culture: Its importance in future risk management*. Paper presented at Second World Bank Workshop on Safety Control and Risk Management, Karlstad, Sweden.
33. Uttal, B. (1983). The corporate culture vultures. *Fortune Magazine*, 17 October, 66-72.
34. Von Thaden, T.L., Gibbons, A.M. (2008). *The Safety Culture Indicators Scale Measurement System (SCISMS)*. Washington: National Technical Information Service.
35. Zysiński, M., Krysiuk, C. (2018). Analysis of trends on the Polish transport and logistics market in the period 2007-2016. *Autobusy: Technika, Eksploatacja, Systemy Transportowe*, 19(6), 1155-1163.

THE A3 REPORT AS A PROBLEM-SOLVING TOOL IN A MANUFACTURING ENTERPRISE – CASE STUDY

Filip KEIPER¹, Joanna FURMAN^{2*}, Sylwia KRUCZYŃSKA³

¹ Filip.keiper@gmail.com

² Silesian University of Technology, Faculty of Materials Engineering, Department of Production Engineering;
joanna.furman@polsl.pl, ORCID: 0000-0002-8828-7186

³ Sylwia.kruczynska@gmail.com

* Correspondence author

Purpose: This article aims to analyze a problem occurring in the pipe production process and then solve it using the A3 report. The analysis was conducted using a production plant in Poland, where non-compliance was identified as gel lumps on the inner surface of pipes, affecting the quality, durability, and safety of use of finished products. Solving the problem using the A3 report methodology enabled understanding of the problem, analysis of its root causes, and development of an action plan, while engaging the team in the improvement process.

Design/methodology/approach: The A3 report was used for the analysis as a tool to support problem-solving in the production environment. According to the A3 report methodology, the problem-solving process included seven stages: defining the problem, analyzing current conditions, defining the action objective, identifying the root cause, defining countermeasures, developing an implementation plan, and defining further actions (monitoring results and drawing conclusions).

Findings: Using the A3 report allowed the identification of the root cause of the problem being analyzed, and taking preventative measures and standardizing the process effectively resolved the problem and prevented its recurrence. The results obtained were also passed on to other company plants as source material.

Research limitations/implications: The analysis focused on a single issue in the company's pipe production process, which limits the ability to compare the results regarding the effectiveness of the A3 report as a problem-solving tool at this plant. Furthermore, the effectiveness of the implemented actions was observed over a limited time period. The results obtained may also depend to some extent on the competence and commitment of the team conducting the analysis, which constitutes a further direction for research in this area.

Originality/value: This article is a case study and presents the practical application of the A3 report in the process of solving a specific problem at a manufacturing company in Poland. The work serves as source material for the company where the analysis was conducted and can also be a source of knowledge for other companies undertaking similar activities. Furthermore, the conducted research can serve as a reference point for further research and comparative analyses in industrial practice.

Keywords: the A3 report, Problem-Solving, PDCA, continuous improvement, Lean Manufacturing.

Category of the paper: research paper, case study.

1. Introduction

Every company, regardless of industry, faces a variety of problems that require corrective action. How a company approaches problem-solving often determines its operational efficiency, competitiveness, and ability to grow. More and more companies are therefore turning to proven, systematic methods and tools that not only help solve specific problems but also support long-term process improvement. One such tool is the A3 report – a practice pioneered at Toyota plants that records the problem, analysis, corrective actions, and action plan on a single sheet of A3 paper. This allows every employee dealing with a problem to see it from the same perspective. At Toyota plants, A3 reports have evolved into a standard method for developing summaries of problem-solving activities, reporting the current status of activities, and planning (Lean Lexicon, 2018; Shock, 2018).

The A3 report is based on the PDCA cycle (Bassuk, Washington, 2013), developed by Deming in 1950, which supports problem analysis and has a wide application (Singh, Ghandi, 2024). The A3 report is not just a form; it's a way of thinking and acting. It allows for understanding the problem, analyzing its causes, and developing a coherent action plan. The report also serves as a communication element, and its greatest advantage is its clarity and logical structure. This allows for presenting the situation to all employees, engaging the appropriate people, and collaboratively developing a solution. This tool therefore fosters a culture of continuous improvement, teamwork, and employee competency development, which in the long run benefits the entire organization (Liker, Meier, 2011; Siwiec et al., 2017).

The study aimed to analyze non-compliance in the production process for pipes at a Polish enterprise. The problem concerned gel lumps on the inner surface of the pipes, which affected the quality, durability, and safety of the finished product. The A3 report was used for the analysis as a tool to support problem-solving in the production environment. The conducted research demonstrates how the use of the A3 report affects the effectiveness of problem identification, cause-finding, and implementing sustainable solutions. This article is a case study that presents the practical application of the A3 report to solve a specific problem at the analyzed company. This work serves as a source material for the company where the analysis was conducted and can also be a source of knowledge for other companies undertaking similar activities. Furthermore, the conducted research can serve as a reference point for further research and comparative analyses in industrial practice.

2. The role of the A3 report in problem solving and continuous improvement

Companies use a variety of methods and tools to ensure the high quality of their products and meet the growing demands of customers. Using appropriately selected methods and tools can be an effective way to resolve emerging problems and prevent their recurrence. Such actions enable the continuous pursuit of excellence, which is crucial for every company (Siwiec et al., 2017).

According to the literature (Hamrol, 2008), improvement is understood as "action undertaken to obtain additional benefits for the organization and its customers". Improvement, which involves incremental improvements to products and processes, can be viewed as a form of problem-solving. Effective problem-solving requires knowledge of the process or product, a set of appropriate methods and tools, and the ability to use them. It is emphasized that the ability to recognize problems is crucial.

The principle of continuous improvement (known as Kaizen in Japan) is an extension of Deming's fifth principle, which advocates a continuous search for the causes of problems to improve all elements of the production system and the actions undertaken. The PDCA (Plan-Do-Check-Act) cycle is linked to the principle of continuous improvement, according to which developing a detailed action plan is the basis for implementing it (Hamrol, Mantura, 2002; Liker, Meier, 2011; Rangel-Sánchez et al., 2024). Good planning enables effective problem-solving, leading to defect-free production and eliminating waste. Problem-solving according to the PDCA cycle is a key element of Lean Thinking (Liker, Franz, 2016). This approach, pioneered by the Toyota Production System, enables companies to achieve more with less by eliminating waste and non-value-added activities, thereby delivering better customer value (Womack, Jones, 1996; Argiyantari et al., 2021; Vijverberg et al., 2023). Consequently, many manufacturing companies worldwide are using TPS-based solutions in Lean Manufacturing to address problems and pursue excellence (Al-Qayoudhi, 2022; Utami et al., 2023; Małysa et al., 2024).

The literature (Smalley, 2018) distinguishes four types (methods) of problem-solving:

1. Removal of faults– reactive problem-solving based on rapid response and reacting only to directly visible symptoms.
2. Eliminating deviations from standards – structured problem-solving involving problem definition, goal setting, root cause analysis, implementing countermeasures, control, setting standards, and planning future actions. This aims to prevent recurrence by eliminating the root cause.

3. Achieving a new target state – continuous improvement (Kaizen) that goes beyond current performance standards; it aims to eliminate waste systematically and may use existing methods in new ways to achieve greater value closer to the target state.
4. Innovation – innovative problem-solving based on creativity and the ability to seize opportunities; it sets new standards leading to radical improvements.

Companies whose production systems are based on Lean Manufacturing concepts solve problems using Types 2 and 3, with the explicit goal of this approach being learning. It is believed (Smalley, 2018) that the most effective tool for solving Types 2 and 3 problems is the A3 report, which aligns with the PDCA cycle.

An A3 report systematically documents a problem, its causes, corrective actions, and their effectiveness (Santos Fihlo, Simao, 2022). The A3 report methodology is based on the need to gather information directly from the source of the problem (Gemba). All information needed to solve a given problem is placed on an A3 sheet in a predetermined format. It's important to note, however, that an A3 report is more of a way of thinking (so-called A3 Thinking) than a standard document format, and therefore should be flexible and adaptable to the current problem within a given organization (Shook, 2018; Rini, 2021; Burka, 2022).

The A3 report includes the following elements:(Shook, 2018; Koskela et al., 2020; Rini, 2021):

1. Situation description/background – a precise definition of the problem that has been observed. The goal is to clearly present the situation requiring a solution, without making interpretations, assessments, or formulating hypotheses. The key is to focus on the facts, and potential causes or solutions should not be suggested yet. This approach allows for objective analysis and provides a foundation for further action.
2. Current conditions – The goal of this phase is to develop the most accurate description of the actual state of affairs possible, using quantitative and qualitative data (process observations, measurements, photographs, charts, etc.).
3. Goals/metrics – at this stage, the goal of the improvement activities should be precisely formulated (the goal may be to eliminate an undesirable phenomenon or improve process parameters). The goal must be measurable, realistic, and closely related to the defined problem.
4. Analyzing and identifying the root cause of the problem is the most important step in the report. This process requires detailed analysis and often a multi-step investigation into the source of the problem. Using appropriate tools to support cause-and-effect analysis, such as 5 Whys, Ishikawa diagram, or Pareto diagram, is crucial. Correctly identifying the root cause is fundamental to the effectiveness of the planned corrective actions.
5. Proposed countermeasures – describe the proposed actions to eliminate the causes of the problem and achieve the intended results.

6. Action plan – the plan should include information on the scope of activities, responsible individuals, resources needed for implementation, a timeline, and indicators that will be used to assess the effectiveness of the activities.
7. Further actions – define how progress will be monitored. Key elements include regular reviews, audits, indicator analysis, and the identification of further improvement opportunities. This ensures that achieved results can be sustained and improved.

The literature analysis indicates that the A3 report is widely applied across various industrial sectors, including plastics manufacturing (Rini, 2021), the automotive industry (Grobelna, Wasilewska, 2023; Santos Filho, Simao, 2022; Lenort et al., 2017; Schwagerman, Ulmer, 2013), and the chemical industry (Kurnia et al., 2021). Studies confirm that the A3 report is an effective problem-solving tool (Grobelna, Wasilewska, 2023), and its application contributes to defect reduction, quality improvement, and process standardization (Rini, 2021). The use of the A3 report also helps reduce operational costs (Kurnia et al., 2021) and improve operational efficiency (Santos Filho and Simao, 2022). Furthermore, the A3 report supports SMED projects (Santos Filho, Simao, 2022) and facilitates the implementation of green innovations in the transportation of an industrial enterprise (Lenort et al., 2017). A3 reports serve not only as a problem-solving tool but also as a structured process for developing employees' problem-solving capabilities, thereby fostering a culture of continuous improvement (Schwagerman, Ulmer, 2013; Shook, 2018). Despite its many benefits, the use of A3 reports can present challenges and limitations that can impact their effectiveness in organizational practice, such as employee resistance to systematically documenting processes and issues, treating the report solely as a formal obligation, the time-consuming nature of the process, and a low level of continuous improvement culture.

3. Research methodology

The study was conducted at a company manufacturing plastic products. The analysis involved pipes made of a polyester resin composite. Each delivery of materials is subject to mandatory sampling and laboratory testing. Additives (including hardener and paint) are stored in designated areas and are also subject to a quality control system. After the production process is completed, the products undergo quantity inspection, visual inspection (to report any defects), verification in the internal IT system, labeling, and a final laboratory inspection.

During a visual inspection of the product, a non-compliance was identified, which posed a significant problem affecting the product's quality, durability, and safety of use. Therefore, steps were taken to identify the potential causes of the non-compliance and eliminate them.

The work aimed to analyze and solve the problem of non-compliance, specifically gel lumps forming inside pipes, using the A3 report. To achieve this goal, a seven-step research methodology was adopted, in accordance with the structure of the A3 report, namely:

1. Problem description.
2. Description of current conditions.
3. Defining the action objective.
4. Analysis and identification of root causes.
5. Defining countermeasures.
6. Development of an action plan.
7. Description of further actions.

The problem-solving process involved a team of employees, including the production manager, shift leader, technologist, maintenance department, operators, and continuous improvement specialist. The process of analyzing and resolving the problem took three months. The implemented solutions effectively eliminated the problem, but their effectiveness was observed only over a limited time horizon.

Only selected data related to the problem analysis is published in this article due to confidentiality concerns, particularly regarding measurement results.

4. Results and discussion

4.1. Problem description

During a visual inspection at the production facility, a product non-conformance was detected. Gel lumps were observed inside the manufactured pipes (Figure 1). This issue was considered significant due to its potential impact on the durability, structural integrity, and safety of the finished product, as well as on the production process and customer complaints. As a result of gel lump formation, the material loses its homogeneity and may not meet quality standards. In some cases, this can lead to micro-cracks, reduced pressure resistance, and, in the long term, product failure during operation.



Figure 1. Gel lumps on the surface of the material.

Source: Materials provided by the company.

This problem required immediate action, i.e., identifying the source and implementing corrective actions to prevent its recurrence and ensure full compliance of the production process with quality requirements.

4.2. Current conditions

In the pipe production process, one of the ingredients is sand, which is mixed with resin, a hardener, and a reaction accelerator (cobalt). This mixture is then fed into a rotating drum, where the pipe's shape is formed. The desired result is a uniform and smooth inner layer free of defects.

The issue being analyzed involved the production of type A pipes, where gel lumps appeared on the inside of the pipes. Initially, the problem did not affect type B pipes, which were produced in parallel, but over time, lumps began to appear on them as well. Visual irregularities were reported on type A pipes, prompting a series of laboratory tests. The gel time of the hardener was checked using a gelometer:

- the gel time of the hardener taken from the tank was 20:13 min,
- the gel time of the fresh reference sample was 19:45 min.

Despite the slight difference in gel time, a significant visual difference was noticed – the hardener from the tank had an orange tint, while the fresh hardener was colorless.

Based on the analysis of laboratory data, it was determined that the formation of lumps could be influenced by:

- a decrease in viscosity – this makes the resin more fluid and more difficult to control during the molding process,
- a prolonged reaction time – this can cause incomplete or delayed curing of the mixture in the rotating drum.

4.3. Defining the action objective

The goal of the remedial actions was to restore stability to the production process for Type A and Type B pipes by eliminating gel lumps on the inner surface of the pipes. Achieving this goal should result in:

- ensuring a uniform material structure inside the pipe in accordance with technical and visual requirements,
- maintaining full control over the gel time and viscosity of the resin and hardener components,
- minimizing process parameter variability resulting from raw material properties and environmental conditions,
- securing the process against similar problems recurring in the future.

The achievement of the goal of eliminating the problem of inconsistencies on the pipe surface should be verified using the following metrics:

- 0% of pipes with gel lumps for a minimum of 4 weeks of production (applies to type A and B pipes),
- stable gel time values in tests (deviation $\leq \pm 0.15$ min from the standard),
- constant resin viscosity within the accepted control range,
- positive visual and quality assessment of all produced pipes.

4.4. Analysis and identification of the causes of the problem

For the analyzed nonconformity, the Ishikawa diagram was developed to identify potential root causes of the problem. Due to the complexity of the process and the numerous possible variables, a detailed verification was conducted in six areas: material, machine, method, human, environment, and measurement (Figure 2). Brainstorming within the team identified the most likely causes: incorrect temperature, incorrect materials, operator error, incorrect recipe, incorrect measurements, and faulty machinery.

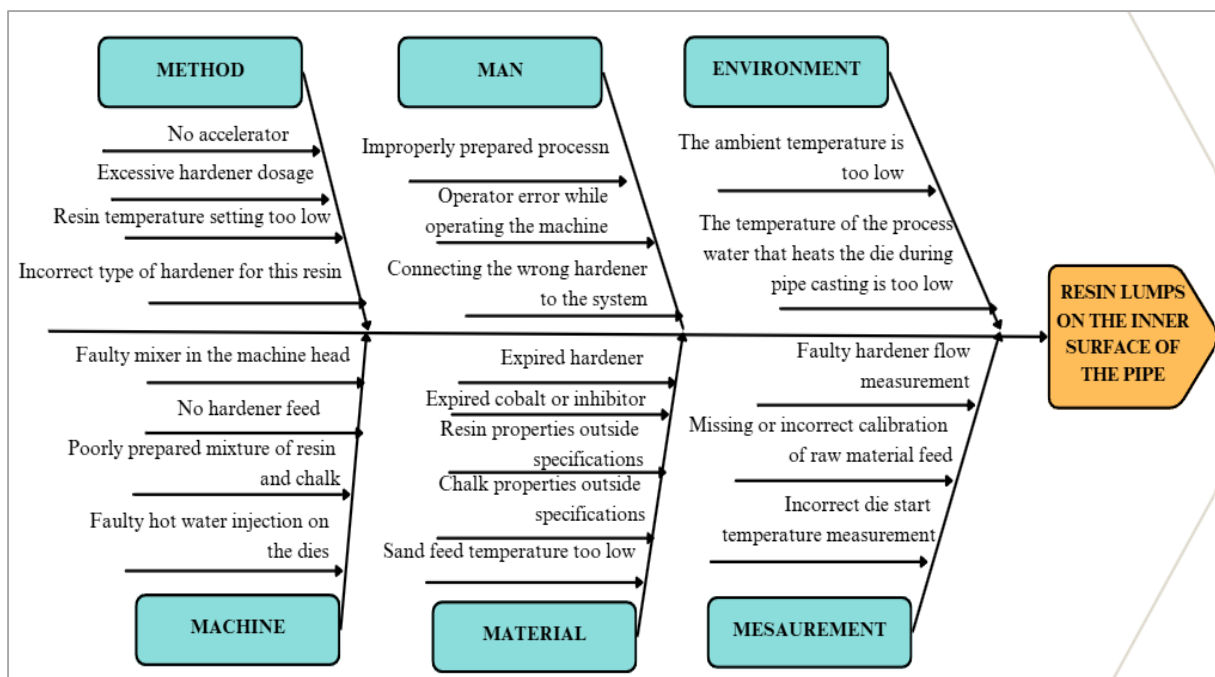


Figure 2. Ishikawa diagram for the analyzed problem.

Source: Own elaboration.

One possible cause was an error in the production recipe. However, it was verified that the recipes used had been unchanged for a long time, and the defect occurred suddenly, without any interference with the technological parameters. The verification showed their compliance with applicable guidelines and calculations.

The next aspect analyzed was the condition of the hot-water spray nozzles, which heat the matrix and initiate the reaction. The nozzles were checked for obstructions and proper adjustment. The inspection revealed no blockages, and the spray angle and direction were set correctly.

Next, a check was conducted to determine whether there may have been a lack of hardener delivery. The condition of the pump tubing and the alarm system was verified. No leaks or malfunctions were detected in the pumps – all were fully operational, and the system did not generate any alarms regarding lack of flow.

At the same time, the correct dosing of cobalt into the resin was checked. The inspection results showed that the doses were delivered according to the set values (no irregularities were found in this range). A potential cause could be the incorrect operation of the "mixer" in the head. Therefore, it was disassembled and inspected for cured resin, clogging, or drive damage. The inspection revealed that the device was functional and clean.

The next step was to analyze the quality of the prepared resin-chalk mixture. The dosing of the ingredients in the tanks was checked – all raw materials were added according to the settings and within the accepted tolerances.

The resin temperature was also verified. The analysis showed that the resin temperature was within the process guidelines (40-45°C) and did not deviate from the standards.

The die temperature was also an important factor – too low a temperature could affect the curing reaction. Measurements were conducted independently using two methods: manually by the operator and using properly calibrated stationary pyrometers. Both systems indicated the correct starting temperature values. No abnormalities were observed in the ambient temperature; environmental conditions in the production hall were stable at approximately 20°C, within the nominal limits for the process.

Similarly, the hot process water temperature was maintained between 60 and 70°C. No issues with the heat exchangers or boiler operation were identified. Water flow and temperature were stable, ruling out this factor as contributing to the defect.

As part of the analysis of raw material supplies, it was checked whether recent chalk deliveries might have deviated from specifications. While minor deviations were found, they were not considered significant because they did not affect the quality of the resin being prepared. Similarly, resin deliveries were within specifications. No changes in viscosity, monomer content, or color were observed, confirming the stability of the base material.

Further analysis focused on the accuracy of the hardener flow measurement. The flow meters were calibrated, and the readings were consistent with the actual flow (no deviations were observed).

The raw material dosing calibration system also showed no errors. All values were within acceptable limits, and the system did not indicate any irregularities.

The use of expired hardener or chemical additives was also ruled out. Each batch had a current expiration date and had been connected for up to two weeks before the problems occurred. The system was also checked to ensure the wrong hardener had not been connected. The hardener tanks were clearly labeled, and a hardener reactivity test confirmed compliance. The difference in gelation time compared to the fresh sample was insignificant and did not indicate an error.

Additionally, the sand temperature was measured at approximately 17°C. This value is acceptable and should not negatively impact the curing reaction.

Finally, the compatibility of the hardener used with the given resin type was analyzed, especially when mixed with chalk. Reactivity tests were conducted with two hardeners. The tests revealed that one of the hardeners did not react properly with the resin mixed with chalk. The samples did not gel throughout the volume, and the reaction time was unnaturally prolonged. Therefore, it was necessary to switch to a different hardener. The root cause of the defects was identified.

4.5. Defining countermeasures

After determining the root cause of the gel lumps on the inner surface of the pipes (an incorrect reaction between the hardener and the resin and chalk mixture), steps were taken to eliminate the incompatibility and ensure process stability. These countermeasures were divided into temporary and permanent measures.

Temporary measures – in the first stage, it was decided to implement measures to immediately reduce the risk of further non-compliance until a permanent solution could be implemented. These measures allowed for a reduction in the number of defective products in the production process and minimized the risk of shipping non-compliant products:

- suspending production of type A and B pipes using the defective hardener until the cause is determined,
- conducting a series of laboratory tests using various types of hardeners to confirm reactivity in the chalk and resin mixture,
- identifying and separating the entire batch of pipes with the suspected defect from the finished goods warehouse,
- increasing visual inspection of each produced pipe in the output area, with the participation of the shift leader and technologists,
- manually recording mixing parameters and reaction times in trial batches to monitor changes.

Target actions – after confirming the incompatibility of the hardener with the mixture currently used, measures were implemented to permanently eliminate the cause of the problem and prevent its recurrence:

- a permanent change in the hardener used in the casting process of type A and B pipes; a different hardener was used, which, in laboratory tests, demonstrated full compatibility with the resin and chalk mixture, ensuring proper gelation throughout the entire sample volume and a stable reaction time,
- updated technological documentation and production recipes; the hardener labels in the recipes and process sheets for the affected product range were updated, specifying its type and dosage,
- training of operators and maintenance staff; staff were trained in recognizing the symptoms of abnormal gelation and in the hardener change and identification procedure,
- additional inspection of raw materials before connecting to the system; mandatory laboratory reactivity tests were introduced for each new hardener batch (before its use in production). For a new supplier, each batch will be subject to a trial inspection using resin and chalk,
- increasing the level of standardization – daily checklists were developed and introduced (Figure 3) with control of the correct connection of chemicals and checking the starting parameters of the process.

[illegible]

Figure 3. Fragment of the daily checklist.

Source: Own elaboration based on the company's data.

All the measures described were implemented to permanently improve process stability, eliminating the risk of human error and increasing product quality. The process was additionally monitored for the following two weeks to confirm the full effectiveness of the implemented measures.

4.6. Development of an action plan

Table 1 summarizes the actions taken to eliminate the problem. These actions were assigned to the employees responsible for their execution, and the required timeframe for their implementation was specified. The plan was intended to both eliminate the non-compliance that had occurred and prevent its recurrence.

Table 1.
The action plan

Action	Responsible person	Deadline for action implementation
Suspending production of type A and B pipes until the problem is resolved	Production manager	Immediately
Conducting laboratory hardener reactivity tests	Technologist Quality control department	Up to 1 day
Isolation of defective pipes from batches suspected of non-compliance	Foreman Warehouse workers	Immediately
Increased visual inspection of pipes at the production exit	Shift leader	Immediately
Manual recording of mixing and reaction parameters in trial batches	Operators Technologists	Immediately
Introduction of the new hardener into production	Technologist	Up to 20 days
Updating recipes and technological documentation	Technology department	Up to 30 days
Training of operators and maintenance personnel on the new hardener and its identification	Production manager Technologist	Up to 30 days
Implementation of mandatory reactivity tests before using a new batch of hardener	Laboratory	Immediately after delivery
Introduction of a daily checklist for monitoring raw materials and process parameters	Shift leader	Up to 30 days

Source: Own elaboration.

4.7. Further actions

To ensure the sustainability of the implemented solutions and prevent similar incompatibilities in the future, the following development activities are planned:

- creation of a central database of resin-chalk reactivity, enabling the rapid identification of risky combinations,
- implementation of periodic comparative tests of hardeners for their behavior under actual production conditions,
- expansion of the raw material qualification program to include mixture reactivity tests,
- training for technologists and operators on the impact of chemical and physical parameters (temperature, viscosity, dosing) on the quality of the final product;
- establishment of a schedule for periodic audits of raw material mixing and dosing;
- verification of technological documentation for the clarity, completeness, and unambiguity of recipe records;
- introduction of a system for early warning of the risk of an incorrect chemical reaction based on historical data and current laboratory analyses.

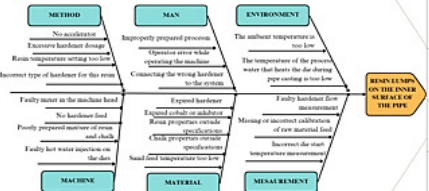
A3 Report - Title: Resin lumps on the inner surface of the pipe		No. X																																	
Step 1: Clarify the problem Current State: The presence of gel lumps on the surface of the material, on the inside, which should not be there (during visual control)  - impact on durability, structural integrity, and safety of use - may lead to micro-cracks, reduced pressure resistance, and even product failure during operation Ideal State: no lumps																																			
Step 2: Break the problem down The problem concerns the production of type A pipes, where gel lumps appeared on the inner side of the pipes (later also on type B pipes). The team reported visual irregularities. Laboratory tests were carried out. The gel time of the hardener was checked using a gelometer: - the gel time of the hardener taken from the tank was 20:13 min, - the gel time of the fresh reference sample was 19:45 min. Despite the slight difference in gel time, a significant visual difference was noticed – the hardener from the tank had an orange tint, while the fresh hardener was colorless. It was determined that the formation of lumps could be influenced by: - a decrease in viscosity – this makes the resin more fluid and more difficult to control during the molding process, - a prolonged reaction time – this can cause incomplete or delayed curing of the mixture in the rotating drum. As a result of gel lump formation, the material loses its homogeneity and does not meet quality standards.																																			
Step 3: Set a goal The goal of the remedial actions is to restore stability to the pipe production process by eliminating the formation of gel lumps on the inner surface: ensuring a uniform material structure inside the pipe in accordance with technical and visual requirements, maintaining full control over the gel time and viscosity of the resin and hardener components, minimizing process parameter variability resulting from raw material properties and environmental conditions, securing the process against similar problems recurring in the future. Indicators: (1) 0% of pipes with gel lumps for a minimum of 4 weeks of production, (2) stable gel time values in tests (deviation $\leq \pm 0.15$ min relative to the standard), (3) constant resin viscosity within the adopted control range, (4) positive visual and quality assessment of all produced pipes.																																			
Step 4: Find a root cause  Most likely causes: incorrect temperature, incorrect materials, operator error, incorrect recipe, incorrect measurements, damaged machinery Root cause: incorrect reaction between the hardener and the resin and chalk mixture (the samples did not gel throughout the entire volume, and the reaction time was unnaturally prolonged)																																			
Step 5: Develop countermeasures Temporary: - Suspending production until the cause is determined, - Conducting a series of laboratory tests, - Identifying and separating the entire batch of defective pipes from the warehouse, - Increasing visual inspection of each produced pipe in the output area, - Manually recording mixing parameters and reaction times in trial batches to monitor changes. Target actions: a permanent change in the hardener, updated technological documentation and production recipes, training of operators and maintenance staff, additional inspection of raw materials before connecting to the system, increasing the level of standardization (daily checklist)																																			
Step 6: Implement solution - Plan <table border="1"> <thead> <tr> <th>Action</th> <th>Responsible person</th> <th>Deadline for action implementation</th> </tr> </thead> <tbody> <tr> <td>Suspending production of type A and B pipes until the problem is resolved</td> <td>Production manager</td> <td>Immediately</td> </tr> <tr> <td>Conducting laboratory hardener reactivity tests</td> <td>Technologist</td> <td>Up to 1 day</td> </tr> <tr> <td>Isolation of defective pipes from batches suspected of non-compliance</td> <td>Foreman</td> <td>Immediately</td> </tr> <tr> <td>Increased visual inspection of pipes at the production exit</td> <td>Shift leader</td> <td>Immediately</td> </tr> <tr> <td>Manual recording of mixing and reaction parameters in trial batches</td> <td>Operator</td> <td>Immediately</td> </tr> <tr> <td>Introduction of the new hardener into production</td> <td>Technologist</td> <td>Up to 20 days</td> </tr> <tr> <td>Updating recipes and technological documentation</td> <td>Technology department</td> <td>Up to 30 days</td> </tr> <tr> <td>Training of operators and maintenance personnel on the new hardener and its identification</td> <td>Production manager</td> <td>Up to 30 days</td> </tr> <tr> <td>Implementation of mandatory reactivity tests before using a new batch of hardener</td> <td>Laboratory</td> <td>Immediately after delivery</td> </tr> <tr> <td>Introduction of a daily checklist for monitoring raw materials and process parameters</td> <td>Shift leader</td> <td>Up to 30 days</td> </tr> </tbody> </table>			Action	Responsible person	Deadline for action implementation	Suspending production of type A and B pipes until the problem is resolved	Production manager	Immediately	Conducting laboratory hardener reactivity tests	Technologist	Up to 1 day	Isolation of defective pipes from batches suspected of non-compliance	Foreman	Immediately	Increased visual inspection of pipes at the production exit	Shift leader	Immediately	Manual recording of mixing and reaction parameters in trial batches	Operator	Immediately	Introduction of the new hardener into production	Technologist	Up to 20 days	Updating recipes and technological documentation	Technology department	Up to 30 days	Training of operators and maintenance personnel on the new hardener and its identification	Production manager	Up to 30 days	Implementation of mandatory reactivity tests before using a new batch of hardener	Laboratory	Immediately after delivery	Introduction of a daily checklist for monitoring raw materials and process parameters	Shift leader	Up to 30 days
Action	Responsible person	Deadline for action implementation																																	
Suspending production of type A and B pipes until the problem is resolved	Production manager	Immediately																																	
Conducting laboratory hardener reactivity tests	Technologist	Up to 1 day																																	
Isolation of defective pipes from batches suspected of non-compliance	Foreman	Immediately																																	
Increased visual inspection of pipes at the production exit	Shift leader	Immediately																																	
Manual recording of mixing and reaction parameters in trial batches	Operator	Immediately																																	
Introduction of the new hardener into production	Technologist	Up to 20 days																																	
Updating recipes and technological documentation	Technology department	Up to 30 days																																	
Training of operators and maintenance personnel on the new hardener and its identification	Production manager	Up to 30 days																																	
Implementation of mandatory reactivity tests before using a new batch of hardener	Laboratory	Immediately after delivery																																	
Introduction of a daily checklist for monitoring raw materials and process parameters	Shift leader	Up to 30 days																																	
Step 7: Monitor Process & Results 																																			
Step 8: Standardize & share best practices The A3 report was presented to other plants as source material																																			

Figure 4. The A3 report.

Source: Own elaboration based on the company's data.

At the end of the process, an A3 report was developed (Figure 4) that concisely outlined the steps for identifying, analyzing, and eliminating nonconformities. The report was prepared on a single sheet, following A3 format guidelines. This provided a comprehensive overview of the actions taken to restore full compliance of the production process with requirements. The A3 report was presented and discussed at a meeting of the team involved in the process, and conclusions from the analysis were shared with other plants within the company.

5. Summary

The A3 report is more than just a form – its main value lies in the cause-and-effect thinking process, also known as A3 Thinking. The A3 report approach stems from the Toyota Production System and is founded on the PDCA cycle. The main goal of the A3 report is to understand the problem in depth and draw logical conclusions from the analysis of data and facts. In the problem-solving process, utilizing tools that support root cause analysis, such as the Ishikawa diagram or 5 Whys, is crucial.

The subject of the analysis was a problem involving gel lumps inside pipes. The A3 report methodology was used to solve the problem. Identifying and describing the problem, followed by formulating the goal, was crucial to initiating a detailed analysis of the current situation and

the reasons for the discrepancy between it and the desired situation. The use of an Ishikawa diagram allowed the identification of possible causes of the incompatibility in six categories. Brainstorming within the team allowed us to identify the most likely causes: incorrect temperature, inappropriate materials, operator error, incorrect recipe, incorrect measurements, and faulty machinery. Based on a detailed verification of possible causes, the root cause of the incompatibility was identified. One of the hardeners did not react properly with the resin-chalk mixture. The samples did not gel throughout the volume, and the reaction time was unnaturally prolonged. A change to a different hardener was necessary. As a result of the analysis, the following actions were implemented:

- the procedure for mixing and dosing resin components was changed,
- more frequent inspections of raw materials and process parameters were introduced,
- operator training was conducted on the operation of mixers and the importance of technological parameters.

Solving the problem using the A3 report effectively eliminated it and prevented its recurrence through preventive measures and process standardization. It should be emphasized that the analysis focused on a single issue in the company's pipe production process, which limits the ability to compare the results regarding the effectiveness of the A3 report as a problem-solving tool at this plant. This problem did not recur, but the effectiveness of the implemented actions was observed over a limited timeframe. The results obtained are also dependent to some extent on the competence and commitment of the team conducting the analysis, which may constitute a further direction for research in this area. Employee involvement in the problem-solving process is an important factor in shaping a culture of continuous improvement, which is crucial for a company implementing Lean Manufacturing solutions.

The conclusions from the analysis were shared with other plants within the company where the research was conducted. Solving the problem according to the A3 report methodology can be a source of knowledge for other companies undertaking similar activities. Furthermore, the obtained results can serve as a reference point for further research and comparative analyses in industrial practice.

Based on the obtained results, several key practical conclusions can be formulated:

- proper problem definition enables the identification of appropriate directions for further actions and prevents decision-making based on assumptions rather than factual evidence,
- the A3 report focuses on root cause elimination; the application of quality management tools facilitates the identification of potential causes and supports accurate determination of the problem source,
- effective and sustainable problem resolution requires a comprehensive approach that integrates technical, organizational, and competency-related aspects,

- the A3 report supports preventive measures and contributes to reducing the likelihood of problem recurrence,
- the effectiveness of the A3 report is influenced by the level of team engagement and the presence of an organizational culture oriented toward continuous improvement.

Acknowledgments

Silesian University of Technology (Faculty of Materials Engineering, Department of Production Engineering) supported this work as a part of BK-224/RM1/2025 (11/010/BK_25/0057).

References

1. Al-Qayoudhi, S.A.S. (2022). A Conceptual Review of the Adoption of Lean Philosophy Tools in Manufacturing Companies. *International Journal of Research in Entrepreneurship & Business Studies*, Vol. 3, Iss. 1, pp. 1-12, doi: 10.47259/ijrebs.311
2. Argiyantari, B., Simatupang, T., Basri, M.H. (2021). Transportation performance improvement through lean thinking implementation. *International Journal of Lean Six Sigma*, doi: 10.1108/IJLSS-06-2020-0075
3. Bassuk, J.A., Washington, I.M. (2013). The A3 Problem Solving Report: A 10-Step Scientific Method to Execute Performance Improvements in an Academic Research Vivarium. *PLOS ONE* 8(10): e76833, doi:10.1371/journal.pone.0076833.t001
4. Burka, I. (2022). Difficulties seen by Polish managers related to the use of the A3 Thinking approach in the problem-solving process. *Zeszyty Naukowe Wydziału Zarządzania GWSH*, Nr 18, pp. 5-18, doi: 10.53259/2022.18.01
5. Grobelna, A., Wasilewska, B. (2023). Evaluation of A3 tool in the production process. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, No. 176, pp. 115-127, doi: 10.29119/1641-3466.2023.176.8
6. Hammel, M.R. (2017). *Warsztaty Kaizen [Kaizen Event Fieldbook]*. Wrocław: LEI Polska.
7. Hamrol, A. (2008). *Zarządzanie jakością z przykładami*. Warszawa: PWN.
8. Hamrol, A., Mantura, W. (2002). *Zarządzanie jakością. Teoria i praktyka*. Warszawa: PWN.
9. Koskela, L., Broft, R.D., Pikas, E., Tezel, A. (2020). Comparing the Methods of A3 and Canvas. In: Tommelein, I.D., Daniel, E. (eds.), *Proc. 28th Annual Conference of the*

- International Group for Lean Construction (IGLC28)* (pp. 13-24) (online). Berkeley: IGLC28, doi.org/10.24928/2020/0136
10. Kurnia, H., Budi Juliantoro, K., Suhendra, Turmudi Zy, A., Apriyani (2024). Combination of lean thinking and A3 problem-solving methods to reduce the cost of purchasing cleaning agents in a paint manufacturer in Indonesia. *SINERGI*, Vol. 28, No. 1, pp. 103-114, <https://dx.doi.org/10.22441/sinergi.2024.1.011>
 11. Lenort, R., Staš, D., Holman, D., Wicher, P. (2017). A3 method as a powerful tool for searching and implementing green innovations in an industrial company transport. *Procedia Engineering*, Vol. 192, pp. 533-538, <https://doi.org/10.1016/j.proeng.2017.06.092>
 12. Liker, J.K., Franz, J.K. (2016). *Droga Toyoty do ciągłego doskonalenia [The Toyota Way to Continuous Improvement]*. Warszawa: MT Biznes.
 13. Liker, J.K., Meier, D.P. (2011). *Droga Toyoty. Fieldbook [The Toyota Way Fieldbook]*. Warszawa: MT Biznes.
 14. *Leksykon Lean [Lean Lexicon grafical glossary for Lean Thinkers]* (2018). Wrocław: LEI Polska.
 15. Małysa, T., Furman, J., Pawlak, S., Šolc, M. (2024). Application of Selected Lean Manufacturing Tools to Improve Work Safety in the Construction Industry. *Applied Science*, 14(14), 6312, doi: 10.3390/app14146312
 16. Rangel-Sánchez, M.-Á., Urbina-González, J.-D.-J., Carrera Escobedo, J.-L., Guirette-Barbosa, O.-A., Murillo-Rodríguez, V.-A., Celaya-Padilla, J.-M., Durán-Muñoz, H.-A., Cruz-Domínguez, O. (2024). Enhancing Scrap Reduction in Electric Motor Manufacturing for the Automotive Industry: A Case Study Using the PDCA (Plan–Do–Check–Act) Approach. *Applied Science*, 14, 2999, doi: 10.3390/app14072999
 17. Rini, S. (2021). Implementation of lean thinking through A3 report in plastic injection company. *International Journal of Industrial Optimization*, Vol. 2, No. 1, pp. 63-68, doi: 10.12928/ijio.v2i1.3055
 18. Santos Fihlo, G.M., Simao, L.E. (2022). A3 methodology: going beyond process improvement. *Revista de Gestão* 30(10), pp. 147-161, doi: 10.1108/REGE-03-2021-0047
 19. Schwagerman, W.C., Ulmer, J.M. (2013). The A3 Lean Management and Leadership Thought Process. *The Journal of Technology, Management, and Applied Engineering*, Vol. 29, No. 4, <https://www.iastatedigitalpress.com/jtmae/article/14149/galley/12913/view/>
 20. Shook, J. (2018). *Zarządzać znaczy uczyć. Rozwiązywanie problemów i rozwój pracowników z wykorzystaniem raportu A3 [Managing to Learn. Using the A3 management process to solve problems, gain agreement, mentor, and lead]*. Wrocław: LEI Polska.
 21. Singh, J., Ghandi, S.K. (2024). Benefits using PDCA cycle of continuous improvement in manufacturing industry – a case study. *International Journal of Management Concepts and Philosophy*, Vol. 17, Iss. 1, pp. 83-97, doi: 10.1504/IJMCP.2024.135088
 22. Siwiec, D., Pacana, A., Dzukova, J. (2017). *Analysis of incompatibility of the product and proposal the improvement actions with the use of the A3 report. Global Existential Risk.*

- Proceedings of the 7th International Conference, Bratislava, Slovak Republic. Retrieved from: https://www.sszp.eu/wp-content/uploads/2017_conference_GER__p-176__SiwiecD_PacanaA__f4-1.pdf, 02.06.2025.
23. Smalley, A. (2018). *Cztery typy problemów i sposoby ich rozwiązywania [Four Types of Problems: from reactive troubleshooting to creative innovation]*. Wrocław: LEI Polska.
24. Thangarajoo, Y., Smith, A. (2015). Lean Thinking: An Overview. *Industrial Engineering & Management, Vol. 4, Iss. 2*, doi:10.4172/2169-0316.1000159
25. Utami, E.Y., Rijal, S., Iwang, B. (2023). Application of Lean Manufacturing Principles in Increasing Factory Productivity. *West Science Journal Economic and Entrepreneurship, Vol. 1, Iss. 10*, pp. 264-270.
26. Vijverberg, J.R.G., Rouppevan der Voort, M.B.V., van der Nat, P.B., Mosselman, M.J., Rigter, S., Biesma, D.H., van Merode, F. (2023). How to Use Lean Thinking for the Optimization of Clinical Pathways: A Systematic Review and a Proposed Framework to Analyze Pathways on a System Level. *Healthcare, 11(18)*, 2488, doi: 10.3390/healthcare11182488
27. Womack, J.P., Jones, D.T. (1996). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Simon & Schuster.

PSYCHOLOGICAL ASPECTS OF MARKET STRATEGIES IN E-COMMERCE

Agata KIELESIŃSKA

Czestochowa University of Technology; agata.kielesinska@pcz.pl, ORCID: 0000-0001-9974-7961

Purpose: The purpose of this article is to identify and analyze the psychological determinants of consumer behavior in e-commerce from a dynamic (2018-2025) and comparative perspective, taking into account differences between markets with varying levels of digital maturity.

Design/methodology/approach: The study is based on an analysis of secondary data, consisting of a systematic review of industry reports and analytical studies. A mixed-methods approach was employed, combining qualitative and quantitative analysis, including trend analysis, comparative analysis, and elements of content analysis across selected markets (Poland, Germany, the U.S., and China).

Findings: The results indicate a shift in purchasing motivations from utilitarian to hedonic, a decline in the importance of technological risk in favor of quality-related risk, and a growing role of trust as a mediator of purchasing decisions. An increase in the importance of emotions and impulsivity was also observed, particularly in highly developed markets. The COVID-19 pandemic accelerated the transition from a rational model to a heuristic-emotional one, although these processes varied depending on cultural context and the level of market maturity.

Originality/value: The originality of this study lies in combining a dynamic (2018-2025) and cross-market perspective to analyze psychological determinants of consumer behavior in e-commerce. The paper demonstrates how the COVID-19 pandemic accelerated the shift from rational to heuristic-emotional purchasing behavior and shows that the intensity of these changes differs depending on market maturity and cultural context.

Keywords: e-commerce, consumer, shopping psychology, emotions, motivations, risk, trust.

Category of the paper: Research paper.

1. Introduction

Online shopping has become an integral part of modern consumer behavior, and online store revenues have been steadily increasing year after year (Laudon, Traver, 2023). Although the purchasing process in the digital environment appears relatively simple—consisting of selecting a product, adding it to the cart, making a payment, and arranging delivery—consumer decisions are, in reality, shaped by numerous psychological factors (Solomon, 2018). Buyers

are guided not only by the product or service itself but also by the overall experience associated with interacting with a given brand (Lemon, Verhoef, 2016; Schmitt, 2010). Despite the growing body of research on e-commerce, there remains a need for a comprehensive analysis of these determinants from a dynamic and comparative perspective, taking into account differences between markets at varying stages of development (Duan et al., 2012; Hajli, 2015; Ladhari et al., 2019). A significant factor influencing the transformation of consumer behavior was the COVID-19 pandemic, which accelerated the digitization process and increased the intensity of online channel usage. As a result of mobility restrictions and the temporary closure of traditional retail outlets, consumers were forced to adapt to the digital environment, leading to lasting changes in their purchasing behavior (Guthrie et al., 2021; Gu et al., 2021). The literature emphasizes that the pandemic not only increased the scale of e-commerce usage but also altered the structure of purchasing decision determinants, leading to a rise in the importance of psychological factors such as emotions, trust, and risk perception (Laato et al., 2020; Alwan et al., 2023). These changes are reflected, among other things, in an increase in the frequency of online shopping, the growing importance of convenience, and the heightened role of user experience in the decision-making process (Gu et al., 2021). At the same time, uncertainty and emotional tension have increased, influencing consumer behavior and leading, among other things, to a rise in impulse purchases and compensatory behaviors (Laato et al., 2020).

The aim of this article is to analyze the psychological aspects of consumer behavior in e-commerce from a comparative and dynamic perspective, covering the years 2018-2025. To achieve this objective, the following research questions were formulated:

RQ1: How have purchasing motivations in e-commerce changed, and has there been a shift from utilitarian to hedonic motivations?

RQ2: What psychological mechanisms influence the reduction of risk perception, and has there been a shift from technological risk to quality-related risk?

RQ3: To what extent does trust serve as a mediator between risk perception and the purchasing decision?

RQ4: What role do emotions play in purchasing decisions in e-commerce, and is their importance increasing?

RQ5: What psychological factors determine impulsive purchasing in e-commerce?

The formulated research questions provide the basis for a comprehensive analysis of the psychological determinants of consumer behavior in e-commerce. Their verification enables the identification of changes in purchasing patterns, risk perception, trust, emotions, and impulsive behavior in the digital environment, taking into account differences between markets with varying levels of digital maturity.

2. Theoretical Background and Hypotheses

The rapid growth of e-commerce in recent decades has led to significant changes in consumer behavior, making the online environment one of the key areas of analysis in management and marketing studies. The rise of e-commerce is associated with the development of digital technologies and the increasing availability of the internet, which have transformed traditional models of purchasing decision-making (Laudon, Traver, 2023). The modern consumer operates simultaneously in both offline and online environments, and the boundaries between these spaces are becoming increasingly blurred (Żmijowska, 2023). The literature emphasizes that purchasing decisions in e-commerce are determined not only by economic factors but also by complex psychological mechanisms. Constructs such as trust, perceived risk, and the usability and ease of use of purchasing systems are of key importance (Gefen et al., 2003; Pavlou, 2003). Trust plays a particularly important role in the online environment, where the lack of direct contact with the product and the seller increases uncertainty, potentially limiting the propensity to purchase. At the same time, a high level of trust significantly reduces perceived risk and facilitates purchasing decisions (Pavlou, 2003). Another important area of research concerns the cognitive processes that influence online consumer behavior. Consumers often rely on simplified decision-making strategies (heuristics), basing their choices on other users' opinions, product ratings, or system recommendations (Lemon, Verhoef, 2016). Social proof is particularly significant in this context, as it serves as an important mechanism for reducing risk under conditions of information uncertainty and supports purchasing decisions (Cialdini, 2009). At the same time, the literature points to the growing role of emotions in the online purchasing process. The digital environment fosters impulsive purchases, which are stimulated by factors such as the visual appeal of websites, limited-time promotions, and personalized offers (Verhagen, van Dolen, 2011). Positive emotions, such as pleasure or excitement, can increase the likelihood of a purchase, whereas negative emotions such as frustration resulting from navigation difficulties can lead to transaction abandonment (Rose et al., 2012). Another key element is the customer experience, which encompasses all user interactions with a brand throughout the purchasing process. As Lemon and Verhoef (2016) point out, customer experience is multidimensional and includes cognitive, emotional, and behavioral components. Positive user experiences, resulting from factors such as an intuitive interface, website speed, and efficient logistics, lead to increased customer satisfaction and loyalty (Homburg et al., 2017). In the context of technological development, the personalization of offerings and the use of user data are also gaining importance. Recommendation systems enable the adaptation of content and products to individual consumer preferences, thereby increasing the effectiveness of marketing activities and enhancing user engagement (Adomavicius, Tuzhilin, 2005). At the same time, challenges related to privacy protection and data security are emerging, which may affect the level of consumer trust in e-commerce platforms (Martin, Murphy, 2017).

3. Research Methodology, Research Subject and Research Sample

This study is based on secondary data analysis and was conducted as a systematic review of industry reports and analytical studies on the e-commerce market (Johnston, 2014; Snyder, 2019). The research approach combines elements of qualitative and quantitative analysis, enabling both the identification of statistical trends and the interpretation of the psychological determinants of consumer behavior (Creswell, 2014; Tashakkori, Teddlie, 2010). The process of selecting research material (table 1) was purposeful and involved identifying sources that met specific quality and substantive criteria, including the credibility of the publishing institution, the periodicity of reports enabling the analysis of changes over time, the comparability of data across countries, and their thematic relevance to the phenomenon under study (Tranfield et al., 2003).

Table 1.
Selection of Countries and Analytical Sources

Country	Characteristics of the E-commerce Market	Key Reports (2018–2025)
Poland	Developing market, dynamic growth after the pandemic	Gemius – <i>E-commerce in Poland</i> (annual reports 2018–2025); IAB Poland – annual reports; PwC – consumer reports
Germany	Mature market, high level of trust	HDE – <i>Online Monitor</i> (2018–2025); Statista – e-commerce reports; Deloitte – retail reports
USA	Highly developed market, high level of innovation	U.S. Census Bureau – e-commerce statistics (2018–2025); McKinsey & Company – consumer reports; Statista – global data
China	Highly digitized market, development of social commerce	Alibaba Group – annual reports (2018–2025); Deloitte – China e-commerce; Statista – Asia e-commerce data

Source: own research.

The e-commerce markets selected for analysis exhibit significant diversity in terms of their level of development, digital maturity, and cultural factors influencing consumer behavior. Poland serves as an example of a developing market, characterized by the dynamic growth of e-commerce and a gradual transformation of consumer behavior (Dąbrowska et al., 2020). Germany represents a mature market, distinguished by a high level of consumer trust and well-developed digital infrastructure (Haucap, Heimeshoff, 2014). The United States and China are among the most advanced e-commerce markets, where technological innovation, personalization, and the expansion of mobile and social commerce play a crucial role, as reflected in the literature on contemporary e-commerce models (Verhoef et al., 2015; Lemon, Verhoef, 2016; Huang, Benyoucef, 2013). The analysis was conducted longitudinally, covering the years 2019–2025, which allows for the identification of changes occurring before, during, and after the COVID-19 pandemic. A comparative perspective was adopted, enabling the identification of similarities and differences in consumer behavior across the selected markets.

4. Presentation of research results

An analysis of industry reports from 2018 to 2025 reveals significant variations in consumer purchasing motivations depending on the level of e-commerce market development. The results of these analyses are presented in Table 2.

Table 2.

Evolution of Purchasing Motivations in E-commerce (2018-2025)

Country	Dominant Motivations (2018-2019)	Direction of Change (2018-2025)	Dominant Motivations (2023-2025)	Nature of Purchasing Decisions
Poland	Price, ability to compare offers, promotions	Clear shift from price toward convenience and availability; increased importance of order fulfillment speed	Convenience, delivery speed, product availability	From rational to mixed (rational-emotional)
Germany	Quality, transaction security, delivery reliability	High stability of motivations; slight changes over time	Quality, trust, logistical reliability	Rational, quality-oriented, planned
USA	Convenience, wide selection, availability	Strong increase in the importance of user experience, personalization, and simplification of the purchasing process	Personalization, user experience, speed	Emotional-experiential, partially impulsive
China	Convenience, mobile shopping, access to platforms	Dynamic development of e-commerce integration with social media; increasing importance of recommendations and instant purchasing	Social commerce, recommendations, immediacy of purchase	Technological-social, impulsive

Source: own research.

In Poland, a clear shift in the structure of purchasing motivations can be observed—from the dominance of economic factors, particularly price and the ability to compare offers, toward the increasing importance of convenience, availability, and order fulfillment speed (Gemius, 2020, 2023; IAB Polska, 2022). This reflects a gradual departure from a decision-making model based solely on economic criteria. The literature on online consumer behavior confirms this trend, emphasizing the growing role of both hedonic and utilitarian motivations in the purchasing decision-making process (Childers et al., 2001; Limayem et al., 2000). In the German market, purchasing motivations exhibit greater stability over time. Consumers continue to be guided primarily by product quality, delivery reliability, and transaction security, as confirmed by report data (HDE, 2021; Statista, 2023). Such behavioral patterns are characteristic of mature markets, where purchasing decisions tend to be more rational and planned, as reflected in studies on trust and risk perception in the e-commerce environment (Gefen et al., 2003). In the United States, a clear shift toward motivations related to the user experience can be observed. Factors such as personalized offers, fast delivery, and a simplified purchasing process play a key role (McKinsey & Company, 2021; U.S. Census Bureau, 2023). As a result, purchasing decisions are increasingly driven by situational and emotional factors, which aligns

with the concept of the growing importance of customer experience and its influence on the decision-making process (Lemon, Verhoef, 2016). The most advanced model of purchasing motivation is evident in China, where online shopping is strongly integrated with social media and digital platforms. Consumer decisions are often influenced by recommendations, user reviews, and influencer activity, as confirmed by industry reports (Alibaba Group, 2022; Deloitte, 2023). In the literature, this phenomenon is referred to as social commerce, in which social factors and user interactions play a key role in shaping purchasing behavior (Huang, Benyoucef, 2013).

In addition to these findings, the analysis also included an examination of risk perception (Table 3), which revealed a systematic decline in perceived risk associated with online shopping across all countries studied, with the most pronounced changes observed in Poland.

Table 3.
Changes in Consumer Risk Perception in E-commerce

Country	Dominant Sources of Risk (2018-2019)	Direction of Change (2018-2025)	Dominant Sources of Risk (2023-2025)	Risk Level	Nature of Risk
Poland	Payment security, data protection, lack of trust in sellers	Clear decline in technological risk; increasing importance of shopping experience	Product quality, consistency with description, returns handling	Medium (decreasing)	Shift from technological to quality-related risk
Germany	Transaction security, data protection	Stabilization at a low level of risk; minor changes over time	Product quality, delivery reliability	Low	Primarily quality-related
USA	Transaction security, data privacy	Decline in the importance of technological risk; increasing importance of customer experience	Product quality, customer service, shopping experience	Low	Quality-experiential
China	Seller credibility, product authenticity	Transformation of risk toward a social-platform dimension	Product authenticity, user reviews, seller reputation	Differentiated	Social-platform-based

Source: own research.

In the early years of the period under review, consumers in Poland expressed relatively high levels of concern regarding transaction security, personal data protection, and product conformity with the description. In subsequent years, however, as digital infrastructure developed and user experience improved, the level of perceived risk declined significantly (Gemius, 2020, 2023). This trend is consistent with research findings indicating that increasing consumer experience and familiarity with the online environment lead to a reduction in perceived risk and a greater propensity for online shopping (Gefen et al., 2003; Pavlou, 2003). Compared to Poland, the German and U.S. markets are characterized by relatively low levels of perceived risk, which stem from their high maturity and well-developed consumer protection mechanisms. Consumers in these countries perceive online shopping as safe and predictable,

and their main concerns relate more to product quality or after-sales service than to the transaction process itself (HDE, 2021; Statista, 2023; U.S. Census Bureau, 2023). The literature emphasizes that a high level of institutional trust and the standardization of purchasing procedures reduce the significance of technological risk in the decision-making process (Gefen et al., 2003). A different pattern of risk perception is observed in China, where, despite a high level of digitization, risk does not disappear but rather undergoes a transformation. Consumers are less concerned about transaction security itself and instead place greater emphasis on seller credibility, product authenticity, and quality (Alibaba Group, 2022; Deloitte, 2023).

Considering the level of trust (Table 4), it should be noted that during the analyzed period of 2018-2025, consumer trust in online shopping exhibits a clear upward trend, constituting one of the key factors driving the development of the e-commerce market.

Table 4.
Evolution of Consumer Trust in E-commerce

Country	Level of Trust (2018-2019)	Direction of Change	Main Sources of Trust	Nature of Trust
Poland	Moderate	Dynamic increase	User experience, payments, logistics	Adaptive
Germany	High	Stable	Regulations, standards, consumer protection	Institutional
USA	High	Stable / slight increase	Platforms, systems, user experience (UX)	Technological
China	Differentiated	Increasing	User reviews, influencers, platforms	Social

Source: own research.

The increase in trust can be attributed to the accumulation of positive shopping experiences, the widespread adoption of secure payment methods, and the systematic improvement in the quality of logistics services (Gemius, 2020, 2023). This trend is consistent with research findings indicating that trust develops as user experience grows and the number of positive interactions with e-commerce platforms increases (Kim et al., 2008). In more mature markets, such as Germany and the United States, the level of trust has reached relative stability and serves as a structural component of the e-commerce system. In Poland, this process is particularly dynamic and reflects a transition from initial consumer caution to the growing acceptance of shopping in the digital environment. In Germany, trust is underpinned by well-developed institutional mechanisms and a high level of consumer protection (HDE, 2021; Statista, 2023), whereas in the United States, it is closely linked to the functioning of advanced digital platforms and their ability to provide a consistent and predictable shopping experience (McKinsey & Company, 2021; U.S. Census Bureau, 2023). The literature indicates that under such conditions, trust stems from both the perceived usefulness of systems and interface quality, as well as the transparency of the purchasing process (McKnight et al., 2002). A different model of trust-building is observed in China, where its development relies heavily on social mechanisms. Purchasing decisions are strongly influenced by the opinions of other users and influencer activity (Alibaba Group, 2022; Deloitte, 2023). Research indicates that in the context

of social commerce, trust is built through social interactions and user-generated content, giving it a distinctly relational character (Lu et al., 2010).

In Poland and Germany, the emotional component (Table 5) remains embedded within rational decision-making and serves a supporting function. Emotions are primarily associated with a sense of comfort, security, and satisfaction with the transaction process, indicating a relative balance between cognitive and affective processing (Gemius, 2023; HDE, 2021). This pattern suggests that, despite the growing importance of user experience, purchasing decisions remain largely rational. The role of emotions takes a different form in the U.S. market, where they become a central element of the decision-making process. The development of advanced personalization systems, dynamic marketing stimuli, and user experience design has led to an increased emphasis on immediate reactions and subjective evaluations of the shopping situation (McKinsey & Company, 2021). In this context, emotions function as a mechanism that reduces the complexity of choice and facilitates decision-making under conditions of limited information processing, as confirmed by classical approaches to hedonic and impulsive consumption (Holbrook, Hirschman, 1982; Beatty, Ferrell, 1998). The most pronounced form of emotional influence is observed in China, where emotions are strongly embedded in the social context. The integration of e-commerce with social media means that emotions are not only individual experiences but also socially constructed and amplified through user reviews, live streaming, and influencer activity (Alibaba Group, 2022; Deloitte, 2023). Under such conditions, the decision-making process becomes more collective and dynamic, with emotions intensified through social interaction mechanisms.

Table 5.

Changes in the Perception of Consumer Emotions in E-commerce

Country	Role of Emotions (2018-2019)	Direction of Change (2018-2025)	Role of Emotions (2023-2025)	Nature of Emotions
Poland	Low, supportive	Increasing importance	Decision-supporting	Affective-rational
Germany	Low to moderate	Slight increase	Complementary	Controlled
USA	Moderate	Strong increase	Dominant	Hedonic, impulsive
China	Moderate	Dynamic increase	Strongly dominant	Socio-emotional

Source: own research.

Compared to the markets analyzed, Poland is characterized by a moderate level of impulse buying. Despite the growing availability of digital tools, consumer decisions remain largely grounded in rational considerations, which limits the extent of spontaneous behavior (Gemius, 2023). A similar, though more pronounced, controlled model is observed in Germany, where a high level of purchase planning and a focus on quality and safety favor reflective decision-making (HDE, 2021). The situation is different in the United States, where impulsivity is a significant element of consumer behavior. The development of personalization technologies, advanced marketing, and user experience design is leading to an increase in the number of decisions made on the spur of the moment (McKinsey & Company, 2021). The online environment, characterized by immediacy and high stimulus intensity, fosters

impulsive behavior to a greater extent than traditional channels in this context (Dholakia, 2000; Rook, Fisher, 1995). The highest level of impulsivity is observed in China, where e-commerce is strongly integrated with social media and digital platforms. Mechanisms such as live streams, time pressure, and social recommendations intensify spontaneous purchasing decisions (Alibaba Group, 2022; Deloitte, 2023).

A marked increase in impulsive behavior is one of the most noticeable changes in consumer behavior in the e-commerce environment during the period under review (Table 6).

Table 6.
Evolution of Impulse Buying in E-commerce

Country	Level of Impulsivity (2018-2019)	Direction of Change	Level of Impulsivity (2023-2025)	Determinants of Impulsivity
Poland	Low to moderate	Increase	Moderate	Convenience, availability, promotions
Germany	Low	Slight increase	Low	Planning, rationality, control
USA	Moderate	Significant increase	High	Personalization, user experience (UX), marketing stimuli
China	Moderate	Dynamic increase	Very high	Social commerce, immediacy, time pressure

Source: own research.

Compared to the analyzed markets, Poland is characterized by a moderate level of impulse buying. Despite the growing availability of digital tools, purchasing decisions remain largely anchored in rational considerations, which limits the extent of spontaneous behavior (Gemius, 2023). A similar, though more strongly controlled, model is observed in Germany, where impulsivity remains relatively low. A high level of purchase planning, combined with a strong orientation toward quality and safety, results in more reflective and structured decision-making (HDE, 2021). In the United States, impulse buying reaches a significantly higher level and constitutes an important element of consumer behavior. The development of personalization technologies, dynamic marketing communications, and user experience design has led to an increase in decisions made on the spur of the moment. Under such conditions, impulsivity is reinforced by the ease of access to products and the reduction of cognitive effort associated with the purchasing process (McKinsey & Company, 2021). Research indicates that the online environment, through its immediacy and richness of stimuli, fosters impulsive behavior to a greater extent than traditional sales channels (Dholakia, 2000; Rook, Fisher, 1995). The highest level of impulsivity is observed in China, where online shopping is strongly integrated with social media and digital platforms. Mechanisms such as live streaming, time-limited offers, and social recommendations intensify spontaneous purchasing decisions (Alibaba Group, 2022; Deloitte, 2023). In this context, impulsivity is not solely the result of individual consumer predispositions but rather emerges from the structure of the shopping environment itself, which actively stimulates rapid responses and limits the time available for reflection.

Based on the analyses conducted, a comprehensive overview of changes in consumer behavior in e-commerce was developed, covering three key phases: before the COVID-19 pandemic, during the pandemic, and in the post-pandemic period. This approach makes it possible to capture both the dynamics of change and to identify lasting shifts in the factors influencing purchasing decisions (table 7).

Table 7.

Evolution of Consumer Behavior in E-commerce Before, During, and After the COVID-19 Pandemic

Dimension	Before the Pandemic (until 2019)	During the Pandemic (2020-2021)	After the Pandemic (2022-2025)
Purchasing Motivations	Dominance of price and rationality; search for savings	Strong increase in the importance of availability and necessity of online shopping	Increased importance of convenience, speed, and user experience
Risk Perception	High (especially in developing countries); technological concerns	Decrease in risk resulting from forced adoption of e-commerce	Low technological risk; increasing importance of product quality risk
Trust	Moderate; dependent on experience	Dynamic increase in trust due to intensive usage	High and stable; trust as a standard element of the market
Emotions	Limited role; dominance of rationality	Increased importance of emotions (uncertainty, stress, need for comfort)	Emotions as a constant element of decision-making; shopping as pleasure and mood regulation
Impulsivity	Relatively low; more controlled decisions	Increase in impulsivity (ease of access, greater online exposure)	Sustained impulsivity; reinforced by technology and marketing stimuli
Dominant Consumer Model	Rational	Adaptive (pragmatic)	Emotional (experiential)

Source: own research.

A comparison of changes in consumer behavior before, during, and after the COVID-19 pandemic reveals a significant transformation in how consumers operate within the e-commerce environment. The pandemic period served as a turning point that accelerated digitalization processes and altered the structure of factors influencing purchasing decisions. In particular, a decrease in risk perception and an increase in trust in online shopping were observed, which in subsequent years led to the consolidation of new behavioral patterns. Post-pandemic, the importance of emotional factors and impulsivity is clearly on the rise, indicating a shift from the rational consumer model to one based on experience, emotions, and situational stimuli.

Summary

In summary, the results of this analysis enable us to achieve the article's objective, which was to identify and compare the psychological determinants of consumer behavior in e-commerce from a dynamic and cross-market perspective. The results indicate a clear shift in purchasing motivations from utilitarian to hedonic (PB1), accompanied by a transformation

of risk perception from technological to quality- and experience-based (PB2). It was also confirmed that trust plays a significant mediating role between risk perception and the purchasing decision (PB3), stabilizing the decision-making process under conditions of uncertainty. The results also point to a systematic increase in the importance of emotions and impulsive buying (PB4-PB5), which is particularly evident in markets with a high level of digital development. This signifies an evolution toward decision-making models based on heuristics and affective responses, while simultaneously reducing the importance of analytical processing. A comparative analysis confirmed that market maturity and cultural conditions significantly differentiate the nature and intensity of the analyzed mechanisms (PB6), pointing to more rational patterns in European economies and a stronger influence of emotional and social factors in the U.S. and China. At the same time, the results obtained allow us to conclude that the COVID-19 pandemic acted as an accelerator of the observed changes, contributing to the acceleration of the transition from a rational model to a heuristic-emotional one (PB7). Consequently, contemporary consumer behavior in e-commerce is hybrid in nature, combining cognitive, emotional, and social elements, which points to the need for further research into its dynamics and implications for the theory and practice of digital marketing.

References

1. Adomavicius, G., Tuzhilin, A. (2005). Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. *IEEE Transactions on Knowledge and Data Engineering*, 17(6), 734-749. <https://doi.org/10.1109/TKDE.2005.99>
2. Alibaba Group (2022). *Annual report 2022*. Alibaba Group Holding Limited. <https://www.alibabagroup.com>
3. Alwan, S.Y. et al. (2023). Sustainable and resilient e-commerce under COVID-19. *Sustainability*, 15(3), 1911. <https://doi.org/10.3390/su15031911>
4. Amos, C., Holmes, G.R., Keneson, W.C. (2014). A meta-analysis of consumer impulse buying. *Journal of Retailing and Consumer Services*, 21(2), 86-97. <https://doi.org/10.1016/j.jretconser.2013.11.004>
5. Badgaiyan, A.J., Verma, A. (2014). Intrinsic factors affecting impulsive buying behaviour—Evidence from India. *Journal of Retailing and Consumer Services*, 21(4), 537-549. <https://doi.org/10.1016/j.jretconser.2014.04.003>
6. Cialdini, R.B. (2009). *Influence: Science and practice* (5th ed.). Pearson.
7. Creswell, J.W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
8. Dąbrowska, A., Janoś-Kresło, M., Wódkowski, A. (2020). E-consumer in Poland – changes and trends. *Journal of Business Research*, 108, 105-113.

9. Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340. <https://doi.org/10.2307/249008>
10. Deloitte. (2022). *China e-commerce report 2021*. <https://www2.deloitte.com>
11. Deloitte. (2023). *China e-commerce report 2022*. <https://www2.deloitte.com>
12. Dholakia, U.M. (2000). Temptation and resistance. *Psychology & Marketing*, 17(11), 955-982.
13. Duan, J., Deng, S., Corbitt, B. (2012). Evaluating the critical determinants for adopting e-market in Australian small-and-medium sized enterprises. *Management Research Review*, 35(3/4), 289-308. <https://doi.org/10.1108/01409171211210172>
14. Gefen, D., Karahanna, E., Straub, D.W. (2003). Trust and TAM in online shopping: An integrated model. *MIS Quarterly*, 27(1), 51-90. <https://doi.org/10.2307/30036519>
15. Gemius (2020). *E-commerce w Polsce 2020*. Gemius dla e-Commerce Polska. <https://www.gemius.pl>
16. Gemius (2022). *E-commerce w Polsce 2022*. Gemius dla e-Commerce Polska. <https://www.gemius.pl>
17. Gemius (2023). *E-commerce w Polsce 2023*. Gemius dla e-Commerce Polska. <https://www.gemius.pl>
18. Gu, S., Ślusarczyk, B., Hajizada, S., Kovalyova, I., Sakhibieva, A. (2021). Impact of the COVID-19 pandemic on online consumer purchasing behavior. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(6), 2263-2281. <https://doi.org/10.3390/jtaer16060125>
19. Guthrie, C., Fosso-Wamba, S., Arnaud, J.B. (2021). Online consumer resilience during a pandemic. *Journal of Retailing and Consumer Services*, 61, 102570. <https://doi.org/10.1016/j.jretconser.2021.102570>
20. Hajli, N. (2015). Social commerce constructs and consumer's intention to buy. *International Journal of Information Management*, 35(2), 183-191. <https://doi.org/10.1016/j.ijinfomgt.2014.12.005>
21. Haucap, J., Heimeshoff, U. (2014). Google, Facebook, Amazon, eBay: Is the internet driving competition or market monopolization? *International Economics and Economic Policy*, 11(1-2), 49-61. <https://doi.org/10.1007/s10368-013-0247-6>
22. HDE. (2021). *Online Monitor 2021: E-commerce in Germany*. Handelsverband Deutschland (HDE). <https://einzelhandel.de>
23. HDE. (2022). *Online Monitor 2022: E-commerce in Germany*. Handelsverband Deutschland (HDE). <https://einzelhandel.de>
24. Homburg, C., Jozić, D., Kuehn, C. (2017). Customer experience management: Toward implementing an evolving marketing concept. *Journal of the Academy of Marketing Science*, 45(3), 377-401. <https://doi.org/10.1007/s11747-015-0460-7>

25. Huang, Z., Benyoucef, M. (2013). From e-commerce to social commerce. *Electronic Commerce Research and Applications*, 12(4), 246-259. <https://doi.org/10.1016/j.elerap.2012.10.001>
26. IAB Polska (2022). *Raport e-commerce Polska 2022*. IAB Polska. <https://www.iab.org.pl>
27. Johnston, M.P. (2014). Secondary data analysis: A method of which the time has come. *Qualitative and Quantitative Methods in Libraries*, 3(3), 619-626. <https://www.qqml-journal.net/index.php/qqml/article/view/169>
28. Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
29. Klaus, P. (2013). The case of Amazon.com: Towards a conceptual framework of online customer service experience (OCSE) using the emerging consensus technique (ECT). *Journal of Services Marketing*, 27(6), 443-457. <https://doi.org/10.1108/JSM-02-2012-0030>
30. Laato, S., Islam, A.N., Farooq, A., Dhir, A. (2020). Unusual purchasing behavior during COVID-19. *Journal of Retailing and Consumer Services*, 57, 102224. <https://doi.org/10.1016/j.jretconser.2020.102224>
31. Ladhari, R., Gonthier, J., Lajante, M. (2019). Generation Y and online fashion shopping: Orientations and profiles. *Journal of Retailing and Consumer Services*, 48, 113-121. <https://doi.org/10.1016/j.jretconser.2019.02.003>
32. Laudon, K.C., Traver, C.G. (2023). *E-commerce 2023: Business, technology, society*. Pearson.
33. Lemon, K.N., Verhoef, P.C. (2016). Understanding customer experience throughout the customer journey. *Journal of Marketing*, 80(6), 69-96. <https://doi.org/10.1509/jm.15.0420>
34. Martin, K.D., Murphy, P.E. (2017). The role of data privacy in marketing. *Journal of the Academy of Marketing Science*, 45(2), 135-155. <https://doi.org/10.1007/s11747-016-0495-4>
35. McKinsey & Company (2021). *The future of e-commerce: Global perspectives*. <https://www.mckinsey.com>
36. McKnight, D.H., Choudhury, V., Kacmar, C. (2002). Developing and validating trust measures for e-commerce: An integrative typology. *Information Systems Research*, 13(3), 334-359. <https://doi.org/10.1287/isre.13.3.334.81>
37. Pantano, E., Pizzi, G., Scarpi, D., Dennis, C. (2020). Competing during a pandemic? Retailers' ups and downs during the COVID-19 outbreak. *Journal of Business Research*, 116, 209-213. <https://doi.org/10.1016/j.jbusres.2020.05.036>
38. Pavlou, P.A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce*, 7(3), 101-134. <https://doi.org/10.1080/10864415.2003.11044275>
39. Rook, D.W., Fisher, R.J. (1995). Normative influences on impulsive buying behavior. *Journal of Consumer Research*, 22(3), 305-313.

40. Rose, S., Clark, M., Samouel, P., Hair, N. (2012). Online customer experience in e-retailing: An empirical model of antecedents and outcomes. *Journal of Retailing*, 88(2), 308-322. <https://doi.org/10.1016/j.jretai.2012.03.001>
41. Schmitt, B.H. (2010). *Customer experience management: A revolutionary approach to connecting with your customers*. Wiley.
42. Sheth, J. (2020). Impact of COVID-19 on consumer behavior: Will the old habits return or die? *Journal of Business Research*, 117, 280-283. <https://doi.org/10.1016/j.jbusres.2020.05.059>
43. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333-339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
44. Solomon, M.R. (2018). *Consumer behavior: Buying, having, and being* (12th ed.). Pearson.
45. Statista (2022). *E-commerce in Germany – statistics & facts*. Statista. <https://www.statista.com>
46. Statista (2023). *E-commerce in Germany – statistics & facts*. Statista. <https://www.statista.com>
47. Tashakkori, A., Teddlie, C. (2010). *Mixed methods in social & behavioral research (2nd ed.)*. SAGE Publications.
48. Tranfield, D., Denyer, D., Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(3), 207-222. <https://doi.org/10.1111/1467-8551.00375>
49. U.S. Census Bureau (2023). *Quarterly retail e-commerce sales: 4th quarter 2023*. U.S. Department of Commerce. <https://www.census.gov>
50. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478. <https://doi.org/10.2307/30036540>
51. Verhagen, T., van Dolen, W. (2011). The influence of online store beliefs on consumer online impulse buying. *Information & Management*, 48(8), 320-327. <https://doi.org/10.1016/j.im.2011.08.001>
52. Verhoef, P.C., Kannan, P.K., Inman, J.J. (2015). From multi-channel retailing to omni-channel retailing. *Journal of Retailing*, 91(2), 174-181. <https://doi.org/10.1016/j.jretai.2015.02.005>
53. Zhang, K.Z.K., Benyoucef, M. (2016). Consumer behavior in social commerce: A literature review. *Decision Support Systems*, 86, 95-108. <https://doi.org/10.1016/j.dss.2016.04.001>
54. Żmijowska, P. (2023). Komunikacja marek w czasach niepewności. Wpływ pandemii na zmiany zachowań zakupowych w sieci i trendy rynku e-commerce. *Media i Społeczeństwo*, 18, 138-150. <https://doi.org/10.5604/01.3001.0053.7742>

CONSUMERS TOWARDS CORPORATE ESG ACTIVITIES

Beata KOLNY

University of Economics in Katowice; beata.kolny@ue.katowice.pl, ORCID: 0000-0002-9162-1704

Purpose: The aim of this article is to present consumer attitudes towards companies' ESG activities and the individual components of this acronym, namely the natural environment (E), society (S), and corporate governance (G). The research focused on the extent to which consumers seek information about companies' ESG activities, pay attention to these activities, their willingness to pay more for a product from a company that conducts ESG activities, and their willingness to recommend companies that conduct such activities to friends or family.

Design/methodology/approach: The direct survey was conducted on a nationwide sample of 1000 adult Poles in 2025 and was anonymous. The survey was carried out using a CAWI electronic questionnaire. The research focused on four thematically related ESG areas. The first area concerned the general attitude of respondents towards the firm's activities in the field of ESG the remaining three concerned the individual components of the ESG acronym, i.e. environment, society and governance. For each of the survey areas, corresponding statements were prepared thematically linked to them.

Findings: The research shows that ESG issues are not particularly important to respondents, and their attitude towards them is neutral. On a scale of 1 to 5, where 1 meant that respondents disagreed with the statements regarding ESG and 5 that they agreed with them, the most common rating was 3, meaning they neither agreed nor disagreed with the statements, and therefore represented an indifferent attitude towards the firms' ESG issues analyzed. Of the three ESG pillars, environmental issues received the highest average rating.

Originality/value: The research results may be of interest to both internal and external stakeholders of companies.

Keywords: ESG, consumers, ESG activities.

Category of the paper: research paper.

1. Introduction

ESG is an acronym increasingly being considered by businesses in developing corporate strategies aimed at sustainable development and social responsibility. It encompasses three spheres of activity: the natural environment (E), society (S) and governance (G). This relatively new paradigm refocuses the economy and its entities on new goals. These include sustainable development, social responsibility, and ethical considerations. It also addresses non-financial

issues that companies should also consider when making investment decisions (Puriwat et al., 2023; Misztal, 2023). Previously, companies did not consider these factors in their strategies. Today, the situation is different, as companies that disclose sustainability information gain greater attention and recognition from stakeholders and achieve better long-term results, improving profitability and market value (Shaikh, 2022). ESG can also improve relationships with consumers and lead to strong, informed, and lasting behavior (Maier et al., 2024). It is assumed that ESG activities increase customer trust in the company and brand and their willingness to repeat purchases (Cao, 2023). However, research (Merrick, 2024) shows that respondents on average preferred purchasing products from companies implementing ESG, and even 35% stated they were unaware of such activities. Therefore, it is important to inform consumers about all company ESG activities. Consumers attach importance to company transparency, especially with regard to sustainability initiatives. When companies openly communicate their efforts to reduce their environmental impact and promote sustainable practices, consumers are more likely to trust and support them (Kabir, Ko, 2025). It is assumed that consumers perceive ESG initiatives as having a positive impact on purchasing decisions. However, the previously cited research (Merrick, 2024) reveals a discrepancy between consumer declarations and their actual purchasing behavior. Although most consumers declare that ESG issues are important, their actual spending does not always reflect these declarations. They may be concerned about these issues but not act on them, often due to a lack of information, lack of time to analyze them, or forgetting about previous declarations. Furthermore, research (Konstantinos et al., 2025) shows that economic aspects often remain a key factor in purchasing decisions, as willingness to pay more for ESG compliant products is not significantly related to perceptions of sustainability. These studies reveal a gap between consumers' declared ESG attitudes and their actual purchasing behavior.

Based on this information, a research question emerged regarding the importance of ESG to consumers. This research was also inspired by publications by Zielińska (2024) and Boufounou (2023). Direct research was conducted in 2025 as part of a grant for research teams on a sample of 1000 adult Poles. The study attempted to answer the following questions: Do consumers seek information about the ESG activities of companies from which they purchase goods or services? Do they consider the seller's ESG activities when choosing goods or services? Would they be willing to pay more for a product from a company that engages in ESG activities? Have they ever recommended a company that engages in ESG activities to friends or family? The aim of this article is to presentation Polish consumers' attitudes toward the overall understood ESG activities of companies and the individual components of this acronym: environment, society and corporate governance.

2. ESG characteristics

ESG (Environmental, Social, Governance) is an acronym for three key pillars, which constitute complementary, non-financial measures of a company's impact on its environment and the quality of its internal governance. The environmental pillar assesses the sustainability of companies' activities that have a direct and indirect impact on the environment. The social pillar assesses the sustainability of companies by analyzing how they manage the social impact of their business activities. The corporate governance pillar addresses how the company is managed and aligns the interests of management with the interests of its shareholders (Maccarrone et al., 2024).

ESG can be described as “a set of activity or processes associated with an organization’s relationship with its ecological surroundings, its coexistence and interaction with human organisms and other populations, and its corporate system of internal controls and procedures (such as processes, customs, policies, laws, rules and regulations, etc.) to direct, administer and manage all the affairs of the organization, in order to serve the interests of stockholders and other stakeholders” (Koh et al., 2022).

ESG is generally considered an opportunity for companies to differentiate themselves in business, improve visibility, and adapt to trends in conscious consumption practices. ESG, as a set of standards and practices, establishes guidelines for decision-making in a specific area, process, or company activity. All sets of ESG standards and practices contribute to promoting and improving company strategies and building strong relationships with consumers of their products and services (Maier et al., 2024).

Analyzing the individual components of this acronym, it is worth emphasizing that environmental factors primarily encompass a company's performance in terms of resource use, pollutant emissions, and response to climate change, emphasizing its responsibility and contribution to environmental protection and sustainable development (Lin, 2024). Companies that embed environmental values into their operations are more likely to gain consumer trust and long-term support. When consumers perceive a company's active commitment to environmental protection such as reducing carbon dioxide emissions, implementing renewable energy sources, or preserving biodiversity it elicits positive emotional responses (Su, Yong, 2025). Social factors focus on a company's relationships with its stakeholders (employees, suppliers, customers, local communities) and its impact on society. They encompass employee rights, community relations, product responsibility, and customer satisfaction, focusing on the company's impact on employees and the environment (Lin, 2024). Corporate governance refers to a company's management system, particularly mechanisms that ensure transparency, ethics, and decision-making effectiveness (Lin, 2024). It serves as a guarantor for the other two pillars. A strong G ensures that E and S objectives are not merely marketing statements but are integrated into the company's strategy, risk management, and daily operations.

Without appropriate governance structures (G), the implementation of environmental (E) and social (S) initiatives is vulnerable to inconsistency. Considering the three components of the ESG acronym, it is worth noting that two of them, the environment (E) and society (S), in which companies operate, have a positive impact on consumer perceptions of companies, while the third, corporate governance (G), does not have a significant positive impact on consumer perceptions of companies. This may be due to the fact that consumers pay more attention to the impacts that directly affect them. The social and environmental factors through which companies implement ESG practices are more readily perceived by consumers, and the benefits of corporate governance may not be directly felt by them if they are not employees of these companies (Song et al., 2024). It is worth noting, however, that although often less visible to consumers compared to environmental or social initiatives, corporate governance practices constitute a driver of consumer perception, trust, and loyalty (Su, Teo, 2025). It should be emphasized, however, that consumers are more likely to purchase a product when they are provided with information about a company's social or environmental activities, and less so when this information is provided about its efforts to promote good corporate governance (Merrick, 2024). Governments can contribute to improving consumer perceptions of ESG activities by focusing on improving ESG laws and regulations and supervising the disclosure of ESG activities by listed companies (Song et al., 2024). Furthermore, companies must actively engage in these activities. They should take the initiative to disclose their ESG activities in a proactive, accurate, and timely manner to improve their image and build trust in the company (Liu et al., 2023).

3. Method and description of the research sample

The direct survey was conducted on a nationwide sample of 1000 adult Poles by the Research and Development Center of the University of Economics in Katowice between July 7, 2025 and September 3, 2025, within the framework of project by the Polish Minister of Science “Regional Initiative of Excellence”. Project title own: The importance of ESG in the sustainable consumption of the different Polish generations. The study received a positive opinion from the Human Subject Research Ethics Committee at the University of Economics in Katowice (No. 08/06/2025) and was anonymous. The survey was carried out using a CAWI (Computer-Assisted Web Interviewing) electronic questionnaire. The face-to-face research focused on four thematically related ESG areas (Figure 1). The first area concerned the general attitude of respondents towards the company's activities in the field of ESG (RA_O) the remaining three concerned the individual components of the ESG acronym, i.e. environment (RA_E), society (RA_S) and governance (RA_G).

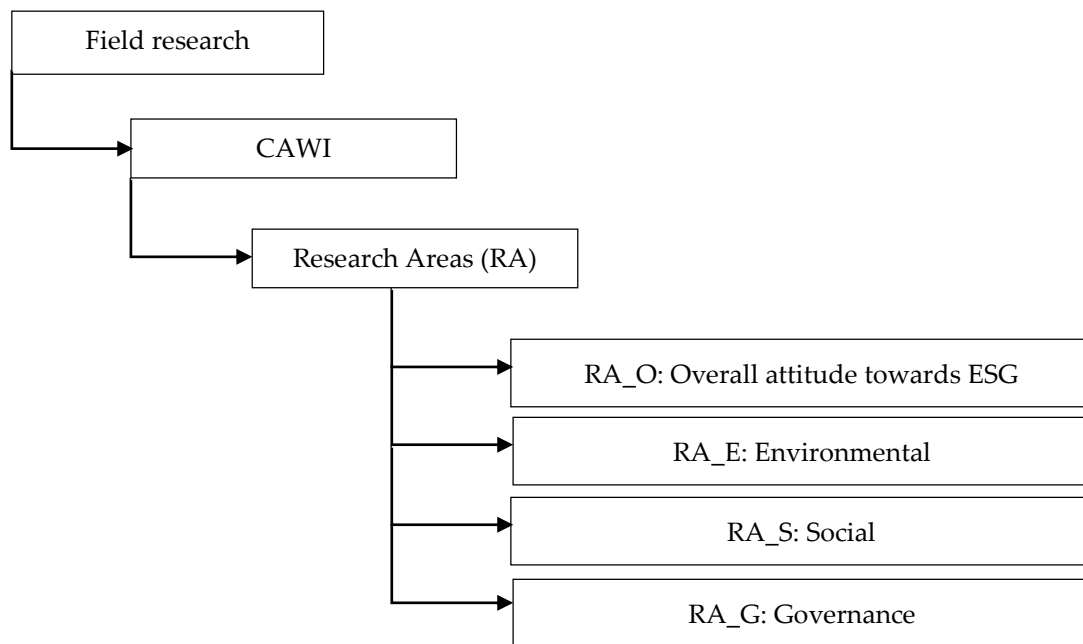


Figure 1. Research method.

Source: Own elaboration.

For each of the survey areas, corresponding statements were prepared thematically linked to them. In the first group, there were four statements. In the remaining ones, concerning the environment (E), social (S), and governance (G), there were five statements corresponding to their themes. – table 1. The surveys were conducted using a scale of 1 to 5, where 1 meant that the respondents disagreed with the statements, while 5 meant that they agreed with them. Before starting the analysis, the scale's reliability was confirmed using Cronbach's α coefficient. The obtained value of Cronbach's α of 0.9 for RA_O, 0,92 for RA_E, 0,91 for RA_S and 0,93 for RA_G indicates that the scale used is characterized by a high level of reliability (Tavakol, Dennick, 2011).

Table 1.

Questions about consumer behavior regarding companies' overall ESG activities and the individual components of this acronym

Items	Questions
RA_O1	I actively seek information about the ESG activities of the companies from which I purchase goods or services
RA_O2	When choosing a good or service I want to buy, I pay attention to the seller's ESG activities
RA_O3	I can pay more for a product from a company that is active in ESG
RA_O4	I have recommended to friends or family the goods or services of a company that conducts ESG activities
RA_E1	When choosing a product, I pay attention to the seller's environmental activities
RA_E2	I am willing to pay more for a product from a company that has a strategy to reduce greenhouse gas emissions
RA_E3	I can pay more for a product from a company that implements a sustainable energy policy
RA_E4	I can pay more for a product from a company that implements a sustainable waste management policy
RA_E5	I gladly recommend products from companies that are environmentally friendly to my friends and family

Cont. table 1.

RA_S1	When choosing a product, I pay attention to the seller's activities for the benefit of society
RA_S2	I am willing to pay more for a product from a company that regularly publishes customer satisfaction survey results
RA_S3	I am willing to pay more for a product from a company that provides employees and co-workers with tools to report complaints and whistleblowing
RA_S4	I can pay more for a product from a company that supports employee development by financing training and classes that improve their competences and qualifications
RA_S5	I gladly recommend products from companies that work for the community to my friends and family
RA_G1	When choosing a product, I pay attention to the seller's actions in favor of organizational order
RA_G2	I am willing to pay more for a product from a company that publishes data about its business ethics strategy
RA_G3	I gladly recommend products from companies that promote organizational order to my friends and family
RA_G4	I am willing to pay more for a product from a company that reports on its environmental protection activities, cooperation with society and management principles (corporate governance)
RA_G5	I am willing to pay more for a product from a company that informs about the impact of its activities in the field of environmental protection, cooperation with society and management principles (corporate governance)

Source: Own elaboration.

The research sample consisted of 1,000 adult Poles. In accordance with the assumptions made before starting the research, four generations were equally represented in the sample. In accordance, 250 responses were collected from each of the four generations: Baby Boomers (BB – 62 years and older), Generation X (X – 46-61 years), Millennials/Generation Y (Y – 30-45 years), and Generation Z (Z – 18-29 years). In addition to the same number of respondents in each of the four age groups in the sample women predominated in the sample (51.6%), followed by men (47.8%). 0.6% of respondents declined to state their gender. The majority of respondents had secondary education (49.2%), while 34.5% had completed higher education. Vocational education was declared by 13.6% of respondents, and primary education by only 2.7% of respondents. Regarding professional activity, it was found that 63.4% of respondents were professionally employed, 26.8% were no longer working professionally, 5.6% were still students, and 4.2% were both studying and professionally employed. Analyzing the place of residence, the largest group of respondents lived in rural areas (20.4%). The next most numerous groups were residents of cities with 100,000 to 199,000 inhabitants (19.6%). Slightly fewer were residents of cities with 20,000 to 99,000 inhabitants (17.3%), followed by cities with over 500,000 inhabitants (16.8%). The fewest respondents were from large cities with 200,000 to 499,000 inhabitants (13.4%) and small towns up to 20,000 inhabitants (12.5%). The majority of respondents rated their financial situation as good, stating they could afford some luxury goods (47.1%). Subsequently, 38.7% reported that their financial situation was adequate, meaning all major expenses had to be planned. Only 8.2% of respondents declared their financial situation as very good, being able to afford everything, and the fewest respondents (6.0%) stated that they only had enough for basic products, indicating a poor financial situation.

4. Research results

Direct research shows that ESG-related issues are difficult to clearly support, either positively or negatively. With respect to all the issues analyzed, the majority of respondents had no opinion, neither agreeing nor disagreeing with the statements presented to them. Most of them (33.7%) expressed this view regarding statement RA_O3: "I can pay more for a product from a company that is active in ESG". The most respondents agreed with statement RA_O4: "I have recommended to friends or family the goods or services of a company that conducts ESG activities"– 11.4%. Considering the statement RA_O1: "I actively seek information about the ESG activities of the companies from which I purchase goods or services," the majority of respondents disagreed with it (14.9%). Averages calculated based on the responses obtained from respondents on a scale of 1-5 confirm indicate that respondents neither agreed nor disagreed with the presented statements. The highest mean (3.06) was achieved in the statement RA_O2 and the lowest in the statement RA_O1 – 2.92 (Table 2).

Table 2.
Consumer attitudes towards companies' ESG activities

Items	By %					Average (scale 1-5)
	I disagree (1)	I tend to disagree (2)	I neither agree nor disagree (3)	I tend to agree (4)	I agree (5)	
RA_O1	14.9	19.6	32.2	25.3	8.6	2.92
RA_O2	12.3	17.4	32.7	27.3	10.3	3.06
RA_O3	13.5	15.9	33.7	26.3	10.6	3.05
RA_O4	14.3	17.2	30.0	27.1	11.4	3.04

Source: Own elaboration.

Analyzing responses regarding the individual components of the ESG acronym, it was found that respondents were unable to clearly state whether they agreed or disagreed with them. Most responded that they neither agreed nor disagreed with the statements presented. From the first pillar (E), this was statement RA_E3: "I can pay more for a product from a company that implements a sustainable energy policy" (33.7%); from the second (S), this was statement RA_S3: "I am willing to pay more for a product from a company that provides employees and co-workers with tools to report complaints and whistleblowing " (34.1%); and from the third (G), statement RA_G2: "I am willing to pay more for a product from a company that publishes data about its business ethics strategy" (34.2%). The largest number of respondents agreed with statements regarding recommending products from companies that conduct ESG activities to friends and family. These were: RA_E5 (14.9%), RA_S5 (14.0%), RA_G3 (12.6%). Of the three ESG pillars, the highest percentage of respondents agreed with environmental aspects (E). Across all analyzed issues in this area, over 40% agreed and tended to agree, including the highest percentage (45.2% in total) with statement RA_E5: " I gladly recommend products from companies that are environmentally friendly to my friends and family". Regarding society (S), the highest percentage (43.5% in total) expressed this opinion

with statement RA_S1: "When choosing a product, I pay attention to the seller's activities for the benefit of society." In the case of the third pillar (G), 43.2% agreed and tended to agree with statement RA_G3: "I gladly recommend products from companies that promote organizational order to my friends and family". The highest mean (3.29) calculated based on the responses obtained from respondents on a scale of 1-5 was achieved in the statement RA_S5: "I gladly recommend products from companies that work for the community to my friends and family" a slightly lower average (3.27) was obtained in the statement RA_E5 (Table 3).

Table 3.

Consumer attitudes towards companies' activities within the individual ESG pillars

Items	By %					Average (scale 1-5)
	I disagree (1)	I tend to disagree (2)	I neither agree nor disagree (3)	I tend to agree (4)	I agree (5)	
RA_E1	10.0	14.3	32.3	30.5	12.9	3.22
RA_E2	13.2	13.8	31.3	29.4	12.3	3.14
RA_E3	12.3	13.9	33.7	27.4	12.7	3.14
RA_E4	12.7	13.6	30.1	30.2	13.4	3.18
RA_E5	9.8	13.5	31.5	30.3	14.9	3.27
RA_S1	9.8	14.7	32.0	30.3	13.2	3.22
RA_S2	13.7	15.3	32.9	28.0	10.1	3.06
RA_S3	12.6	14.8	34.1	27.3	11.2	3.10
RA_S4	12.7	15.8	30.8	29.1	11.6	3.11
RA_S5	9.5	12.9	31.2	32.4	14.0	3.29
RA_G1	11.3	15.0	32.0	30.4	11.3	3.15
RA_G2	12.5	14.6	34.2	27.9	10.8	3.10
RA_G3	9.7	13.5	33.6	30.6	12.6	3.23
RA_G4	12.5	14.0	31.7	29.6	12.2	3.15
RA_G5	13.2	12.7	32.1	30.5	11.5	3.14

Source: Own elaboration.

The calculated average ratings (scale 1-5, where 1 means disagree and 5 means agree) based on the responses respondent's center around a rating of 3, meaning respondents neither agree nor disagree with the issues examined. Table 4 presents the average ratings by gender and generation (BB, X, Y, Z), obtained based on the calculated average ratings from each analyzed research area. Across almost all demographics, the Environmental (E) component received the highest average scores (Total Average: 3.19). This suggests that consumers generally prioritize ecological initiatives over social or governance issues. A consistent trend is observed where Female respondents score higher than Male respondents across all categories. Generation Z shows the strongest engagement with ESG activities, particularly in the Environmental sector (3.28). Baby Boomers (BB) and Generation X show slightly more conservative scores, though Generation X remains notably concerned with environmental factors (3.22). The Overall Opinion remains relatively neutral (Average: 3.02), suggesting that while specific ESG components are valued, the holistic perception of ESG is still developing.

Table 4.*Consumer attitudes towards companies' ESG activities by gender and generation (average)*

Items	Average	Respondents by					
		Gender		Generation			
		F	M	Z	Y	X	BB
O - Overall opinion on ESG	3,02	3,08	2,95	3,12	3,01	2,99	2,95
E - Environmental	3,19	3,28	3,10	3,28	3,11	3,22	3,14
S - Social	3,16	3,24	3,06	3,25	3,12	3,18	3,06
G - Governance	3,15	3,26	3,05	3,27	3,11	3,16	3,08

Note: The mean scores were calculated from all the mean scores obtained from the answers to the questions in the four research areas.: Overall attitude towards ESG (RA_01-RA_04); Environmental (RA_E1-RA_E5); Social (RA_S1-RA_S5); Governance (RA_G1-RA_G5).

Explanations: F – Woman, M – Man; Generations: Z (18-29 years old); Y (30-45 years old); X (46-61 years old); BB (62 and over years old).

Source: Own elaboration.

The provided data illustrates consumer attitudes toward corporate Environmental, Social, and Governance (ESG) activities, segmented by gender and generation. The scores represent averages, on a 5-point scale, where higher values indicate more positive attitudes or higher importance placed on these factors. Of the three ESG pillars, environmental issues received the highest average rating. In general, women and Generation Z are more likely to agree with the analysed ESG issues than other respondents. To maximize impact, companies should focus on the "Environmental" pillar, as it resonates most strongly across all surveyed groups.

5. Conclusions

Contemporary literature highlights a significant cognitive and behavioral gap in the ESG domain, manifested as a clear discrepancy between consumers' declared attitudes and their actual purchasing decisions. Although the majority of buyers claim that sustainability issues are important to them, their real-world spending often fails to reflect these declarations due to information barriers, a lack of time to analyze corporate activities, and the prevailing influence of economic factors. Furthermore, an asymmetry is identified in the perception of individual ESG pillars: while environmental (E) and social (S) initiatives elicit positive emotional responses and build trust, corporate governance (G) remains the least visible to consumers and less frequently influences purchase intentions, despite serving as the fundamental guarantor for the consistency and authenticity of all other initiatives. The own research on consumer attitudes toward corporate ESG activities, which covered the following: respondents' seeking information about the ESG activities of companies from which they purchase goods or services, paying attention respondents to the ESG activities of the seller of the goods or services they intend to purchase. Furthermore, their willingness to pay more for a product from a company that engages in ESG activities, and recommending companies that engage in ESG activities to friends or family, indicates that issues related to the analyzed ESG issues are not particularly

important to respondents, and their attitude toward these issues is neutral. On a rating scale of 1 to 5, where 1 meant respondent disagreed with the statements presented and 5 meant they agreed with them, the most common rating was 3, meaning they neither agreed nor disagreed with the statements, thus representing a neutral attitude toward ESG issues. Of the three ESG pillars, the most respondents agreed with environmental aspects. This is likely due to the fact that they are most often visible, understandable, current, and measurable to the average consumer. This makes them more likely to influence purchasing decisions. Environmental criteria often translate into specific product features that consumers can touch or see. It should be emphasized that social aspects were indicated in second place behind them. In conclusion, it is worth noting the limitation of the presented results of own research, the imperfection of which the reliance on the declarations of the respondents not actual purchasing behavior and concerning only selected aspects of ESG without delving into the specifics of the functioning companies of individual industries. The present study, despite its relatively high level of representativeness, is subject to methodological constraints inherent to the use of online survey techniques. The findings are derived from self-reported data provided by respondents, which may introduce bias associated with social desirability, particularly in the context of attitudes and behaviors related to ecology. Future research should prioritize the empirical verification of self-reported statements by incorporating data on actual consumer attitudes from ecology (E), social (S) and governance (G) and their purchasing behavior. Based on the research results, several recommendations for business can be formulated. Companies should conduct proactive and transparent communication regarding ESG activities, with a particular emphasis on environmental and social pillars, to bridge the information gap and build consumer trust. It is crucial to anchor these initiatives in robust corporate governance, which guarantees the authenticity of the message and allows for the transformation of declared consumer attitudes into lasting relationships and actual purchasing decisions. Considering the empirical findings presented. Firms should refrain from relying on generic claims such as “We are ESG compliant”. Instead, they should translate the abstract concept of ESG into specific language for different cohorts’ people and in particular pay special attention to environmental aspects in their communication activities. Finally, research results indicate „green baseline” of environmental awareness has been established Polish population, indicating a societal readiness to accept and comply with more rigorous environmental regulations.

Acknowledgements

This research has been supported by University of Economics in Katowice within the framework of project by the Polish Minister of Science “Regional Initiative of Excellence”. Project title own: The importance of ESG in the sustainable consumption of the different Polish generations.

References

1. Boufounou, P., Moustairas, I., Toudas, K., Malesios, Ch. (2023). ESGs and Customer Choice: Some Empirical Evidence. *Circular Economy and Sustainability*, vol. 3, 1841-1874.
2. Cao, Y. (2023). ESG, Brand Trust and Brand Loyalty. *Communications in Humanities Research*, 22(1), 183-189. DOI: 10.54254/2753-7064/22/20231704
3. Kabir, M.S., Ko, I. (2025). *The Perception of ESG Management and its Relationship with Customer Satisfaction and Loyalty in Green Consumerism*. Proceedings of the 58th Hawaii International Conference on System Sciences. DOI: 10.24251/HICSS.2025.059
4. Koh, H-K., Burnasheva, R., Suh Y.G. (2022). Perceived ESG (Environmental, Social, Governance) and Consumers' Responses: The Mediating Role of Brand Credibility, Brand Image, and Perceived Quality. *Sustainability*, 14(8), 4515, DOI: 10.3390/su14084515
5. Konstantinos, Ch., Panagiota, K., Roido, M., Despina, S. (2025). The effect of esg criteria on consumer preferences regarding the choice of a company's products and services. *Sustainable Development Culture Traditions Journal*. Vol 10A, 50-64. DOI: 10.26341/issn.2241-4010-2025-10a-5-K02108
6. Lin., Y. (2024). The Role of ESG Strategy Implementation in Long-Term Value Creation for Companies. *Journal of Social Science and Cultural Development*, 1(2). DOI: 10.70767/jsscd.v1i2.288
7. Liu, L., Nemoto, N., Lu, Ch. (2023). The Effect of ESG performance on the stock market during the COVID-19 Pandemic — Evidence from Japan. *Economic Analysis and Policy*, vol. 79, 702-712.
8. Maccarrone, P., Illuzzi, A., Inguanta, S. (2024). Does a Change in the ESG Ratings Influence Firms' Market Value? Evidence from an Event Study. *Journal of Risk and Financial Management*, vol. 17(8), DOI: 10.3390/jrfm17080340
9. Maier, G.P., Serena, M., Julkovski, D.J., (2024). Environmental, Social and Governance (ESG) and Consumer Behavior: Trends Towards Conscious Consumption. *Revista de Gestão Social e Ambiental* 18(10). DOI: 10.24857/rgsa.v18n10-244
10. Merrick, A. (2024, 8 July). *Consumers Say They Care about ESG, but Don't Spend Like They Do*. Chicago Booth Review.
11. Misztal, A. (2023). Zrównoważony rozwój przedsiębiorstw, CSR i ESG w dobie kryzysu makroekonomicznego i geopolitycznego. *Kwartalnik Nauk o Przedsiębiorstwie*, 68(2), 87-99. DOI: 10.33119/KNpP.2023.68.2.6
12. Puriwat, W., Tripopsakul, S. (2023). Sustainability Matters: Unravelling the Power of ESG in Fostering Brand Love and Loyalty across Generations and Product Involvements. *Sustainability*, no. 15, 11578.

13. Shaikh, I. (2022). Environmental, social, and governance (ESG) practice and firm performance: an international evidence. *Journal of Business Economics and Management*, 23(1), 218-237. DOI: 10.3846/jbem.2022.16202
14. Song, P.-T., Oyunbazar, B., Kang, T.-W. (2024). The Impact of Agricultural Food Retailers' ESG Activities on Purchase Intention: The Mediating Effect of Consumer ESG Perception. *Sustainability*, 16(19), 8376, DOI: 10.3390/su16198376
15. Su, T., Teo, P.-Ch. (2025). A Literature Review of Understanding Consumer Behavior in ESG through Stimulus-Response (S-R) Theory. *International Journal of Academic Research in Business and Social Sciences*, 15(4). DOI:10.6007/IJARBS/v15-i4/25263
16. Tavacol, M., Dennick, R. (2011). Making Sense of Cronbach's Alpha. *International Journal of Medical Education*, 2, 53-55. DOI: 10.5116/ijme.4dfb.8dfd53© 2011
17. Zielińska, A. (2024). Kto kupuje od odpowiedzialnych przedsiębiorstw: analiza różnic między pokoleniami w preferencjach zakupowych polskich konsumentów. *Zeszyty Naukowe TNP, Praksekologia i Zarządzanie*, Nr 2, 89-100.

URBAN TRANSPORT AS A KEY ELEMENT OF SMART CITY DEVELOPMENT: A COMPARATIVE ANALYSIS OF WARSAW AND LONDON

Agnieszka KOWALSKA-STYCZEŃ^{1*}, Przemysław SIELSKI²

¹ Silesian University of Technology, Faculty of Organization and Management, agnieszka.kowalska-styczeń@polsl.pl, ORCID: 0000-0002-7404-9638

² Silesian University of Technology, Faculty of Organization and Management; przesie492@student.polsl.pl

* Correspondence author

Purpose: The purpose of the article is to compare the development and implementation of smart mobility and sustainable urban transport solutions in Warsaw and London in the context of smart-city development, transport accessibility, environmental sustainability, and quality of life improvement.

Design/methodology/approach: The study applies a comparative case-study approach based on a literature review, analysis of strategic and policy documents, statistical data, and secondary sources related to smart mobility, sustainable transport systems, and urban governance in Warsaw and London

Findings: The study applies a comparative case-study approach based on a literature review, analysis of strategic and policy documents, and secondary statistical data related to smart mobility and sustainable urban transport systems in Warsaw and London. In the first stage of the research, a set of original indicators was developed to quantitatively assess the efficiency and sustainability of urban transport systems in both cities. These indicators were subsequently used to compare smart mobility solutions, transport accessibility, environmental performance, and the level of integration of intelligent transport systems.

Originality/value: The article provides a comparative perspective on smart mobility development in two European capitals characterised by different historical, economic, and institutional conditions. It contributes to the discussion on sustainable urban transport by integrating smart-city concepts, intelligent transport systems, quality of life, and inclusive urban development.

Keywords: smart city; smart mobility; sustainable transport; intelligent transport systems; urban mobility; quality of life.

Category of the paper: Research paper.

1. Introduction

Urban transport systems are increasingly recognised as a fundamental component of the smart-city paradigm, whereby cities leverage digital technologies, integrated infrastructure, and sustainable mobility practices in order to enhance the quality of life, reduce environmental impact and improve urban competitiveness (Angelidou, 2022). In this context, the capitals of Poland and the United Kingdom, Warsaw and London present particularly instructive cases. They exemplify different trajectories in implementing smart-mobility solutions, offering a rich basis for comparative analysis and policy learning.

The concept of the “smart city” has evolved to integrate multiple dimensions including governance, infrastructure, economy, society and environment (Masik et al., 2021). For example, in the case of Warsaw, its “Towards a Smart City” document outlines key pillars such as intelligent city management, sustainable economic growth, infrastructure and public transport as foundational elements of its smart-city agenda (Knight Frank/Poland report, 2018).

Within this broader lens, “smart mobility” or “smart transport” has emerged as a critical sub-domain: technologies such as ICT, IoT, big data analytics and real-time information systems are increasingly deployed to improve transport efficiency, accessibility and sustainability (Paiva et al., 2021). As one study notes, the deployment of smart-mobility solutions in public transport is central to cities aspiring to the “smart city” status (Korneć et al., 2018).

Transport remains a major challenge for metropolitan areas, given the dual imperatives of reducing congestion and emissions, while also ensuring accessibility and inclusivity (Shakibamanesh et al., 2018). Smart-mobility approaches therefore offer potential to address these challenges by promoting integration of modes, optimising use of data and enhancing citizen-centric service delivery (Chen et al., 2021).

The rationale for positioning urban transport as a key element in smart-city development is multi-fold. First, transport systems influence urban form, connectivity and the spatial distribution of social and economic opportunities. For instance, smart-growth strategies emphasise transit-oriented development (TOD) to create compact, reachable neighbourhoods that reduce car dependency (Shakibamanesh et al., 2018).

Second, from a technological perspective, transport networks generate vast streams of data which can feed into decision-making systems, real-time operations and citizen services. In the London context, the city data strategy identifies transport data as a major enabler for urban management and innovation (Greater London Authority, 2015).

Third, sustainable transport is integral to the environmental dimension of smart cities: public and active transport reduce emissions, support air-quality improvement and align with sustainable-development targets (Zawieska, 2018). Finally, transport is a deeply social and

civic realm: accessibility, equity and user experience are core concerns of smart-mobility agendas (Warchoń-Jakubowska et al., 2024).

Warsaw and London represent contrasting yet complementary cases for analysis. London is an established global city with mature transport infrastructure, extensive digital innovation in mobility and ambitious smart-city governance frameworks (London Data Strategy, 2018). Warsaw, while dynamically developing, is in a somewhat earlier phase of smart-mobility transformation, with specific challenges in accessibility and integration (Mościcka, 2019).

By comparing these two capitals, we can explore how differing urban contexts — scale, governance structure, legacy infrastructure, level of digitalisation — influence the uptake and impact of smart transport strategies. Moreover, lessons from London's advanced development may inform Warsaw's ongoing journey, while Warsaw offers insight into emerging-market conditions, path-dependency and incremental institutional change.

The aim of this paper is to conduct a comparative analysis of urban transport as a key element of smart-city development in Warsaw and London. Attention will focus on governance and organisational mechanisms, technological and infrastructural innovations, and measurable performance outcomes (e.g., accessibility, integration, sustainability). The comparative lens enables identification of success factors, obstacles and transferable lessons.

The remainder of the paper is structured as follows. First, the theoretical background related to smart cities, smart mobility, and sustainable urban transport is presented. Next, the research methodology and comparative approach applied to Warsaw and London are described. The subsequent section discusses and compares smart mobility solutions and transport policies implemented in both cities. Finally, the paper concludes with a discussion of the findings, practical implications, limitations, and directions for future research.

2. Research Methods

The study applies a comparative quantitative-qualitative research design focused on evaluating urban transport systems as a fundamental component of smart-city development in Warsaw and London. The analysis takes into account both long-term infrastructure transformations and short-term fluctuations caused by global events such as the COVID-19 pandemic.

The research objective was to identify differences and similarities between both cities in the domains of sustainable mobility, intelligent transport systems (ITS), and accessibility, and to determine how these features contribute to broader smart-city strategies (Angelidou et al., 2022; Chen, Silva, 2021).

2.1. Sources of data

The study is based primarily on secondary data sources, complemented by statistical and documentary analysis. The main sources include:

- official reports and datasets from Warsaw Public Transport Authority (ZTM), Transport for London (TfL), Eurostat, and the OECD Urban Indicators Database,
- strategic documents: Smart London Plan (Greater London Authority, 2015) and Warsaw – Towards a Smart City (Knight Frank, 2018),
- sectoral publications and media reports addressing Intelligent Transport Systems (ITS) and accessibility solutions.

Quantitative data for Warsaw and London were standardised to ensure comparability between the two cities. For each indicator, units were adjusted to common measures (e.g., per 1000 inhabitants or per km²), which enabled the development of comparable metrics across time and space (Paiva et al., 2021).

2.2. Research procedure

In the first stage, a set of proprietary (author-developed) indicators was designed to quantitatively assess the performance and sustainability of urban transport systems in Warsaw and London. Each indicator was constructed to ensure comparability between cities and over time, using standardised ratios and population-adjusted values.

The first proposed indicator is the *number of public transport vehicles per 1000 inhabitants (PTV)*, which is described by formula 1.

$$PVT = \frac{\text{Number of buses, trams, and metro trains}}{\text{Population}} \times 100 \quad (1)$$

This indicator indicates the availability of public transport vehicles relative to the city's population. Higher values suggest greater service capacity.

The second indicator is the *density of transport infrastructure (TID)* - formula 2.

$$TID = \frac{\text{Total length of metro, tram, and bus routes}}{\text{City area (km}^2\text{)}} \times 100 \quad (2)$$

TID measures the spatial coverage and availability of transport infrastructure; higher density indicates stronger network connectivity.

The next proposed indicator is *urban CO₂ emissions per capita (CO₂ pc)*, presented in Formula (3).

$$CO_2pc = \frac{\text{Total annual CO}_2 \text{ emissions}}{\text{Population}} \quad (3)$$

Indicator (3) measures the average level of urban carbon emissions generated per resident; lower values indicate better environmental sustainability and a higher level of transport decarbonisation.

Another proposed indicator is *the average number of passengers per vehicle in public transport (PPV)*, presented in Formula (4).

$$PPV = \frac{\text{Total annual passengers}}{\text{Number of vehicles in public transport}} \quad (4)$$

PPV measures the operational efficiency and occupancy level of the public-transport fleet; excessively high values may indicate overcrowding and reduced travel comfort.

The following indicator is *the average annual number of public transport trips per resident (PTT)*, presented in Formula (5).

$$PTT = \frac{\text{Total annual number of trips}}{\text{Population}} \quad (5)$$

Indicator (5) indicates the intensity of public-transport usage among urban residents; higher values suggest stronger reliance on collective transport and lower dependence on private cars.

An additional indicator included in the analysis is *the number of available city bikes per 1000 inhabitants (CB)*, presented in Formula (6).

$$CB = \frac{\text{Number of available city bikes}}{\text{Population}} \times 1,000 \quad (6)$$

CB measures the availability and accessibility of shared micromobility services within the urban transport system; higher values reflect stronger development of sustainable and active mobility.

The final indicator applied in the study is *the share of low-emission vehicles in total traffic (LEV)*, presented in Formula (7).

$$LEV = \frac{\text{Number of low – emission vehicles}}{\text{Total number of vehicles}} \times 1,000 \quad (7)$$

This indicator indicates the proportion of environmentally friendly vehicles within the overall transport system; higher values reflect greater progress in transport decarbonisation and sustainable mobility policies.

The temporal scope of the analysis differs among indicators because of variations in data availability from official and municipal sources. In several cases, continuous data were accessible only from 2014 or 2016, while for other indicators, longer historical series (2000–2023) could be obtained. These differences were considered when interpreting long-term trends.

In addition, qualitative indicators were included to evaluate the level of ITS implementation, integration of transport modes, road-infrastructure quality, and accessibility for persons with disabilities (Warchoń-Jakubowska et al., 2024).

The analytical model combines elements of benchmarking and multi-criteria evaluation (Shakibamanesh et al., 2019), assessing both performance outcomes and policy implementation frameworks. Each indicator was interpreted through the lens of sustainable-mobility principles and smart-city governance (Cohen, 2012; Angelidou et al., 2022).

The methodological procedure consisted of four stages:

- Selection of indicators – based on literature review and alignment with ISO 37120:2018 standards for sustainable cities.
- Data compilation and normalization – collection of time-series data from official and open sources.
- Comparative analysis – descriptive statistics and graphical representation of trends for both cities.
- Interpretation and contextualization – linking observed patterns with policy interventions, such as low-emission zones, fleet electrification, or public-bicycle programs.

A combination of trend analysis, ratio comparison, and contextual interpretation was applied to ensure consistency across indicators and time horizons (Creswell, Plano Clark, 2018).

3. Results

The research findings are presented in two main parts, corresponding to the methodological framework described in the previous chapter. In the first stage, a quantitative analysis was conducted based on statistical indicators describing the structure, performance, and sustainability of urban transport systems in Warsaw and London. This analysis covered indicators such as the number of public-transport vehicles per 1000 inhabitants, density of transport infrastructure, urban CO₂ emissions per capita, average number of passengers per vehicle in public transport, average annual number of public transport trips per resident, number of available city bikes per 1000 inhabitants and share of low-emission vehicles in total traffic. These metrics made it possible to identify long-term trends, measure efficiency, and evaluate the environmental dimension of transport development in both cities.

In the second stage, a qualitative analysis was performed to assess institutional, technological, and social aspects of smart mobility. This part focused on evaluating the implementation of Intelligent Transport Systems (ITS), multimodal integration, quality of road infrastructure, and accessibility for persons with disabilities. These qualitative indicators provide insight into the level of technological advancement, governance efficiency, and inclusiveness of transport systems—dimensions that cannot be fully captured by numerical data alone (Angelidou et al., 2022; Masik et al., 2021).

The first indicator, the number of public transport vehicles per 1000 inhabitants, is shown in Figure 1.

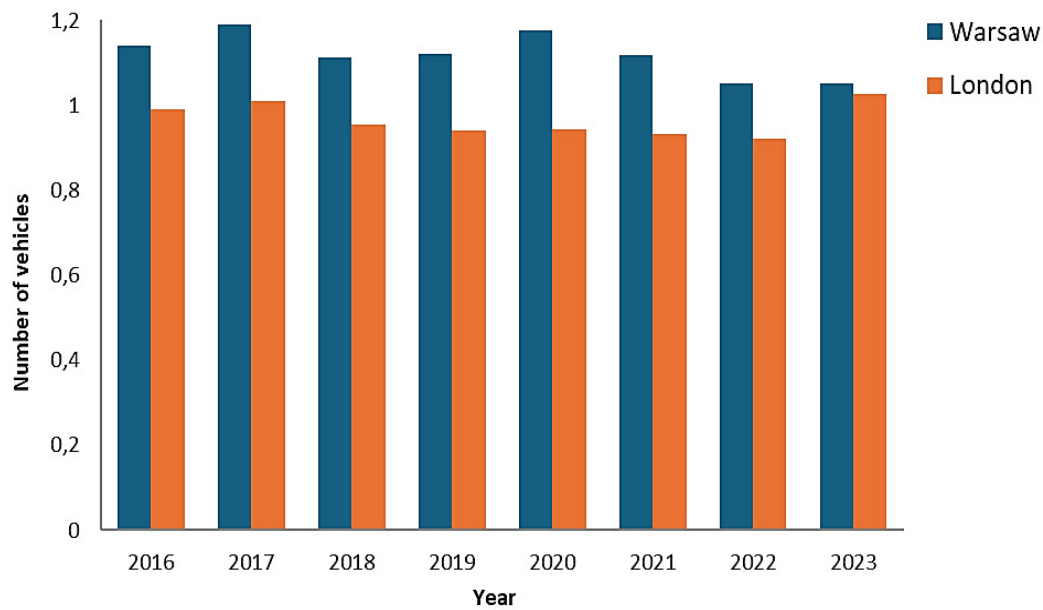


Figure 1. Number of public transport vehicles per 1000 inhabitants in London and Warsaw (PVT).

Source: own analysis based on secondary data.

The analysis of public-transport vehicle density (Figure 1) shows noticeable differences between Warsaw and London in both magnitude and dynamics. Throughout the analysed period, Warsaw consistently maintained a higher number of vehicles per 1000 inhabitants compared to London. In 2016-2023, Warsaw's ratio ranged between approximately 1.0 and 1.2 vehicles, while London's fluctuated between 0.7 and 0.9.

This difference is primarily explained by population scale and fleet composition. London operates a smaller number of vehicles with larger passenger capacity (e.g., double-decker buses and long metro trains), enabling efficient transport coverage with fewer units per capita. Warsaw, in contrast, relies on a denser bus and tram fleet composed of smaller-capacity vehicles, which increases the number of units required to serve the metropolitan area effectively (Korneć, Wereda, 2018).

The overall upward trend in both cities until 2020 reflects continuous investment in public transport and growing urban mobility demand. The temporary stagnation observed in 2021-2022 corresponds to the COVID-19 pandemic, which reduced passenger numbers and limited fleet expansion due to fiscal constraints (Chen, Silva, 2021). By 2023, the indicator in both cities had begun to rise again, suggesting a gradual recovery of public transport operations and renewed fleet modernisation, especially through the introduction of low-emission and electric buses (Paiva et al., 2021).

The density of transport infrastructure, i.e. the total length of tram lines, metro and bus routes per 1 km² of area, is shown in Figure 2.

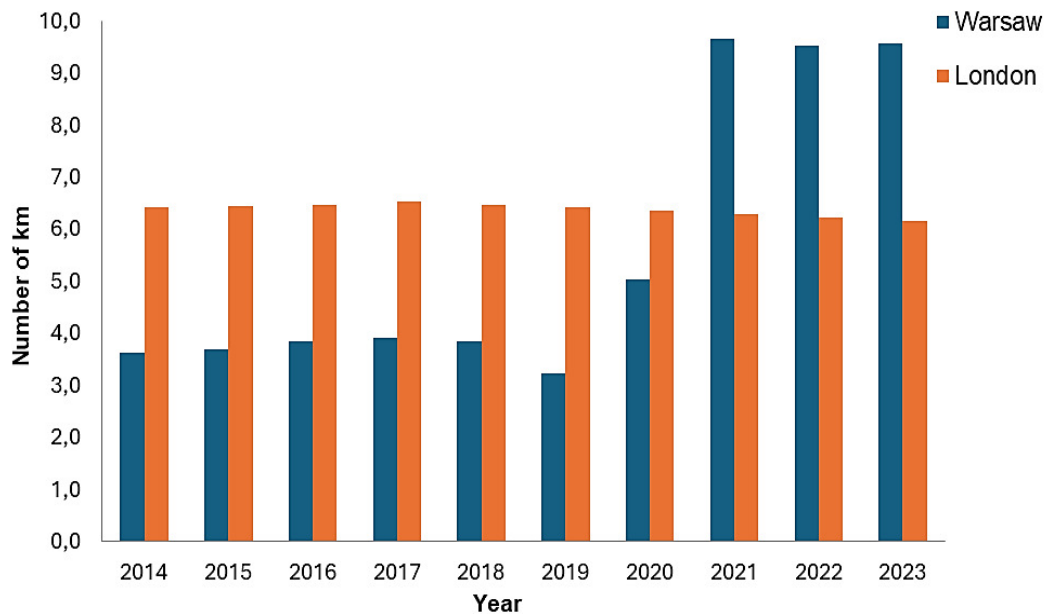


Figure 2. Density of transport infrastructure (number of km per 1 km²) in London and Warsaw (TID).

Source: own analysis based on secondary data.

As can be seen in Figure 2, the comparison of transport-infrastructure density between Warsaw and London demonstrates clear differences in both scale and development dynamics.

Throughout the analysed period (2014-2023), London maintained a higher infrastructure density, ranging between 5 and 7 km of network per km², while Warsaw's level ranged from approximately 3 to 4 km/km².

London's results reflect a long-term, stable system that has reached a high degree of spatial coverage, with only incremental improvements in recent years.

Warsaw, in contrast, shows a progressive upward trend after 2021, primarily driven by the expansion of the metro's second line and the construction of new tram corridors linking peripheral districts with the city centre.

These results confirm that Warsaw's transport policy emphasises infrastructure expansion and integration, whereas London focuses on optimising and digitalising an already mature network (Masik et al., 2021; Angelidou et al., 2022).

Another indicator, average CO₂ emissions in cities per capita, is shown in Figure 3.

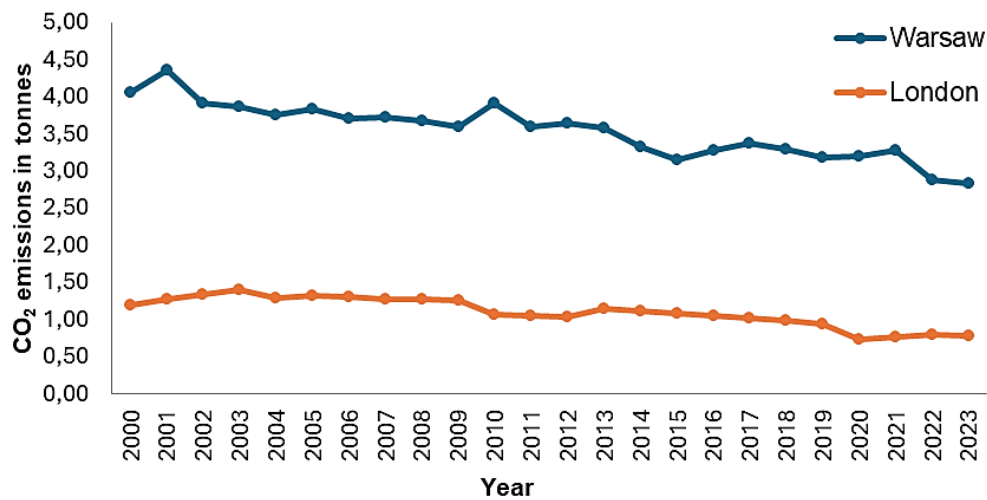


Figure 3. Average CO₂ emissions in London and Warsaw per capita in tonnes (CO₂ pc).

Source: own analysis based on secondary data.

The results show a systematic decrease in CO₂ emissions per capita in both Warsaw and London between 2000 and 2023, though the magnitude of reduction differs. In Warsaw, emissions declined from approximately 4.2 to 2.5 tonnes per capita, while in London they fell from about 1.1 to 0.6 tonnes per capita.

This demonstrates the stronger and earlier implementation of low-emission policies in London, including the Ultra Low Emission Zone (ULEZ) and congestion charging, introduced already in the early 2000s (Greater London Authority, 2015). Warsaw's improvement corresponds to the electrification of bus fleets, the expansion of the metro system, and new Clean Transport Zone (CTZ) initiatives.

Overall, both cities have achieved significant progress towards emission decarbonisation, confirming that smart mobility and clean technologies are central to sustainable urban transport development (Zawieska, Pieriegud, 2018; Paiva et al., 2021).

The average number of passengers per vehicle in public transport is shown in Figure 4. It highlights the differences in the capacity and efficiency of the transport system in the analysed cities.

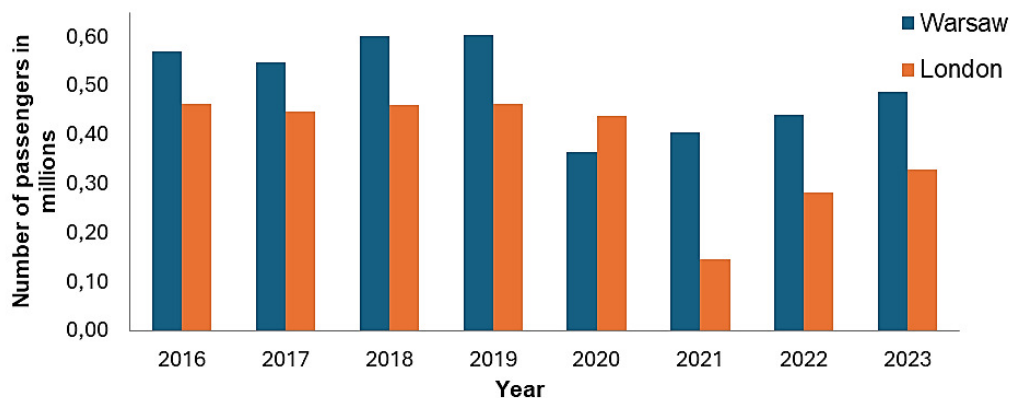


Figure 4. Average number of passengers per vehicle in public transport (in millions) - PPV.

Source: own analysis based on secondary data.

Between 2016 and 2019, Warsaw recorded higher passenger loads per vehicle, indicating more intensive fleet use and higher occupancy levels (Figure 4). During the COVID-19 period (2020–2021), both cities experienced sharp declines in this indicator, reflecting reduced mobility demand and social-distancing measures. London's decline was more pronounced due to stricter restrictions and the widespread adoption of remote work. After 2022, a gradual recovery trend emerged in both cities, with passenger levels rising but still below pre-pandemic figures.

These results underline the impact of external shocks on public-transport performance and the resilience of smart-transport systems in maintaining service continuity (Chen, Silva, 2021).

The average annual number of public transport trips per resident is shown in Figure 5. The data in Figure 5 indicate that Warsaw experienced a strong increase in the number of public transport trips per capita between 2000 and 2019, from roughly 400 to 700 trips annually. London maintained a stable level of 500–550 trips per person per year during the same period.

The COVID-19 pandemic caused a drastic fall in ridership in both cities (Warsaw $\approx$ 400; London $<$ 200), exposing the vulnerability of public transport to behavioural and health crises.

Recovery began in 2022, but ridership remains lower than pre-pandemic levels, particularly in London, where remote work continues to reduce daily commuting (Mościcka et al., 2019).

The indicator confirms the importance of policy adaptation and user-oriented innovation to rebuild trust and increase modal share in the post-pandemic era.

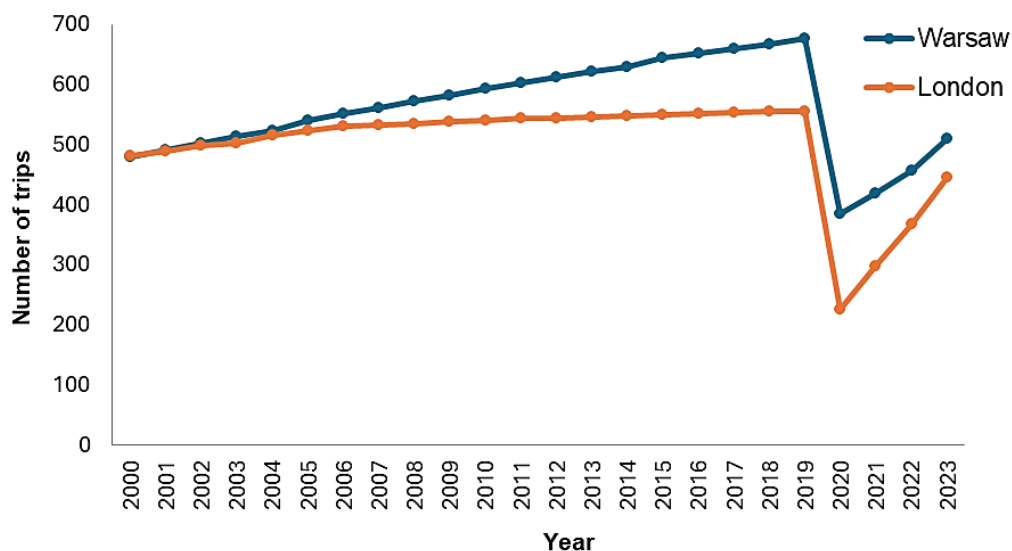


Figure 5. Average annual number of public transport trips per resident (PTT).

Source: own analysis based on secondary data.

Figure 6 shows the changes in the number of available city bikes per 1,000 inhabitants of Warsaw and London in the years 2012–2023. The development of public-bicycle systems reflects contrasting dynamics in Warsaw and London. Between 2012 and 2020, Warsaw achieved a rapid increase in bicycle availability—from less than 1 to around 3 bicycles per 1000

inhabitants, positioning the city among the leading Central European capitals in shared cycling. After 2020, a moderate decline occurred due to the temporary suspension and restructuring of the Veturilo system during the pandemic. In London, the Santander Cycles network remained relatively stable (≈ 0.1 - 0.2 bicycles per 1000 inhabitants), targeting primarily the city centre and tourist areas.

The results indicate that Warsaw's strategy prioritises expansion and accessibility, while London focuses on integration with other mobility modes and safety infrastructure (Shakibamanesh et al., 2019).

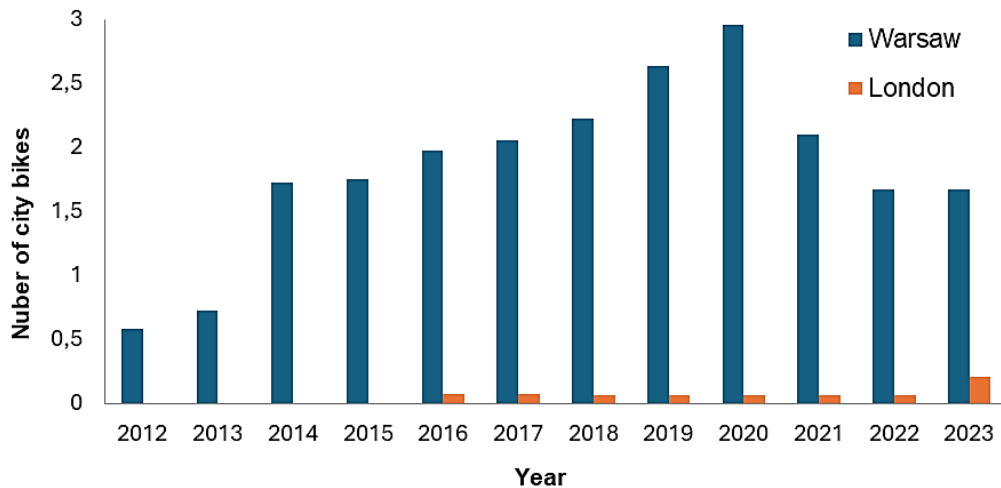


Figure 6. Number of available city bikes per 1000 inhabitants (CB).

Source: own analysis based on secondary data.

Changes in the share of low-emission transport over the years 2011-2023 in London and Warsaw are shown in Figure 7.

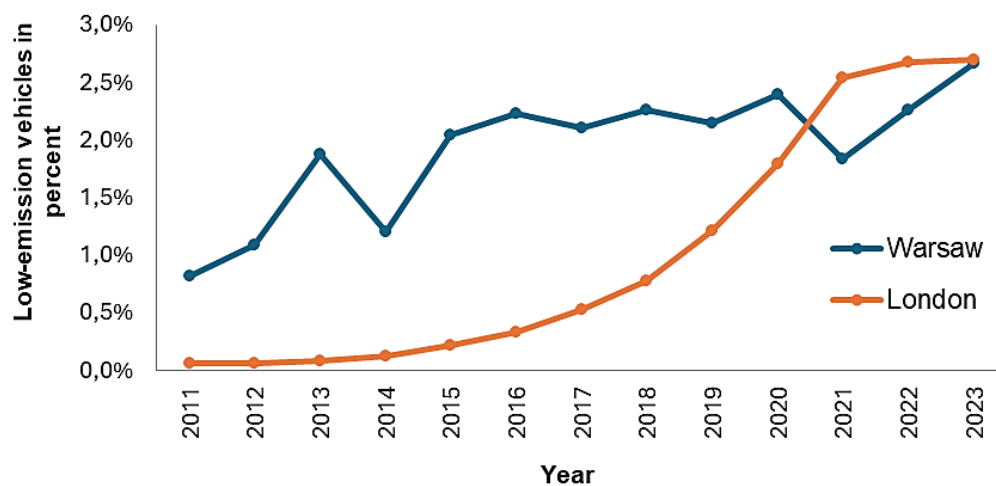


Figure 7. Share of low-emission vehicles in total traffic (in percent) - LEV.

Source: own analysis based on secondary data.

As can be seen in Figure 7, in the years 2011-2023 the share of low-emission vehicles was different in both cities. Warsaw showed steady growth until 2016, reaching around 2.5 %, after which the trend stabilised due to limited funding for further fleet replacement.

London, on the other hand, achieved a rapid increase after 2018, surpassing Warsaw by 2021 and reaching approximately 3 % in 2023. This dynamic reflects London's regulatory measures, such as ULEZ expansion and electric-vehicle incentives (Greater London Authority, 2015), while Warsaw's efforts remain primarily municipally driven.

The results confirm that policy instruments and financial incentives are crucial for accelerating low-emission transitions in urban transport (Angelidou et al., 2022).

After examining the quantitative indicators, the analysis proceeds to the qualitative dimension, which explores governance mechanisms, innovation levels, and accessibility aspects that underpin the development of smart and sustainable transport systems.

The qualitative assessment focuses on four interrelated dimensions of smart urban transport: the implementation of Intelligent Transport Systems (ITS), multimodal integration, the quality of road infrastructure, and accessibility for persons with disabilities.

These dimensions reflect the non-material components of smart mobility related to governance, innovation and inclusiveness, which complement quantitative transport performance indicators.

In this context, the comparative qualitative analysis of Warsaw and London shows noticeable differences in the level of development, integration, and accessibility of their transport systems.

In terms of the implementation of Intelligent Transport Systems (ITS), both cities use a wide range of modern technological solutions, but their level of integration differs (Warsaw Public Transport, 2025; Transport for London, 2025). In London, ITS solutions are more advanced and better coordinated. Real-time traffic management systems, data analysis tools, and open-data platforms are integrated into everyday transport management, which allows for more efficient traffic control and supports decision-making processes (Dona, 2023).

In Warsaw, many ITS elements have also been introduced, such as adaptive traffic lights, passenger information systems, and mobile applications (Kamiński, 2022). However, these solutions do not yet form a fully integrated system. This is typical for cities that are still developing their smart mobility solutions, where the implementation of new technologies happens faster than their full integration. In this context, a comparative qualitative analysis of Warsaw and London reveals significant differences in the maturity, integration, and inclusiveness of their transport systems.

A similar situation can be observed in the area of multimodal integration. London represents a high level of integration, supported by unified ticketing systems, coordinated timetables, and the implementation of Mobility as a Service (MaaS), which allows users to plan and carry out journeys using different modes of transport within one system (Hensher et al., 2020; Transport for London, 2025). This makes travelling more convenient and easier for users.

Warsaw has also made noticeable progress in this area, especially through the development of metro infrastructure, the introduction of integrated tickets, and the expansion of shared mobility systems such as public bicycles (Warsaw Public Transport, 2025). However, the level of integration is still lower than in London. This indicates that Warsaw is still in a stage where the main focus is on infrastructure development rather than full system integration. This observation is consistent with the general direction of smart mobility development, in which cities are gradually moving from infrastructure expansion to more integrated, user-oriented systems (Mitieka et al., 2023). At the same time, improving the efficiency of transfers between different modes of transport remains an important aspect of further system development.

In terms of road infrastructure, London has a well-developed and maintained transport network, which is additionally supported by modern traffic management systems. This contributes to the stable and efficient operation of the whole system (INRIX Global Traffic Scorecard, 2024). Warsaw, on the other hand, is still developing its infrastructure, for example, through metro expansion and new tram lines (General Directorate for National Roads and Motorways, 2024). These investments improve connectivity and support the development of sustainable transport. At the same time, differences between central and peripheral areas are still visible. Reducing these differences is important for improving the overall functioning of the transport system, and this situation is typical for cities that are still developing their smart city solutions (Augustyn, 2020).

Accessibility for persons with disabilities is the last analysed dimension and shows how inclusive the transport system is. London has implemented many solutions in this area, such as step-free access, low-floor vehicles, and clear passenger information systems (Hill, 2024). These measures help ensure that transport is accessible to all users (Wang et al., 2020). In Warsaw, accessibility has also improved, especially thanks to modern vehicles and metro infrastructure. However, not all elements of the system are fully adapted, particularly older infrastructure and some interchange points. Ensuring full accessibility across the entire transport system is still a challenge, which is consistent with the assumption that accessibility is an important element of sustainable urban development (Augustyn, 2020; Wolniak, 2023).

To synthesise the qualitative findings, Table 1 presents a comparative overview of the analysed dimensions.

Table 1.
Comparative qualitative assessment of smart mobility in Warsaw and London

Dimension	Warsaw	London	Assessment
ITS implementation	Developing, partially integrated	Advanced, fully integrated	London more mature
Multimodal integration	Expanding, improving	Highly integrated (MaaS)	London more seamless
Infrastructure quality	Rapidly developing, uneven	Mature and stable	Warsaw catching up
Accessibility	Improving, but inconsistent	Comprehensive and standardised	London more inclusive

Source: own study.

Overall, the qualitative analysis demonstrates that while both cities align with the principles of smart mobility, they differ significantly in terms of system maturity and integration. London represents a highly developed, optimised, and user-oriented transport system, whereas Warsaw is undergoing dynamic transformation, gradually moving towards greater integration and inclusiveness. These findings confirm that the effectiveness of smart mobility strategies depends not only on technological implementation, but also on governance capacity, coordination between stakeholders, and the ability to ensure equitable access to transport services (Wolniak, 2023; Mitieka et al., 2023; Nikitas et al., 2020).

4. Conclusion

The conducted comparative analysis confirms that urban transport plays a fundamental role in the development of smart cities and significantly influences the sustainability, accessibility, and quality of life of urban residents. Both Warsaw and London have implemented numerous smart mobility solutions; however, the scale, maturity, and level of integration of these systems differ considerably due to historical, economic, and institutional factors.

The results indicate that London represents a more advanced stage of smart mobility development, particularly in the areas of Intelligent Transport Systems (ITS), multimodal integration, low-emission transport policies, and the application of data-driven governance. The implementation of solutions such as the Ultra Low Emission Zone (ULEZ), integrated Mobility as a Service (MaaS) systems, and extensive open-data platforms demonstrates a high level of technological and organisational maturity. Warsaw, on the other hand, has achieved significant progress in the expansion of transport infrastructure, fleet modernisation, and the development of sustainable mobility solutions such as public bicycle systems and low-emission public transport. Nevertheless, the city is still undergoing a transition from infrastructure-oriented development towards fully integrated and user-centred smart mobility systems.

The study also confirms that the integration of digital technologies, including Big Data, Internet of Things (IoT), artificial intelligence, and autonomous systems, increasingly determines the effectiveness of urban transport management. Smart mobility solutions contribute not only to reducing congestion and emissions, but also to improving transport accessibility, operational efficiency, and urban resilience. In this context, the findings of Nikitas et al. (2020) emphasise that artificial intelligence and autonomous transport systems are becoming one of the key dimensions of future smart-city development, particularly in relation to connected and autonomous vehicles (CAVs), data integration, and intelligent infrastructure management. At the same time, as highlighted by Wang et al. (2020), the development of

autonomous vehicles also requires particular attention to safety issues, legal regulations, and public trust, which remain significant barriers to large-scale implementation.

The obtained results are also consistent with previous studies concerning smart city development and sustainable urban transformation. Jonek-Kowalska and Wolniak (2021) emphasise that the implementation of smart city solutions strongly depends on the economic capacity, governance quality, and technological maturity of urban areas. Furthermore, Jonek-Kowalska and Wolniak (2023) indicates that sustainable smart-city development should not be limited solely to technological advancement, but should also focus on improving residents' quality of life, environmental conditions, and social inclusiveness. Similar conclusions were formulated by Jonek-Kowalska (2023), who demonstrated that environmental effectiveness and air-quality improvement constitute important determinants of sustainable smart-city development. Additionally, Jonek-Kowalska and Wolny (2025) underline the importance of inclusiveness and age sustainability in smart cities, particularly in the context of adapting urban services and infrastructure to the needs of senior citizens. The sustainable development of smart cities should therefore focus not only on technological progress, but also on improving the quality of life of residents, inclusiveness and everyday living conditions in the city (Jonek-Kowalska, 2025).

The analysis, therefore shows that sustainable urban mobility should not be limited to technological innovations alone. Equally important are governance quality, multimodal integration, accessibility for vulnerable groups, environmental responsibility, and long-term strategic planning. Smart transport systems should therefore be understood as socio-technical ecosystems in which technology supports broader sustainability and inclusiveness objectives.

From a practical perspective, London may serve as a benchmark for Warsaw in the areas of transport-system integration, digital governance, and low-emission policy implementation. Conversely, Warsaw illustrates how rapidly developing cities can effectively modernise transport infrastructure and gradually implement smart mobility solutions despite financial and institutional limitations.

Future research should extend the comparative framework by including a broader group of European cities representing different levels of economic development, transport maturity, and smart-city implementation. This would make it possible to identify whether the differences observed between Warsaw and London are city-specific or reflect wider regional patterns in smart mobility development.

A particularly important direction would be the inclusion of primary empirical research among urban transport users. Surveys, interviews, and focus groups could help assess residents' satisfaction, perceived accessibility, willingness to use low-emission transport, and attitudes towards digital mobility services. Such research would allow future studies to complement statistical indicators with the social dimension of smart mobility.

Future research should also focus more strongly on transport equity and social inclusion. This includes the accessibility of smart mobility services for elderly people, persons with disabilities, low-income residents, and inhabitants of peripheral districts. Such studies would help determine whether smart transport systems reduce or reproduce existing inequalities in urban mobility.

Acknowledgements

This paper was published as part of the statutory research ROZ 1: 13/010/BK_26/0093 at the Silesian University of Technology, Faculty of Organization and Management.

References

1. Angelidou, M., Politis, C.E., Panori, A., Bakratsas, T., Fellnhöfer, K. (2022). Emerging smart city, transport and energy trends in urban settings: Results of a pan-European foresight exercise with 120 experts. *Technological Forecasting and Social Change*, 183, 121915. <https://doi.org/10.1016/j.techfore.2022.121915>
2. Augustyn, A. (2020). *Zrównoważony rozwój miast w świetle idei smart city*. Wydawnictwo Uniwersytetu w Białymstoku.
3. Chen, Y., Silva, E.A. (2021). Smart transport: A comparative analysis using the most used indicators in the literature juxtaposed with interventions in English metropolitan areas. *Transportation Research Interdisciplinary Perspectives*, 10, 100371. <https://doi.org/10.1016/j.trip.2021.100371>
4. Dona, A. (2023). *Intelligent transport systems: the best thing since sliced bread*, *SmartCitiesWorld*. Available at: <https://www.smartcitiesworld.net/4g-and-5g/intelligent-transport-systems-the-best-thing-since-sliced-bread>, 20 April 2025.
5. *General Directorate for National Roads and Motorways* (2024). <https://www.gov.pl/web/gddkia/generalnadyrekcja-drog-krajowych-i-autostrad>
6. Greater London Authority (2015). *The Future of Smart: Update Report of the Smart London Plan*. London: Greater London Authority.
7. Hensher, D.A., Ho, C.Q., Mulley, C., Nelson, J.D., Smith, G., Wong, Y.Z. (2020). *Understanding Mobility as a Service (MaaS): Past, Present and Future*. Oxford: Elsevier.
8. Hill, A. (2024). Improving disabled access to UK's public transport 'almost impossible'. *The Guardian*. *The Guardian article*, 7 March 2025.

9. *INRIX Global Traffic Scorecard* (2024). <https://inrix.com/press-releases/2024-global-traffic-scorecarduk>, 7 March 2025.
10. Jonek-Kowalska, I. (2023). Assessing the Effectiveness of Air Quality Improvements in Polish Cities Aspiring to Be Sustainably Smart. *Smart Cities*, 6(1), 24. <https://doi.org/10.3390/smartcities6010024>
11. Jonek-Kowalska, I. (2025). *Smart Living in Smart Cities*. Cheltenham: Edward Elgar Publishing.
12. Jonek-Kowalska, I., Wolniak, R. (2021). Economic opportunities for creating smart cities in Poland. *Sustainable Cities*, 114, 103222. <https://doi.org/10.1016/j.cities.2021.103222>
13. Jonek-Kowalska, I., Wolniak, R. (2023). *Smart Cities in Poland: Towards Sustainability and a Better Quality of Life?* London/New York: Routledge.
14. Jonek-Kowalska, I., Wolny, M. (2025). Age Sustainability in Smart City: Seniors as Urban Stakeholders in the Light of Literature Studies. *Sustainability*, 17(14), 6333. <https://doi.org/10.3390/su17146333>
15. Kamiński, M. (2022). Inteligentne systemy transportowe (ITS) na polskich drogach. *Auto Świat*. Available at: <https://www.auto-swiat.pl/wiadomosci/aktualnosci/inteligentne-systemy-transportowe-its-na-polskich-drogach/w8nwn40>, 20 April 2026.
16. Knight Frank/Poland report (2018). *Knight Frank in cooperation with the Digitisation Department and the Economic Development Department of the City of Warsaw. Warsaw – Towards a Smart City*. Knight Frank Poland. <https://content.knightfrank.com/research/1500/documents/en/warsaw-towards-smart-city-april-2018-5462.pdf>
17. Korneć, R., Wereda, W. (2018). Urban transport as an important element of „The Smart City”. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, 128, 205-215. Gliwice: Silesian University of Technology Press.
18. Masik, G., Sagan, I., Scott, J.W. (2021). Smart City strategies and new urban development policies in the Polish context. *Cities*, 108, 102970. <https://doi.org/10.1016/j.cities.2020.102970>
19. Mitieka, D., Luke, R., Twinomurinzi, H., Mageto, J. (2023). Smart mobility in urban areas: A bibliometric review and research agenda. *Sustainability*, 15, 6754.
20. Mościcka, A., Pokonieczny, K., Wilbik, A., Wabiński, J. (2019). Transport accessibility of Warsaw: A case study. *Sustainability*, 11(19), 5536. <https://doi.org/10.3390/su11195536>
21. Nikitas, A., Michalakopoulou, K., Njoya, E.T., Karampatzakis, D. (2020). Artificial Intelligence, Transport and the Smart City: Definitions and Dimensions of a New Mobility Era. *Sustainability*, 12(7), 2789. <https://doi.org/10.3390/su12072789>
22. Paiva, S., Ahad, M.A., Tripathi, G., Feroz, N., Casalino, G. (2021). Enabling technologies for urban smart mobility: Recent trends, opportunities and challenges. *Sensors*, 21(6), 2143. <https://doi.org/10.3390/s21062143>

23. Shakibamanesh, A., Ghorbanian, M., Mashhadi Moghadam, S.N. (2019). *Smart Growth and Sustainable Transport in Cities (1st ed.)*. Routledge. <https://doi.org/10.4324/9780429292095>
24. Transport for London (2025). Available at: <https://tfl.gov.uk/>, 20 April 2025.
25. Wang, J., Zhang, L., Huang, Y., Zhao, J. (2020). Safety of Autonomous Vehicles. *Journal of Advanced Transportation*, Article ID 8867757, <https://doi.org/10.1155/2020/8867757>
26. Warchoń-Jakubowska, A., Szwoch, I., Szczeciński, P., Krejtz, I., Krejtz, K. (2024). Accessible public transport: A case study of Warsaw. In: A. Marcus-Quinn, K. Krejtz, C. Duarte (Eds.), *Transforming Media Accessibility in Europe* (pp. 21-38). Springer. https://doi.org/10.1007/978-3-031-60049-4_2
27. Warsaw Public Transport (2025). <https://www.wtp.waw.pl/>, 20 April 2025.
28. Warsaw Public Transport (2025). Available at: <https://www.wtp.waw.pl/>, 20 April 2025.
29. Wolniak, R. (2023). Smart mobility jako element koncepcji smart city. *Management and Quality [Zarządzanie i Jakość]*, 5(1). Gliwice: Politechnika Śląska.
30. Zawieska, J., Pieriegud, J. (2018). Smart city as a tool for sustainable mobility and transport decarbonisation. *Transport Policy*, 63, 39-50. <https://doi.org/10.1016/j.tranpol.2017.11.004>

PROVIDER – CLIENT COLLABORATION: IMPLEMENTATION OF QUALITY MANAGEMENT FRAMEWORKS VERSUS AI-BASED MODELS

Paweł KRÓLAS

Politechnika Poznańska; pawel.krolas@put.poznan.pl, ORCID: 0000-0002-1189-2484

Purpose: The paper analyzes the role of supplier–client collaboration in quality management system (QMS) implementation and compares traditional approaches with AI-based models.

Design/methodology/approach: The study examines QMS implementation projects conducted in Polish enterprises between 2014 and 2025. The research combines consulting case studies with comparative analysis of models generated by ChatGPT, Claude, and Bard.

Findings: Close supplier–client collaboration improves QMS implementation effectiveness. Market pressures and certification requirements accelerate implementation, while traditional models remain more aligned with practical organizational needs than AI-based models. AI can support QMS implementation through structured frameworks, although practical validation is required.

Research limitations/implications: The study is limited to Polish enterprises and selected ISO systems. Future research could include international comparisons and broader analysis of organizational culture and AI applications.

Practical implications: Organizations should combine consulting expertise with AI-supported tools to improve implementation effectiveness and certification readiness.

Social implications: The research may support improvements in quality standards, workplace safety, and environmental management.

Originality/value: The paper compares traditional QMS implementation approaches with AI-based models, providing new insights into supplier–client collaboration and AI-supported management systems.

Keywords: Quality Management Standards, Quality Management Frameworks, Supplier–Client Collaboration, Artificial Intelligence.

Category of the paper: Research paper.

1. Introduction

The implementation of quality management systems in Poland began in the early 1990s. The initial implementations of quality management systems were associated with a significant investment of time and effort, as well as the involvement of the entire enterprise. Often, during the implementation process, companies used the services of advisor companies', which provided their knowledge and experience to support organizations during the implementation process and the audit of the certification body.

Currently, in the case of large enterprises, there are dedicated organizational units such as the Quality Manager or the Quality Director, as well as internal auditors who carry out cyclical activities related to the maintenance of the system. Micro, small and medium-sized enterprises often do not have such capabilities. This situation creates an opportunity to establish cyclical cooperation with a supplier in the field of quality management systems.

In the subject of literature there is a large amount of literature dealing with implementation of quality management systems in organizations (Nowotarski, Paślawski, Kadler, 2018;19 In most cases, the literature presents the implementation of a selected standard using the example of a selected enterprise. Presenting research results based on a case study allows for in-depth analysis, but at the same time limits the generalizability of the findings. Other authors focus on selected issues related to Quality Management Systems, including risk management (Wysokińska-Senkus, Górna, 2021; Jedynak, 2017; Algheriani et al., 2019), Industry 4.0 (Santos et al., 2021; Carvalho, Lima, 2022; Zaidin et al., 2018), organizational efficiency (Milovanović, Paunović, Casadesús, 2023; Gremyr et al., 2021; Brooks et al., 2021), and corporate social responsibility (Majerník et al., 2022; Baltos, 2018).

An important gap exists in research examining the holistic implementation of management systems and the evolution of their objectives. To address this gap, the following research questions were posed:

- Q1: How does collaboration between consulting providers and organizations affect the effectiveness of QMS implementation?**
- Q2: What circumstances accelerate the implementation of quality management systems (QMS)?**
- Q3: What differences in the development and implementation of quality management systems can be observed based on traditional case studies compared to AI-based models?**
- Q4: Could AI serve as a tool to simulate the implementation of quality management systems (QMS)?**

The theoretical part presents a historical perspective on the development of quality systems in Poland. A literature review of quality management systems (QMS) and artificial intelligence as a tool of supporting the implementation process of QMS in organizations.

Through collaboration with an advisor company, the practical aspects of the research were introduced. The research conducted a sample of 37 organizations, including micro, small, medium, and large businesses, in which introduced various of quality standards. As part of implementation of Management Systems in organizations several actions were carried out: Diagnosis, Training, preparation of the Documentation, Audit and Management review. The scope of activities depended on the organization and its needs. The research was carried out between 2014 and 2025.

2. Theoretical background

The early 1990s witnessed the first implementations of the International Organization for Standardization's (ISO) quality management system (QMS) on Polish market (Krolas, 2020). The ISO 9000 series of standards, in operation for over three decades, remains a prominent offering within the International Organization for Standardization's (ISO) portfolio. Since its initial publication in 1987, the series has undergone significant revisions, with the most notable occurring in 2000. These revisions introduced a process-based approach and discontinued the use of ISO 9002 and 9003. The most recent update, published by ISO on September 15, 2015, for ISO 9001, incorporated several key changes. These include the integration of risk management, a heightened focus on customer empowerment and motivation, and an emphasis on the role of top management in implementing the standard's requirements (Midor, Wilkowski, 2021).

Over one million companies and institutions across 170 countries hold certifications according to ISO 9001. In Europe the number of issue certificates estimates about 400 000 (ISO, 2024).

ISO 9001: 2015 has emerged as the most popular QMS standard in Poland. Possession of this certification is often a prerequisite for participation in public tenders, highlighting its significance. The number of certificates issued by certification bodies changed has evolved over the years. At the beginning of the 1990s, large production organizations were the initial adopters of these standards, aiming to improve process efficiency, promote an objective focus on measurement, enhance employee competence, and establish the continuous improvement cycle mandated by ISO specifications (Krolas, Heilala, 2023). After years also medium and small organizations introduced the QMS. The number of ISO 9001 certificates has varied over time. Initially, a steady increase can be noted (from the 1990s to 2002). Subsequently, in the years following (2003-2005), there was a significant growth, which could be linked to Poland's accession to the EU on May 1, 2004. The highest number of issued certificates 12,000 was in 2009. Between 2011 and 2021, the number of issued certificates has maintained a similar level, with over 10,000 implemented and certified quality management systems (ISO, 2024) (Fig. 1).

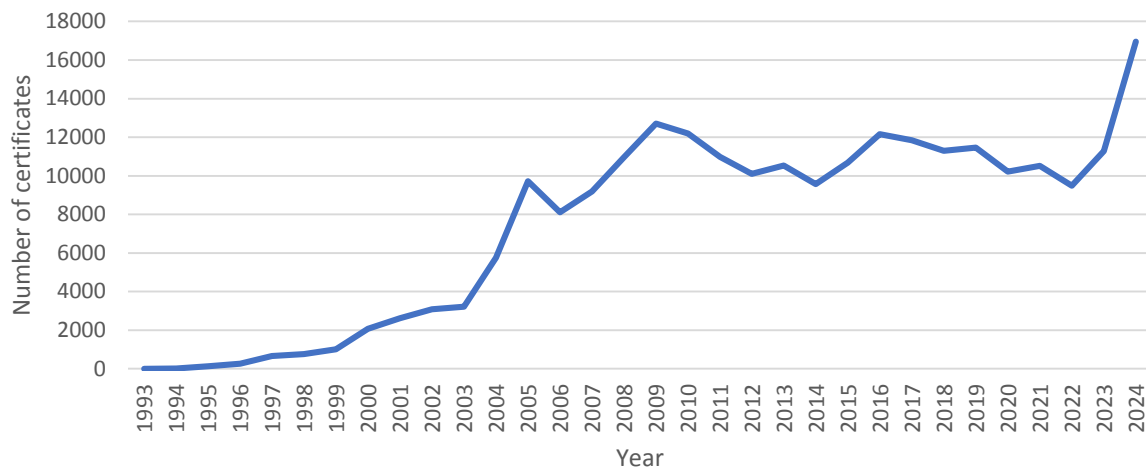


Figure 1. Number of certificates ISO 9001 issued in Poland.

Source: Own study based on www.iso.org

The beginnings of the ISO 14001 standard in 1996, when the ISO developed Environmental Management Systems (EMS) standard. This standard was created to provide organizations with a framework for establishing, implementing, maintaining, and improving an environmental management system (Lemkowska, Wiśniewska, 2021). Since its inception, ISO 14001 has gone through several revisions and updates (2004, 2015) to ensure that it remains relevant and effective in addressing evolving environmental challenges (ISO, 2024).

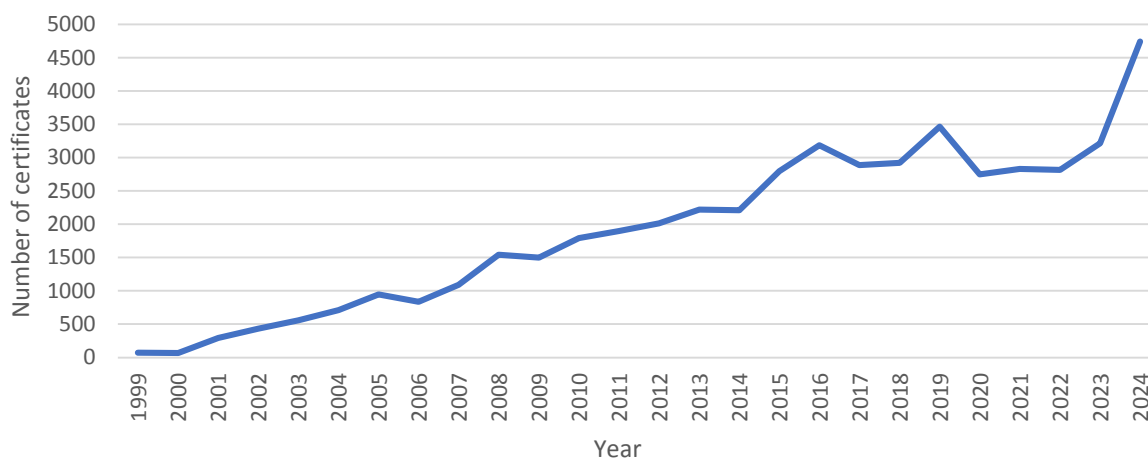


Figure 2. Number of certificates ISO 14001 issued in Poland.

Source: Own study based on www.iso.org

The number of ISO 14001 certificates granted in Poland has been steadily increasing since its inception in 1996. By 2021, the number of issued certificates had reached almost 3000 (ISO, 2024).

OHSAS 18001 (Occupational Health and Safety Assessment) was a standard developed for managing occupational health and safety. It was first issued in 1999 by the British organization BSI Group. This standard was developed in response to the needs of organizations that wanted to effectively manage risks associated with employee safety. OHSAS 18001 was accredited and

certified by certifying organizations in accordance with international standards (in Poland it was PN-N-18001). In 2018, the OHSAS 18001 standard was replaced by the international standard ISO 45001, which combines best practices related to managing safety and health at work. ISO 45001 provides organizations with a solid framework to identify and control health and safety hazards, as well as to continuously improve the management system in these areas (Šolc et al., 2022).

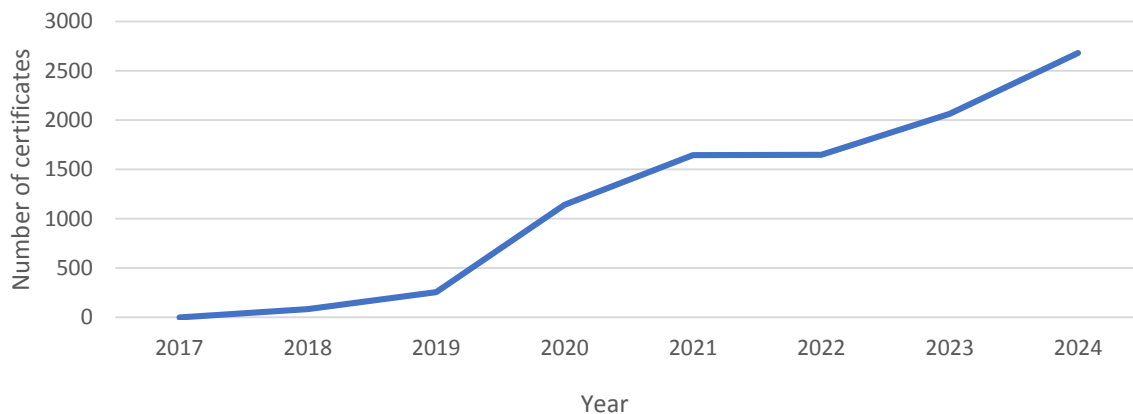


Figure 3. Number of certificates ISO 45001 issued in Poland.

Source: Own study based on www.iso.org

The number of issued certificates has increased rapidly over the years, reaching 1646 in 2021 (ISO, 2024). The adoption of ISO 45001 leads to a reduction in the occurrence of accidents and occupational diseases, decreased absenteeism, and improved productivity and work efficiency (Šolc et al., 2022).

The current ISO standards are structured according to a harmonized framework, ensuring uniformity in the core clauses across different management systems. This standardization facilitates the integration of multiple management systems within organizations and creates a consistent foundation for process improvement initiatives. In this context, the emergence of artificial intelligence (AI) technologies offers new opportunities to enhance the design, implementation, monitoring, and continuous improvement of ISO-based management systems.

The origins of artificial intelligence (AI) can be traced back to the 1950s. A pivotal moment was the Dartmouth Conference in 1956, where John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon introduced the term "artificial intelligence" and outlined the primary research directions for the field (McCarthy et al., 2006, p. 13). During this period, the first programs capable of performing logical reasoning tasks were developed. The early decades of AI research were marked by optimism, leading to the development of symbolic AI methods and early machine learning concepts. However, limitations in computational power and algorithmic approaches presented significant challenges, slowing the rapid progress initially anticipated.

A breakthrough occurred in the 1980s with the introduction of the backpropagation algorithm for training neural networks (Rumelhart, Hinton, Williams, 1986, pp. 533-536). The rise of machine learning enabled the creation of more complex and flexible models, reigniting enthusiasm for AI research. In the 21st century, AI development accelerated dramatically, driven by advances in computational power (e.g., GPUs), the availability of large datasets (big data), and innovations in deep learning. A landmark achievement was the victory of AlphaGo over Go world champion Lee Sedol in 2016 (Silver et al., 2016, pp. 484-489), demonstrating the effectiveness of combining deep learning with tree search methods. Contemporary AI research focuses on areas such as explainable AI (XAI), AI safety, and the development of AI management standards like ISO/IEC 42001:2023 (Benraouane, 2024, pp. 54-76).

A critical research gap exists concerning the comprehensive implementation and evolving objectives of management systems. To address this knowledge deficit, the present study examines the implementation trends and underlying rationale for quality systems in Poland over the past decade. The research was conducted within a selected consulting company, focusing specifically on the Polish market. Practical findings were compared with selected AI models, enabling a more holistic approach by incorporating current technological advancements.

3. Methodology

Research

Beta¹ is an advisor company with 40 years' experience on polish market. The main activity of the company is implementation, training, auditing and management reviewing of Quality Management Systems (QMS) of: ISO 9001, ISO 14001, ISO 45001, ISO 27001 and others. Beta has introduced about 350 QMS implementations on small, medium and large organization.

The research involved a sample of 37 organizations across various size categories (micro, small, medium, and large) that had implemented diverse quality standards. The author of the article leads the advisory unit at Beta organization and also holds the position of Quality Manager. Their work within the unit played an important role in the successful completion of the research. Beta has also developed, implemented, and obtained certification for the ISO 9001, ISO 14001, ISO 45001, and ISO 22000 systems. However, at present, only the ISO 9001 system is being actively maintained and certified.

The data collection spanned a ten-year period, from 2014 to 2024.

¹ The author of the publication was not authorized to publish the name of the organization presented in the case study. For the purposes of this article, the organization was named of the Greek alphabet – Beta.

Implementing a Management System at a client's site follows a three-stage process (Fig. 4). The first stage involves a thorough needs assessment to understand the client's specific requirements and objectives. Based on this assessment, a comprehensive proposal outlining the services, timeline, and costs was prepared. Negotiations often occurred during this stage, ultimately leading to a signed agreement for implementing the chosen ISO standard (9001, 14001, 45001, or an Integrated System).

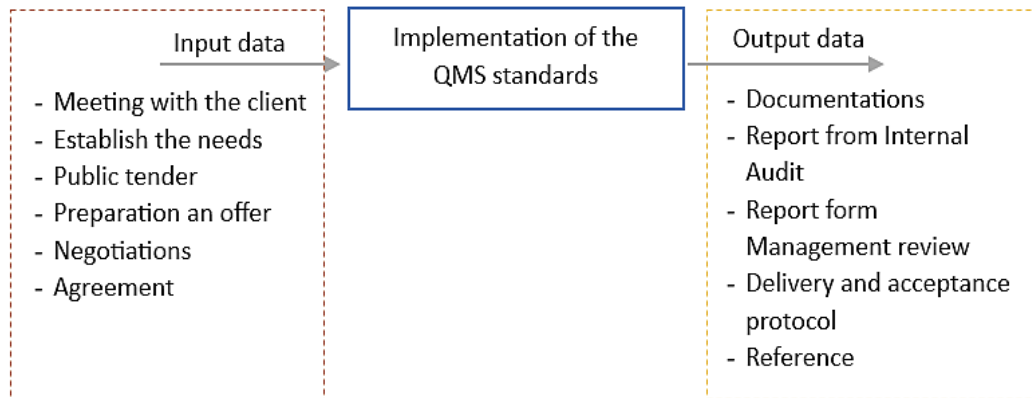


Figure 4. General process of Implementation of QMS.

Source: Own study.

The second stage involves the implementation of Quality Management standards in client organizations. Six different approaches were presented based on a sample of 37 organizations, as shown in Figures 7 to 9.

The final stage of implementation includes creating documentation, conducting an internal audit, and reviewing management practices. These activities allow for an evaluation of the organization's compliance with the ISO standards that have been implemented. The assessments helped determine if the organizations were ready for an audit by the certification body.

Furthermore, during this phase, a delivery and acceptance protocols were carried out, along with the issuance of a reference letter recognizing the successful collaboration. This ensures that all parties involved were satisfied with the results of the implementation process.

The research was conducted on 37 organizations, including (Fig. 5):

- 3 micro,
- 12 small,
- 16 average,
- 6 large.

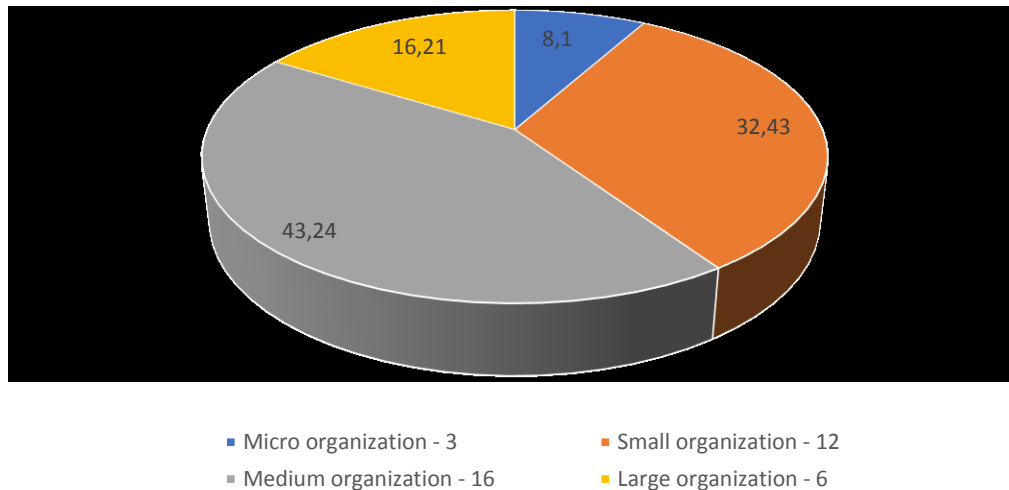


Figure 5. Size of the organizations implemented during the research.

All of the organizations were located in Poland.

The portfolio of implemented systems included (Fig. 6):

- Quality Management System According ISO 9001.
- Environmental Management System according ISO 14001.
- Integrated Management System according to ISO 9001, ISO 14001, ISO 45001.

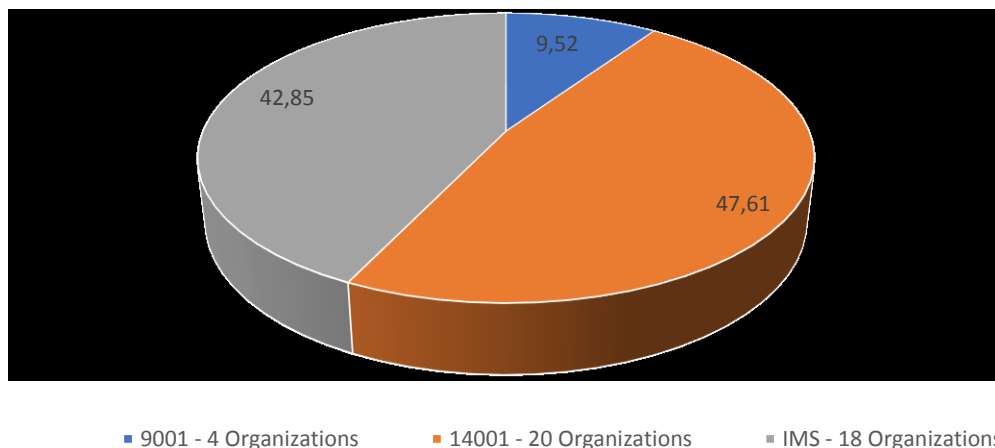


Figure 6. Types of Quality Management standards implemented during the research.

The implementation time depended on the organization. The shortest implementations lasted 3 months (ISO 9001, small company) and the longest 7 months (ISO 9001, ISO 14001, ISO 45001, large organization).

Results of the research

The most popular variant of the implementations of Quality Management Systems included (Fig. 7 – variant 1):

- **Diagnosis of the current state** - the advisor company conducted an analysis of the current state of the enterprise Alpha, including its strategy, organizational structure, processes, and adherence to ISO standards.
- **Training: Requirements of ISO 9001** - a training course was conducted to educate clients representatives on the requirements of ISO 9001.
- **Creation of Management System documentation** - development of Management System Documentation were established: Quality Manual, Procedures, and Instructions by Beta advisor company. Client organizations approved the documentations.
- **Consultations regarding the implementation of the 9001 standard** - consultations on QMS Implementation: Discussions were held to define and consult the required records from individual processes.
- **Conducting an internal audit ended with a report** - An internal audit was conducted to assess compliance with standards, identify strengths and non-conformities, and implement corrective actions.
- **Management review ended with the report** - following the requirements outlined in the ISO 9001 standard, a comprehensive summary of the activities within the implemented system was developed. The management board of the organizations, in collaboration with a advisor company, assessed the feasibility of participating in the certification body's audit.

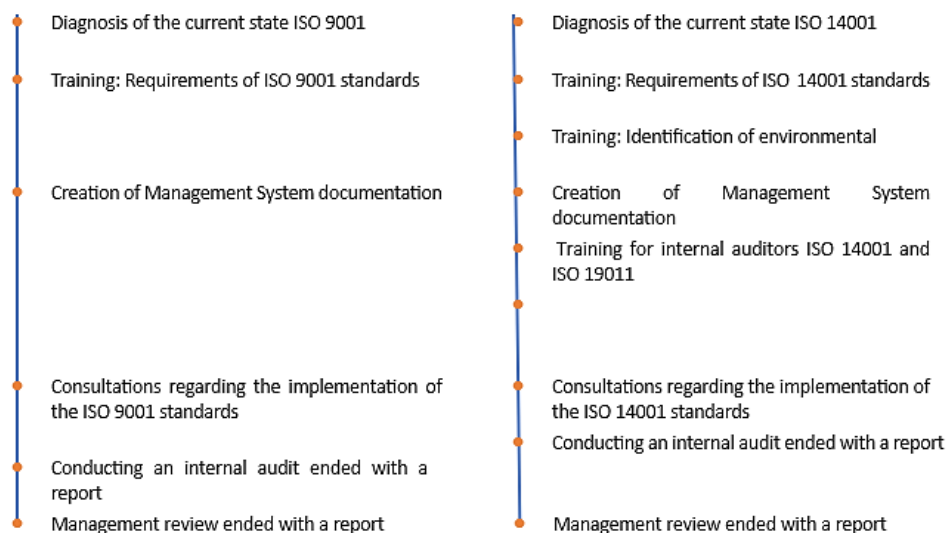


Figure 7. Implementations of Quality Management Standards – variant 1 (fundamental) and 2 (Common).

Out of the 37 organizations where Quality Management Systems were implemented, 20 of them (small and medium) implemented an Environmental Management System according to ISO 14001. The organizations were located in different regions of Poland (Fig. 7 – variant 2).

The individual phases of the implementation of ISO 14001 were similar to the basic variant in Figure 7. The differentiating element was the subject of implementation: ISO 14001 and a more extensive implementation schedule, which additionally took into account:

- **Training: Identification of environmental aspects** - training included identification and assessment of environmental aspects with is crucial element of ISO 14001 standard.
- **Training for internal auditors ISO 14001 and 19001** - as part of the two-day training, candidates for internal auditors were introduced to auditing guidelines. The training lasted two days and ended with an exam.

Variant 3 and 4 of Implementations of Quality Management Standards include: quality - ISO 9001, environmental – ISO 14001 and safety ISO 45001 include extensive scope of training (Fig. 8):

- **Training: Quality, Environment, Health and Safety (IMS) requirements – management staff** – during the training, trainers from the advisor company presented the main requirements of the ISO 9001, ISO 14001, ISO 45001 standards, with particular emphasis on the responsibilities of the organization's management staff.
- **Training: Quality, Environment, Health and Safety (IMS) requirements – implementation team** – During the training session, the standards for quality, environment, and occupational health and safety were discussed in relation to operational activities and process owners. The presentation took into consideration the specific requirements of each standard and how they should be implemented in the workplace. Additionally, the training covered the method of work that should be followed during the execution of a project to ensure compliance with these standards.
- **Training: Risk Management** – during the training, participants were educated on the procedure for identifying and assessing risks according to ISO 9001, ISO 14001, and ISO 45001 standards. Additionally, they were given the chance to utilize a specialized risk management software tool.
- **Training: Internal and external context** – during the training, participants identified both internal and external factors that are important for the selected enterprise. This analysis was conducted using strategic analysis methods such as: SWOT and Porter's Five Forces Analysis.
- **Implementation of a computer program to risk management** - as per the terms of the agreement, Beta company created applications for the purpose of identifying and assessing risks. Upon completion of this phase, the application was officially handed over to the client, along with login credentials.



Figure 8. Implementations of Quality Management Standards – variant 3 (expanded) and 4 (consultation).

In case of implementations of Quality Management Standards – consultation variant (Fig. 8 – variant 4) the particular phases of implementations of QMS were similar as in Figure 7 – common variant). In the case most stages (except training) were based on consultations. This is due to the extensive knowledge of the implementation team on the client's side, maintaining the implemented systems for several years, as well as the great commitment of the management staff. The company where the implementation took place was affiliated with a foreign company, specifically a Mother-Daughter company relationship. Additionally, there were cyclical activities such as internal audits and management reviews conducted by chosen representatives from the parent company. This led to increased dedication among the staff of the daughter company and ensured that deadlines agreed upon with Beta were met.

During the COVID-19 pandemic, the implementations of Quality Management Standards (Fig. 9 – on-line variant) were carried out primarily online, with only the Diagnosis and Trainings elements taking place on-site. The organization utilized mobile phones, emails, and online meetings via communication platforms for most of the implementation process. Additionally, virtual audits by certification bodies were conducted online. Despite the challenges posed by the pandemic, the organization successfully implemented an integrated system covering quality, environment, and health and safety standards, ultimately receiving a certification for their efforts.

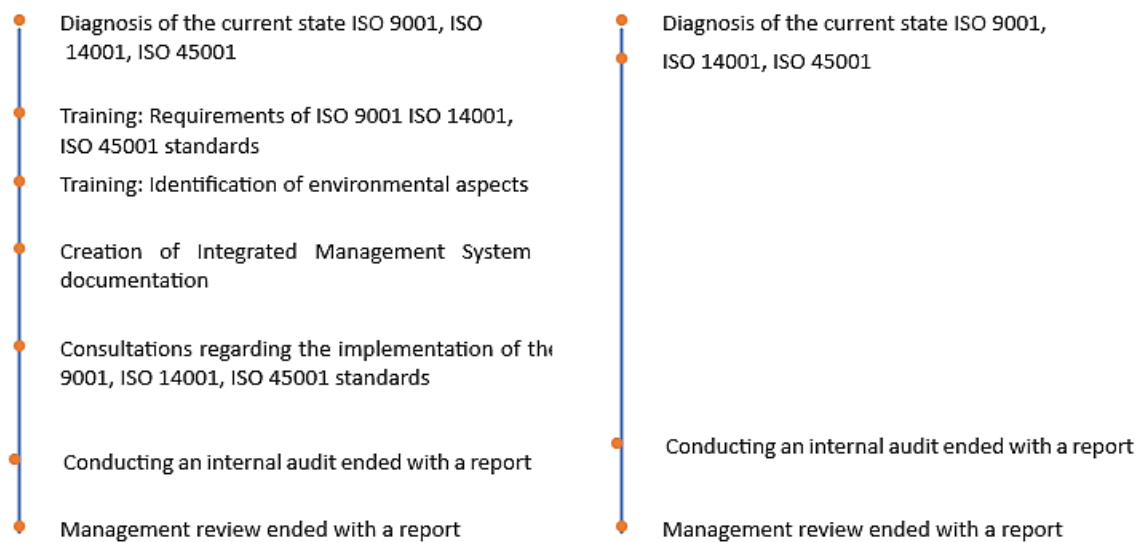


Figure 9. Implementations of Quality Management Standards – variant 5 (on-line) and 6 (supervision).

Figure 9 (variant 6) is structured around three key stages: Diagnosis, Internal Audit, and Management Review. While the company had initially put the system in place, subsequent operational and personnel changes prompted a decision to enlist external expertise to pinpoint crucial areas for system maintenance. This methodology enables an impartial evaluation of the existing systems and helps determine where corrective measures are needed.

The models presented in the study were based on implementation projects carried out between 2014 and 2025. These models reflect practical experiences accumulated over more than a decade of collaboration with enterprises of various sizes and sectors, providing a foundation for understanding the dynamics and challenges of quality management system deployment in real-world conditions. Building upon the insights gained from these traditional implementation models, the study further explores the potential of artificial intelligence in supporting management system development. To this end, three AI-based models were analyzed, utilizing advanced tools such as ChatGPT, Claude, and Bard. The integration of AI into the analysis marks a significant shift towards leveraging new technologies to enhance the efficiency, accuracy, and adaptability of management system implementations.

Figure 10 presents two models developed using AI tools, specifically ChatGPT and Claude. In both models, two critical stages are identified: the decision to implement the management system and the subsequent maintenance of the system as an integral part of the implementation process. When considering the collaboration between the service provider and the client organization, these stages may either form part of the negotiated service package or, in some cases, may not be explicitly included - particularly in relation to the ongoing maintenance of the system. In such instances, the responsibility for maintaining the management system rests primarily with the client organization where the system was implemented. Maintenance activities can, however, be formalized as a separate contractual agreement between the provider and the client if deemed necessary.

The models emphasize that while the initial decision to implement a management system typically involves negotiation and external support, the long-term upkeep of the system often becomes an internal responsibility. This distinction highlights the importance of clearly defining roles and responsibilities during the negotiation phase and underscores the potential for flexible arrangements tailored to the specific needs and capabilities of the client organization.

Importantly, none of the three AI models involved additional machine learning or model training for the purposes of this study. The same prompt was entered into ChatGPT, Claude, and Bard in order to ensure comparability of results. In two cases — ChatGPT and Claude — the generated responses were highly similar and reflected comparable implementation structures. In contrast, Bard generated a substantially different implementation model, indicating variations in interpretation and response structure despite the use of an identical prompt.



Figure 10: Implementations of Quality Management Standards – variant 7 (based on Chat GPT) and 8 (based on Claude).

Despite certain differences, the two models generated using ChatGPT and Claude demonstrate a strong alignment with the practical implementation patterns observed in the real-world projects labeled as Variants 1 through 5. Both AI-driven models closely reflect the sequence of decision-making processes, system deployment, and maintenance activities that were consistently reported during the actual consulting engagements. This close correlation

suggests that AI-based tools, when properly prompted and guided, are capable of accurately reproducing established best practices and implementation methodologies.

In contrast, a notably different situation emerges in the case of Figure 11 - Variant 9, which was generated using Bard.

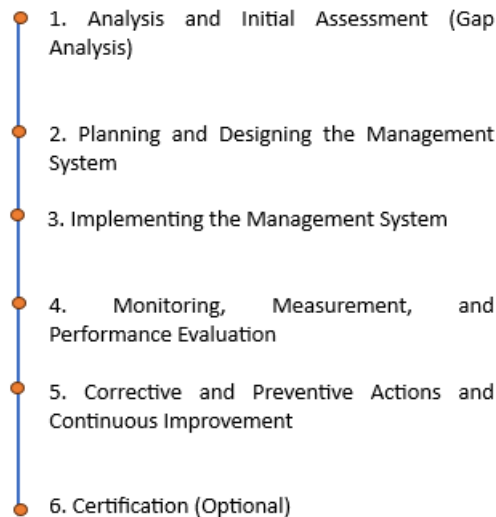


Figure 11. Implementations of Quality Management Standards – variant 9 (based on Bard).

Figure 11 presents the implementation model of Integrated Management Systems (quality, environmental, safety) based on Variant 9 generated by Bard. The model consists of six stages, beginning with a gap analysis, followed by system planning, implementation, monitoring, and improvement activities, and optionally culminating in certification. It emphasizes the organization's internal responsibility for maintaining and improving the system, with minimal reliance on external support. This approach reflects contemporary trends toward greater autonomy and flexibility in management system development.

4. Findings

Based on research conducted between 2014 and 2025, it is evident that provider–client collaboration significantly influences the effectiveness of quality management system (QMS) implementation. Organizations that engaged in close cooperation with external consultants were able to develop systems that were better aligned with market expectations, particularly in the context of tender participation and fulfilling strategic client requirements (**Q1**) (Figure 12). Strong collaboration enhanced both the efficiency and relevance of QMS deployment.

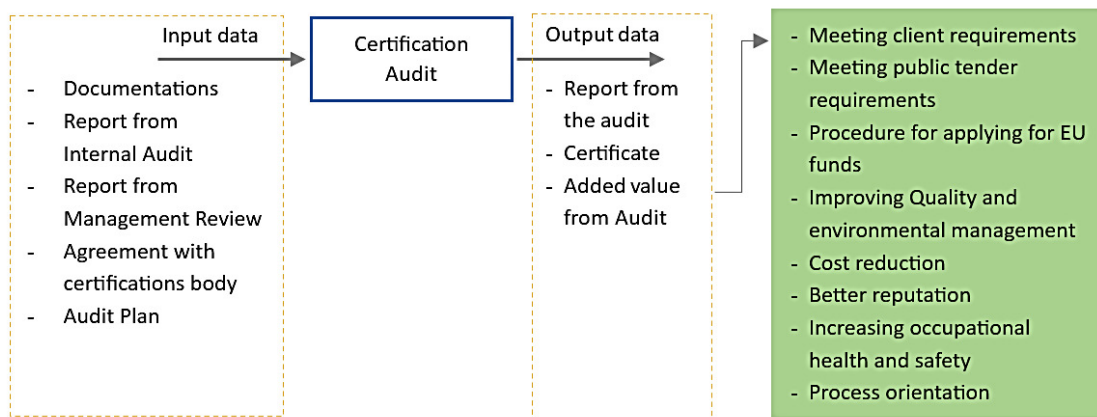


Figure 12. Value from certification of Quality Management Systems.

The study also indicates that external market pressures serve as key drivers accelerating the implementation of management systems. The necessity to obtain certifications such as ISO 9001, ISO 14001, and ISO 45001 — often as a prerequisite for maintaining business relationships or participating in competitive tenders — provided companies with a strong incentive to expedite the implementation process. At the same time, certification requirements contributed not only to faster implementation but also to improving the quality and effectiveness of implemented management systems. The risk of losing strategic partnerships in the absence of certification emerged as a decisive factor motivating rapid system development (Q2).

A comparison between traditional implementation models and AI-based models revealed notable differences. Traditional models, grounded in empirical consulting experience, closely reflect the realities of organizational constraints and client expectations. In contrast, AI-generated models propose more idealized, internally focused development paths that emphasize autonomy and continuous improvement. While AI models offer innovative perspectives, traditional approaches remain more attuned to external market conditions and the practicalities of provider–client collaboration (Q3).

Finally, the findings confirm that artificial intelligence can serve as an effective tool for simulating the implementation of quality management systems. AI-based solutions, by integrating best practices and analyzing large volumes of data, can generate structured implementation frameworks. However, their practical application requires careful validation, especially in scenarios where external certification demands and business partner expectations are critical to the success of the management system (Q4).

5. Conclusions

The study highlights the crucial role of provider–client collaboration in the successful implementation of quality management systems, particularly in environments driven by market and certification pressures. External demands serve as strong accelerators of system development, influencing both the pace and focus of implementation efforts. While traditional implementation models are firmly grounded in practical experience and external requirements, AI-based models offer new, internally oriented perspectives that, although innovative, require critical validation before practical application.

The research confirms that artificial intelligence can be a valuable supporting tool in simulating and designing management systems, provided that its outputs are carefully aligned with real-world organizational needs and market expectations. Furthermore, the growing role of AI in management system implementation is increasingly reflected in emerging international regulatory standards, including International Organization for Standardization/IEC 42001:2023, which establishes requirements for artificial intelligence management systems. This demonstrates that AI-supported QMS implementation is becoming an important area of international standardization and organizational development.

References

1. Algheriani, N.M.S., Majstorovic, V.D., Kirin, S., Spasojević-Brkić, V.K. (2019). Risk Model for Integrated Management System. *Technical Gazette*, 26(6, Supplement 1.1), 1833-1840. DOI: <https://doi.org/10.17559/TV-20190123142317>
2. Baltos, G.C. (2018). Quality Management, Standardization and Auditing Meet Multiple Organizational Risks, Strengthening Open Market Understanding and Social Responsibility. *Academic Journal of Interdisciplinary Studies*, Vol. 7, No. 3. Doi: 10.2478/ajis-2018-0060
3. Benraouane, S.A. (2024). *AI Management System Certification According to the ISO/IEC 42001 Standard*. CRC Press, 54-76. <https://doi.org/10.1201/9781003463979>
4. Brooks, T., Gunning, J.G., Spillane, J.P., Cole, J. (2021). Regulatory decoupling and the effectiveness of the ISO 9001 Quality Management System the Construction sector in the UK – a case study analysis. *Construction Management and Economics*, Vol. 39, No. 12, 988-1005 <https://doi.org/10.1080/01446193.2021.1983186>
5. Carvalho, A.V., Lima, T.M. (2022). Quality 4.0 and Cognitive Engineering Applied to Quality Management Systems: A Framework. *Appl. Syst. Innov.*, 5, 115. <https://doi.org/10.3390/asi5060115>

6. Gremyr, I., Lenning, J., Elg, M., Marti, J. (2021). Increasing the value of quality management systems. *International Journal of Quality and Service Sciences Vol. 13, No. 3*. Emerald Publishing Limited, pp. 381-394. 1756-669X. DOI 10.1108/IJQSS-10-2020-0170
7. Jedynak, P. (2017). *Znormalizowane Systemy Zarządzania a ryzyko działalności organizacji*. Wydawnictwo Uniwersytetu Jagiellońskiego. DOI: 978-83-233-4422-3
8. Krolas, P. (2020). Human Aspect and Risk in Quality Management Systems. In: S. Trzcielinski W. Karwowski (eds.), *Advances in The Ergonomics in Manufacturing: Managing the Enterprise of the Future. AHFE (2020) International Conference. AHFE Open Access, vol. 12*. USA: AHFE International, <http://doi.org/10.54941/ahfe100433>
9. Krolas, P., Heilala, J. (2023). Life cycle opportunity based on implementation of Quality Management Systems. In: W. Karwowski, S. Trzcielinski (eds.), *Human Aspects of Advanced Manufacturing. AHFE International Conference. AHFE Open Access, vol. 80* (pp. 57-66). USA: AHFE International, <http://doi.org/10.54941/ahfe1003508>
10. Lemkowska, M., Wiśniewska, D. (2021). Elements of Environmental Management Systems according to ISO 14001 relevant from the point of view of an insurance company – the results of empirical research. *Argumenta Oeconomica, No. 2(46)*, pp. 271-306. PL ISSN 1233-5835, DOI: 10.15611/aoe.2021.2.12
11. Majerník, M., Štofková, J., Malega, P., Barilová, B. (2022). Standardisation of the Social Responsibility System as a Tool for Business Sustainability. *Quality Innovation Prosperity / Kvalita Inovácia Prosperita*, 26/2. DOI: 10.12776/QIP.V26I2.1703
12. McCarthy, J., Minsky, M.L., Rochester, N., Shannon, C.E. (2006). A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence. *AI Magazine*, 27, 12-14. <https://doi.org/10.1609/aimag.v27i4.1904>
13. Midor, K., Wilkowski, G. (2021). Recertification of a Quality Management System based on ISO 9001 - is it a must for a modern manufacturing company? *Production Engineering Archives*, 27(3), 217-222. DOI: 10.30657/pea.2021.27.29
14. Milovanović, V., Paunović, M., Casadesús, M. (2023). Measuring the Impact of ISO 9001 on Employee and Customer Related Company Performance. *Quality Innovation Prosperity / Kvalita Inovácia Prosperita* 27/1, 79-102. DOI: 10.12776/QIP.V27I1.1808
15. Nowotarski, P., Paślawski, J., Kadler, A., (2018). Quality Management Systems as a key element for company strategy selection - case study. *MATEC Web of Conferences*, 222, 01012. DOI: <https://doi.org/10.1051/mateconf/201822201012>
16. Rumelhart, D.E., Hinton, G.E., Williams, R.J. (1986). Learning Representations by Back-Propagating Errors. *Nature*, 323, 533-536. <https://doi.org/10.1038/323533a0>
17. Santos, G., Sá, J.C., Félix, M.J., Barreto, L., Carvalho, F., Doiro, M., Zgodavová, K., Stefanovi, M. (2021). New Needed Quality Management Skills for Quality Managers 4.0. *Sustainability*, 13, 6149. <https://doi.org/10.3390/su13116149>

18. Sârb, A., Glevitzky, I., Itul, L., Popa, M., (2019). The improvement of quality management system in a porcelain factory. *MATEC Web of Conferences*, 290, 900, MSE. DOI: <https://doi.org/10.1051/mateconf/201929005003>
19. Shaikh, F., Sohu, S. (2020). Implementation, Advantages and Management of ISO 9001 in the Construction Industry. *Civil Engineering Journal*, Vol. 6, No. 6, June. DOI: <http://dx.doi.org/10.28991/cej-2020-03091535>
20. Silver, D., Huang, A., Maddison, C.J., Guez, A., Sifre, L., van den Driessche, G., Schrittwieser, J. et al. (2016). Mastering the Game of Go with Deep Neural Networks and Tree Search. *Nature*, 529, 484-489. <https://doi.org/10.1038/nature16961>
21. Šolc, M., Blaško, P., Girmanová, L., Kliment, J. (2022). The Development Trend of the Occupational Health and Safety in the Context of ISO 45001:2018. *Standards*, 2, 294-305. <https://doi.org/10.3390/standards2030021>
22. www.iso.org, February 29, 2024.
23. Wysokińska-Senkus, A., Górna, J. (2021). Towards sustainable development: Risk management for organizational security. *Entrepreneurship and Sustainability Issues*, Vol. 8, No. 3, pp. 527-544. DOI: [http://doi.org/10.9770/jesi.2021.8.3\(33\)](http://doi.org/10.9770/jesi.2021.8.3(33))
24. Zaidin, N.H.M., Diah, M.N.M., Po, H.Y., Sorooshian, S. (2018). Quality Management in Industry 4.0 Era. *Journal of Management and Science*, 8(2), 82-91. DOI: 10.26524/jms.2018.17

IMPROVEMENT OF THE WAREHOUSING USING RFID TECHNOLOGY IN A MANUFACTURING ENTERPRISE – A LITERATURE REVIEW

Marzena KUCZYŃSKA-CHAŁADA^{1*}, Michał MIKINA²

¹ Silesian University of Technology; marzena.kuczynska-chalada@polsl.pl, ORCID: 0000-0002-5273-8328

² Timken Polska sp. z o.o.; mm277165@student.polsl.pl

*Correspondence author

Purpose: The purpose of this publication is to present a review of the existing literature regarding the use of RFID technology in warehouse processes in manufacturing enterprises. The publication aims to identify the benefits and challenges associated with RFID implementation, as well as to highlight areas where this technology can improve warehouse processes and inventory management.

Design/methodology/approach: A literature analysis was conducted on the applications of RFID in logistics and warehousing, focusing on research related to the automation of inventory processes, improving inventory accuracy, and reducing waste. The paper also compares results from different industries to identify universal benefits and challenges associated with RFID implementation.

Findings: The literature points to several benefits of implementing RFID technology, such as improved inventory accuracy, reduction of human errors, acceleration of warehouse processes, and better warehouse space management. RFID implementation also allows real-time tracking of goods, leading to better inventory control and faster decision-making. However, the literature also highlights challenges related to initial implementation costs, integration with existing systems, and the need for staff training.

Research limitations/implications: Further research should focus on investigating the long-term impact of RFID on operational costs in warehouses and analyzing the effectiveness of RFID technology across different industries. There is a need for research on integrating RFID with other technologies, such as IoT (Internet of Things) and artificial intelligence, to further improve warehouse processes.

Originality/value: The article provides a comprehensive review of the existing literature on RFID technology in warehouse processes, highlighting its potential for automation and optimization. The publication adds value by analyzing various aspects of RFID technology, its implementation, and the long-term benefits resulting from its use in manufacturing enterprises.

Keywords: RFID, warehouse automation, inventory management, logistics, technology in logistics.

Category of the paper: Literature review.

1. Introduction

Modern manufacturing enterprises operate under conditions of increasing market competition, which requires continuous process optimization, reduction of operational costs, and ensuring high product quality. One of the key factors determining competitive advantage is the implementation of modern information and technological tools that support process management. Among such solutions is RFID (Radio-Frequency Identification) technology, which is based on the use of radio waves for automatic identification and tracking of objects. RFID systems enable real-time recording of the flow of materials, raw materials, and semi-finished products throughout the entire production chain, thereby providing more comprehensive control over operational processes. Consequently, their implementation contributes to enhancing organizational efficiency, reducing material losses, and improving product quality through precise monitoring of individual stages of production.

RFID technology brings numerous benefits, such as the ability to automatically identify and locate raw materials, semi-finished products, and finished goods, which enables precise inventory management. As a result, enterprises can reduce costs associated with maintaining excessive stock levels and minimize the risk of stock shortages. Moreover, RFID accelerates warehousing processes, order picking, and goods dispatch, thereby shortening order fulfillment times and increasing operational efficiency.

In various production sectors, RFID technology has found wide application. It is extensively used in logistics, manufacturing, retail, healthcare, and many other fields, ensuring fast and accurate data collection as well as streamlining operational processes. In the automotive industry, RFID is employed to track car parts along the production line, enabling quality monitoring and assembly speed control. In the food sector, it supports supply chain management by tracking products from the moment of production to final delivery to the customer. RFID fosters modern production management by improving efficiency, reducing costs, and enhancing product quality. The benefits of its implementation are recognized by enterprises worldwide.

The application of RFID technology reduces the time required to locate components and tools, automates information flows, and eliminates errors resulting from manual data entry, thereby ensuring real-time updates of inventory levels (Zhang, 2011; Gładysz, Grabia, Santarek, 2017; Weiland, 2025; Jankowska-Miśkiewicz, Kłos, Grzechca, 2016; Wójtowicz-Kowalska, Rebec, 2013). This solution also enables warehouse space optimization, reduces operational costs, and improves control over material flows. When integrated with ERP-class systems (e.g., SAP), RFID contributes to the full automation of logistics and production processes, enhancing data security and shortening the execution time of warehouse tasks. Consequently, the use of RFID reduces warehouse losses and improves customer service quality through faster and more reliable order fulfillment. The findings indicate that RFID

constitutes an effective tool supporting process management and a source of competitive advantage for enterprises (Kisperska-Maróń, 2009; Ciesielski, 2009; Sharma, 2014; Matulewski, 2018; Wicki, 2021; Gładysz, 2014; Zakrzewski, 2023; Jones, Chung, 2017; Godfryd, 2006; Finkenzeller, Gebhart, 2012; Albrecht, 2006).

The aim of this article is to provide a comprehensive review of the scientific literature concerning the application of RFID technology in warehouse and production processes, with particular emphasis on its role in logistics management and its impact on enterprise competitiveness. By synthesizing prior research, the paper identifies the main areas of RFID implementation, the associated operational and strategic benefits, as well as the technological and organizational challenges reported in the literature.

Based on the conducted review, several future research directions can be identified. In particular, further studies are needed to examine the long-term cost-effectiveness and return on investment (ROI) of RFID implementations, especially in dynamically changing production and warehouse environments. Moreover, deeper investigation of RFID integration with IoT and artificial intelligence solutions is recommended in order to support predictive analytics and the development of autonomous warehousing systems. Future research should also address cybersecurity and data protection issues, including regulatory compliance requirements. Additionally, cross-industry comparative studies would contribute to validating the generalizability of existing findings.

From a practical perspective, the results of this review provide guidance for practitioners planning RFID implementation. The findings may support decision-makers in selecting priority warehouse processes for RFID deployment, planning effective ERP/WMS integration (including data flow architecture and middleware solutions), identifying key cost categories and implementation risks, and designing employee training and change-management strategies to reduce adoption barriers and increase organizational readiness.

2. RFID Technologies in Warehouse Logistics

RFID systems consist of three fundamental components: tags, readers (scanners), and a data management system. RFID tags are small electronic devices containing a microchip and an antenna (Figure 1). The microchip stores unique identification data, while the antenna enables communication with the reader through radio waves. Tags can be either active (with their own power source) or passive (powered by the radio waves emitted by the reader) (Długosz, 2017; Bidermann, 2014).

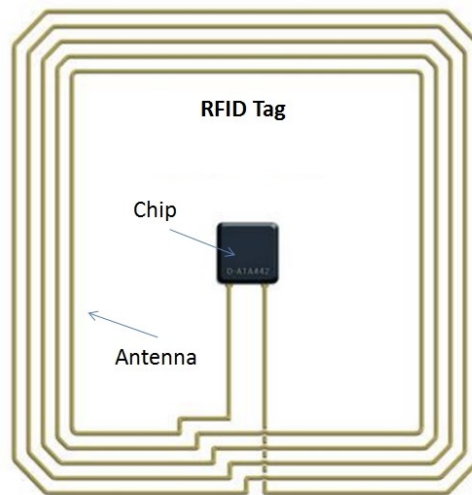


Figure 1. RFID handheld reader (data collector).

Source: Długosz et al., 2017.

RFID readers are devices that transmit radio signals to tags and receive responses containing identification data. The readers are equipped with antennas and data processing modules, which subsequently transfer the information to the management system. The data management system integrates readings from RFID readers with databases and business applications. This enables monitoring and analysis of goods flow, inventory management, and the optimization of logistics and production processes. The operation of RFID systems is based on data exchange between the tag and the reader via radio waves. When a tag enters the reader's range, the reader's antenna sends a signal that activates the tag and enables the transmission of data from the microchip to the reader. The received data are then processed and analyzed within the management system, allowing for automatic identification and real-time tracking of objects (Kiedrowicz, 2013; Munoz-Ausecha, Ruiz-Rosero, Ramirez-Gonzales, 2021; Abugabah, Nizamuddin, Abugabbeh, 2020; Akram, Mian, 2022; Liu, Zhang, Kong, Zhang, 2018; Gao, Zhang, Ma, 2017; Chen, Sun, Chen, Zheng, 2014; Munilla, Hassan, Burmester, 2020; Jones, Wyld, Totten, 2005).

The integration of RFID systems with existing warehouse solutions (such as ERP/WMS systems) involves the implementation of technology that enables automatic data collection, processing, and synchronization in real time, thereby making logistics processes more efficient. (Ciesielski, Długosz et al., 2010).

The key aspects of RFID integration include:

- **Data synchronization:** RFID integrates data with existing systems such as Warehouse Management Systems (WMS) and Enterprise Resource Planning (ERP), enabling the automation of processes such as inventory control, asset tracking, and order fulfillment. For example, data from RFID tags are transmitted to ERP systems in real time, supporting both operational and strategic decision-making.

- Operations automation: The integration of RFID simplifies inbound and outbound goods processes through automatic updates of product status, eliminating the need for manual data entry. This leads to greater operational accuracy and a reduction in human errors.
- Technological adaptation: To ensure smooth integration, technologies such as middleware, APIs, or integration platforms are applied. These are used to connect RFID with the systems already operating in the warehouse.
- Testing and validation: A pilot implementation of RFID makes it possible to verify the system's functionality under real warehouse conditions and to resolve integration issues before full-scale deployment.
- Improved tracking and resource management: RFID technology enables precise real-time tracking of goods, which contributes to the optimization of inventory placement, better utilization of warehouse space, and improved customer service quality.

The implementation of RFID systems involves various costs, including both initial investments and ongoing expenses. Initial expenditures include the purchase of equipment such as RFID tags, readers, and antennas, as well as the costs of installation and integration with existing information systems. Staff training is often required, which generates additional expenses. Ongoing costs of maintaining RFID systems cover hardware maintenance, software updates, and the possible replacement of damaged tags and readers. In addition, companies must take into account the costs associated with system management, such as technical support and data administration.

Despite these expenditures, the benefits resulting from operational efficiency, data accuracy, and the reduction of errors and losses may significantly outweigh the costs of implementing and maintaining RFID systems. In the long term, investment in RFID often leads to savings and an increase in the competitiveness of the enterprise (Gołębska, 2018; Chrobak, 2010).

Despite their numerous advantages, RFID systems pose significant challenges in terms of data security and privacy. Since RFID tags transmit information via radio waves, there is a risk of unauthorized data access by third parties. To counteract such threats, various security techniques are applied, such as data encryption, authentication, and the use of protective shielding for tags.

In addition, there is the issue of user privacy protection. RFID tags may be used to track individuals, which raises concerns related to surveillance. Companies implementing RFID must comply with data protection regulations, such as the GDPR in the European Union, and ensure that RFID systems are used in accordance with privacy principles. Effective management of data security and privacy in RFID systems requires the application of advanced security technologies as well as the establishment of appropriate data protection policies and procedures, in order to minimize the risk of unauthorized access and ensure compliance with legal regulations.

Interoperability and standardization are key aspects for the effective implementation and functioning of RFID systems.

Interoperability refers to the ability of different RFID systems to cooperate and exchange data. For RFID systems to function effectively in global supply chains, they must be compatible with the diverse devices and technologies used by different companies. This requires consistency at the hardware, software, and communication protocol levels. Interoperability enables the seamless integration of RFID systems with existing Warehouse Management Systems (WMS) and Enterprise Resource Planning (ERP) solutions, thereby allowing for more efficient management of logistics and production processes.

Standardization in the context of RFID involves the establishment of common norms and technical specifications that ensure products and services from different providers are compatible and can interoperate. Organizations such as ISO (International Organization for Standardization) and EPCglobal develop and publish standards covering various aspects of RFID technology, including operating frequencies, communication protocols, and data formats. Przykłady standardów RFID to:

- ISO 18000 – a series of standards covering different RFID frequency ranges.
- EPC Gen 2 (ISO 18000-6C) – a standard for UHF RFID, widely used in global supply chains.
- ISO 15693 – a standard for HF RFID, commonly applied in areas such as personal identification and libraries.

Standardization brings benefits such as reduced implementation costs, easier integration of systems from different providers, and increased confidence in the performance and reliability of RFID systems. Thanks to established standards, companies can invest in RFID technologies with greater assurance that their systems will be compatible and sustainable in the future.

Trends and forecasts for the development of RFID technology indicate its intensive integration with solutions based on the Internet of Things (IoT) and Industry 4.0. RFID is increasingly applied in smart factories, where it enables automatic monitoring of production processes, resource management, and quality control (Konecka, Maryniak, 2020). Within the framework of IoT, this technology is used for real-time data management, which contributes to more efficient and automated processes.

Research directions in RFID also include the development of Ultra High Frequency (UHF) technology and anti-collision protocols, which improve system performance in large-scale environments. Moreover, RFID is becoming increasingly compatible with database and data analytics systems, enabling better demand forecasting and supply chain optimization.

In the future, a further decrease in the costs of RFID technology is anticipated, which will allow for wider application in sectors such as healthcare, smart cities, and public transportation. Research has also highlighted the growing importance of RFID in the context of security, both in consumer and industrial applications (Sharma et al., 2014).

RFID technology is continuously evolving, and its future appears promising due to numerous potential innovations and improvements. (Schwartz, 2011).

The integration of RFID with artificial intelligence enables more advanced analysis of data collected from RFID tags (Zhu, Li, Xu, Wang, 2013). AI systems can support faster and more accurate pattern recognition as well as forecasting of needs and trends in supply chains, which facilitates more effective inventory management and optimization of logistics processes.

AR and VR can already be used for the visualization of RFID data on-site, enabling warehouse and factory workers to manage resources more quickly and intuitively. With these technologies, operators will be able to locate and identify RFID-tagged items more easily and accurately.

RFID tags with multifunctional features, such as measuring temperature, humidity, or condition, open up new application possibilities. Such tags can be used in more demanding environments, such as pharmaceutical manufacturing or the food industry, where monitoring storage conditions is crucial.

RFID has potential applications in healthcare, such as patient monitoring, hospital asset management, and medication tracking. Through RFID, the precision of patient data management can be improved, and the safety of medical processes can be enhanced.

Innovations in RFID may also include the development of tags with lower energy consumption, which will enhance their durability and environmental sustainability. Energy-efficient RFID tags can be more easily applied in scenarios where long-term operations are required without the need for frequent battery replacement. (Sharma et al., 2014; Zakrzewski et al., 2023).

2.1. Integration of the RFID System with the Existing Production System

Designing the architecture of an RFID system requires careful definition of its components and their interrelationships in order to meet the needs of the enterprise under study. The foundation is an understanding of process flows within the company, such as production, warehousing, and shipping, which makes it possible to identify key points for the installation of RFID devices. The system architecture must take into account the placement of RFID tags on products, RFID readers and antennas in strategic locations, and the management software.

At the physical infrastructure level, RFID tags should be located on products or their packaging in a way that does not interfere with production or transportation processes. Tags should be read at designated points such as production lines, where progress in manufacturing is monitored; warehouse entry and exit gates, which control the flow of products; and loading zones, where shipment completeness is verified. RFID antennas should be arranged to ensure maximum range and reading accuracy, taking into consideration possible physical obstacles such as metal racks or other equipment.

The next step is the configuration of RFID middleware, which acts as an intermediary between the RFID hardware and the SAP system. The middleware receives data from RFID readers, processes them, and transmits them to SAP in the appropriate format. For this purpose, it is necessary to integrate the middleware with SAP modules responsible for warehouse management, such as SAP WM (Warehouse Management) or SAP EWM (Extended Warehouse Management). The integration may use standard SAP interfaces such as IDoc (Intermediate Document), SOAP, or OData. The middleware should also provide functionalities such as data filtering, duplicate elimination, and real-time event reporting.

Integration with the SAP system is a key element of the RFID system architecture. The system must enable real-time data transmission, such as the current location of products, their production status, or warehouse availability. Most commonly, APIs, OData connectors, or standard SAP protocols such as IDoc are used. This makes it possible to automatically update inventory levels, manage orders, and optimize production processes.

At the communication level, the architecture should include a stable and reliable network infrastructure. RFID devices may be connected to the network via Ethernet cables or wirelessly (Wi-Fi), depending on local conditions. The use of Power over Ethernet (PoE) technology can simplify installation by allowing both power supply and data transmission through a single cable.

When designing the RFID system architecture, scalability must also be considered, meaning the ability to easily expand the system in the future, for example, by adding additional readers, antennas, or new software functionalities. Appropriate redundancy should also be provided to minimize the risk of failures and operational downtime (Zakrzewski et al., 2023).

The implementation of an RFID system integrated with SAP for inventory management can be divided into several key stages, encompassing both technical and organizational aspects.

The first step is requirements analysis and system architecture planning. A detailed audit of warehouse and production processes should be carried out to identify the key areas where RFID can deliver the greatest benefits, such as the automation of inventory readings, tracking product flows along production lines, and streamlining shipping processes. Based on this, a process map can be developed, and the locations for RFID readers, antennas, and tags can be designated.

Readers and antennas must be compatible with the tags, providing the appropriate range and reading reliability. Attention should also be paid to supported communication protocols, such as EPC Gen2 or ISO 18000-6C, which allow for seamless integration with middleware and the SAP system.

On the SAP side, appropriate configurations must be prepared to enable the processing of data received from the RFID system. This can be achieved by defining new identification points in warehouses and assigning them suitable roles in logistics processes. SAP configuration must consider business logic, such as real-time inventory updates, automatic recording of material receipts and issues, and the tracking of stock transfers between warehouses.

The system implementation also involves the physical installation of RFID devices, including readers and antennas, in the locations specified during the architecture design stage. It is crucial to ensure stable power supply and network connectivity for the devices, preferably through Power over Ethernet (PoE) technology. Once the devices are installed, their configuration and testing are carried out under real conditions to verify reading quality and the correctness of data transmission.

A key stage is the integration of the RFID system with SAP, during which the flow of data across the entire IT environment is tested. It must be ensured that RFID tag data are correctly processed by the middleware and properly interpreted by SAP. It is also advisable to perform simulations of business scenarios, such as goods receipt into the warehouse, order picking, or internal warehouse transfers, in order to verify the correct functioning of the system.

After completing system tests, user training sessions are conducted, covering the operation of RFID devices as well as the operational process changes resulting from the adoption of the new technology. Finally, the system is launched in the production environment, and its performance is monitored during a pilot phase to identify and resolve any potential issues.

The first step in preparing an RFID implementation plan is to define the objectives and expected results, such as the automation of warehouse processes, improved accuracy of inventory data, and real-time tracking of material and product flows. A detailed analysis of the company's business processes should be conducted in order to identify the key points where RFID technology will bring the greatest benefits. On this basis, an implementation schedule is developed, covering the stages of system design, installation, testing, integration with SAP, and user training.

An important element of the plan is budgeting, which includes the costs of purchasing tags, readers, antennas, middleware, and installation and integration services. The budget should also account for additional expenses, such as IT infrastructure modernization or employee training.

The implementation plan must also address potential risks, such as electromagnetic interference in warehouses or integration issues with the existing SAP system. A risk management strategy should be developed, which includes testing devices under real conditions and ensuring technical support at each stage of the project (Gładysz et al., 2014).

The implementation begins with the procurement and delivery of hardware and software. RFID readers and antennas are first installed at strategic locations, such as warehouse entry points, production lines, order-picking zones, and shipping points.

Once the devices are physically installed, the RFID middleware is configured to collect, process, and transmit data to the SAP system. The middleware must be adapted to handle different types of tags and readers, and it should provide functions such as data filtering, error elimination, and report generation.

Next, the middleware is integrated with SAP using standard interfaces such as IDoc, OData, or SOAP. Within SAP, the appropriate modules—such as SAP WM (Warehouse Management) or SAP EWM (Extended Warehouse Management)—must be configured to enable automatic inventory updates and real-time product tracking.

The following stage involves functional and performance testing of the RFID system. The tests include verifying the accuracy of tag readings, the stability of network connections, and the smoothness of data flow between RFID devices and the SAP system. At this stage, issues such as incorrect readings under specific conditions or delays in data processing can be identified and resolved.

After testing is completed, training sessions for employees are conducted. These cover the operation of RFID devices, the use of the new software, and the changes in operational procedures. Training is crucial to ensure a smooth transition to the new system and to minimize errors in daily operations.

The final step is the launch of the RFID system in the production environment. During the first weeks of operation, the system is monitored to identify potential issues and to optimize its configuration. After the pilot phase has been completed, the implementation is considered finalized, and the system is fully integrated into the company's business processes (Gładysz et al., 2014).

3. Summary

The implementation of RFID technology in warehouses and production processes brings a multifaceted improvement in enterprise efficiency. The use of this technology reduces the time required to locate components and tools, which translates into increased operational performance both in warehouse management and internal transport. The automation of information flows eliminates errors resulting from manual data entry, ensuring real-time updates of inventory levels. Precise identification and localization of resources enable the optimization of warehouse space utilization, thereby reducing operating costs associated with maintaining excessive stock levels and minimizing production downtime.

RFID technology enhances the control of material flows by enabling accurate tracking of resources and minimizing the risk of material shortages. Automated identification shortens the execution time of warehouse tasks and increases the level of data security through the use of encryption mechanisms. The integration of RFID systems with ERP-class solutions (e.g., SAP) ensures full automation and coordination of logistics and production processes. As a result, the implementation of RFID reduces warehouse losses caused by storage errors or damages and improves customer service quality through faster and more reliable order fulfillment. The findings indicate that RFID technology constitutes an effective tool supporting logistics and production management and significantly contributes to the competitiveness of enterprises.

Acknowledgements

Silesian University of Technology (Faculty of Material Engineering Department of Production Engineering) supported this work as a part of BK-224/RM1/2025 (11/010/BK_25/0057).

References

1. Abugabah, A., Nizamuddin, N., Abuqabbeh, A. (2020). A review of challenges and barriers implementing RFID technology in the healthcare sector. *Procedia Computer Science*, 170, pp. 1003-1010. DOI: 10.1016/j.procs.2020.03.081
2. Akram, M.A., Mian, A.N. (2022). Security of an RFID based authentication protocol with bitwise operations for supply chain. *Wireless Personal Communications*, 126(2), pp. 1881-1894. DOI: 10.1007/s11277-022-09826-4
3. Albrecht, K., McIntyre, L. (2006). *Spychips: How major corporations and government plan to track your every move with RFID*. New York: Plume.
4. Biedermann, W. (2014). *Technologie identyfikacji w logistyce: RFID i kod kreskowy*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego.
5. Chen, C.-M., Sun, H.-M., Chen, S.-M., Zheng, X., Chen, P.-Y. (2014). A secure RFID authentication protocol adopting error correction code. *The Scientific World Journal*. DOI: 10.1155/2014/704623
6. Chrobak, P. (2010). Opłacalność wdrażania technologii RFID w przedsiębiorstwach. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 88, pp. 45-53.
7. Ciesielski, M., Długosz, J. (Eds.) (2010). *Strategie łańcuchów dostaw*. Warszawa: PWE.
8. Długosz, J. (2009). *Nowoczesne technologie w logistyce*. Warszawa: PWE.
9. Finkenzeller, K., Gebhart, M. (2012). *RFID-Handbuch: Grundlagen und praktische Anwendungen von Transpondern, kontaktlosen Chipkarten und NFC*. München: Hanser.
10. Gao, L., Zhang, L., Ma, M. (2017). Low cost RFID security protocol based on Rabin symmetric encryption algorithm. *Wireless Personal Communications*, 96(2), pp. 683-696. DOI: 10.1007/s11277-017-4196-1
11. Gładysz, B. (2014). Ocena strategiczna efektów wdrożenia RFID. *Logistyka*, 6, pp. 1234-1242.
12. Gładysz, B., Grabia, M., Santarek, K. (2017). *RFID: Od koncepcji do wdrożenia. Polska perspektywa*. Warszawa: PWN.
13. Gołębska, E. (2019). *Logistyka: Teoria i praktyka*. Warszawa: PWE.

14. Gotfryd, S. (2006). *The insider's guide to working with RFID** (1st ed.). New York: McGraw-Hill.
15. Jankowska-Mihułowicz, M., Kłos, A., Grzechca, D. (2016). *Rozwój systemów RFID w przedsiębiorstwach: Wyniki badań metodą delficką*. Rzeszów: Oficyna Wydawnicza Politechniki Rzeszowskiej.
16. Jones, E.C., Chung, C.A. (2017). *RFID and auto-ID in planning and logistics: A practical guide for military UID applications*. Boca Raton, FL: CRC Press.
17. Jones, M., Wyld, D.C., Totten, J. W. (2005). The adoption of RFID technology in the retail supply chain. *The Coastal Business Journal*, 4(1), pp. 4-10.
18. Kiedrowicz, M. (2013). *Wykorzystanie technologii RFID i GPS do lokalizowania zasobów i osób*. Warszawa: Biblioteka Narodowa.
19. Kisperska-Moroń, D., Krzyżaniak, S. (Eds.) (2009). *Logistyka*. Poznań: Biblioteka Logistyka.
20. Konecka, S., Maryniak, A. (2020). RFID as an element of Economy 4.0 used to create sustainable supply chains. *IOP Conference Series: Materials Science and Engineering*, 1001, 012035. DOI: 10.1088/1757-899X/1001/1/012035
21. Liu, G., Zhang, H., Kong, F., Zhang, L. (2018). A novel authentication management RFID protocol based on elliptic curve cryptography. *Wireless Personal Communications*, 101(3), pp. 1445-1455. DOI: 10.1007/s11277-018-5771-9
22. Matulewski, M., Pawlak, Z. (2018). Technologia RFID jako czynnik konkurencyjności w zarządzaniu logistyką służby zdrowia. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, 12, pp. 89-102.
23. Munilla, J., Hassan, A., Burmester, M. (2020). 5G-compliant authentication protocol for RFID. *Electronics*, 9(11), 1951. DOI: 10.3390/electronics9111951
24. Muñoz-Ausecha, C., Ruiz-Rosero, J., Ramírez-González, G.A. (2021). RFID applications and security review. *Computation*, 9(6), 69. DOI: 10.3390/computation9060069
25. Schwartz, G. (2011). *The impulse economy: Understanding mobile shoppers and what makes them buy*. New York: Atria Books.
26. Sharma, M., Moon, S. (2014). The evolution of RFID applications in construction: A review. *Automation in Construction*, 39, pp. 42-56.
27. Weiland, D. (2025). Innowacyjne technologie monitorowania taboru kolejowego – znaczenie RFID w kontekście wyzwań gospodarczych i bezpieczeństwa. *Współczesna Gospodarka*, 19(1/S), pp. 121-136.
28. Wicki, L. (2021). Innowacje w logistyce dystrybucji branży odzieżowej. *Economics and Organization of Logistics*, 4, pp. 45-58.
29. Wójtowicz-Kowalska, M.M., Rebech, J. (2013). Wykorzystanie technologii RFID do zabezpieczenia zbiorów w wolnym dostępie w Bibliotece Uniwersytetu Papieskiego Jana Pawła II w Krakowie. *Digital Fides*, 6(2), pp. 419-428.

30. Zakrzewski, M. (2023). Automatyzacja procesów znakowania i identyfikacji produktów a efektywność logistyczna. *Akademia Zarządzania*, 2, pp. 25-38.
31. Zhang, Y., He, Y. (2011). Application of RFID technology in logistics and supply chain management. *Procedia Environmental*, DOI: 3390/s19132957
32. Zhu, F., Li, P., Xu, H., Wang, R. (2019). A lightweight RFID mutual authentication protocol with PUF. *Sensors*, 19(13), 2957, DOI: 10.3390/s19132957

THE LEVEL OF SOCIAL AWARENESS OF SUSTAINABLE DEVELOPMENT IN THE MANAGEMENT OF IMAGE AND PRODUCT ACTIVITIES

Aleksandra KUZIOR^{1*}, Dariusz KRAWCZYK²

¹ Silesian University of Technology Faculty of Organization and Management; aleksandra.kuzior@polsl.pl,
ORCID: 0000-0001-9764-5320

² Silesian University of Technology Faculty of Organization and Management; dariusz.krawczyk@polsl.pl,
ORCID: 0000-0003-1823-0309

*Correspondence author

Purpose: The aim is to present the legal changes that will be implemented in EU countries to strengthen the position of consumers in the process of ecological transformation. The presentation of the norms, which change the actual state of affairs by protecting purchasers of goods and services against unfair practices and ensuring their right to access reliable information, is confronted with the results of empirical research into social and environmental awareness. It was found that environmental awareness in Poland is systematically increasing, and that the perception of climate protection or the need for rational management of natural resources is translated into specific purchasing decisions. Therefore, the commercial importance of the labelling of goods and services that refer to a nature-friendly value system in economic activities is also increasing.

Design/methodology/approach: An analysis has been carried out of the provisions that, by virtue of Directive (EU) 2024/825 of the European Parliament and of the Council adopted on 28 February 2024, will be introduced into the legal order of the European Union Member States in 2026. An interpretation of the data relating to the area covered by the amended EU law was made. The results of public opinion surveys (EKObarometer 2024) on ecology and sustainable development were also compared with the area of the described legal changes. Transformations in the perception of the surveyed parameters over the last five years are also presented. Considering the suggested implementation solutions in the context of educational and popularisation activities, an analysis of Regulation (EU) 2024/1083 of the European Parliament and of the Council of 11 April 2024 establishing a common framework for media services in the internal market and amending Directive 2010/13/EU is also made.

Findings: The introduction of amended and still under preparation EU legislation strengthening the position of consumers will change the situation in commercial relations in the market for goods and services, the sale of which involves the use of environmental or social certification schemes. The current discretionary labelling and labelling practices expose consumers to unfavourable purchasing decisions, which may result in them purchasing products or services promoted as 'environmentally friendly' at a higher price with no guarantee that they are obtaining a good that actually meets environmental protection requirements. The published Directive introduces new prohibited market practices into the existing list (Annex I of Directive

2005/29/EC). It is worth pointing out that work is under way on a further piece of legislation, namely the Environmental Claims Directive, which will precisely regulate the system of voluntary product certification, setting out the requirements and criteria for eco-labels. The change of law should be accompanied by an information campaign explaining the principles of the introduced transformations and, at the same time, popularising the idea of sustainable development. A suggested medium for conducting communication activities is the media of local government units.

Practical implications: It has been shown that the increasing recognition of sustainability and ecology among consumers is linked to unfair practices of ‘pseudo environmental marketing’. This EU directive targets similar practices. The revision of the law will enable the use of labelling that provides reliable, verified and credible data on the specificity, nature and overall environmental impact of a given product.

Keywords: sustainable development, changes in EU law, greenwashing, social and environmental labels, ecobarometer, local government press in Poland.

Category of the paper: Research.

1. Introduction

In the spring of 2024, the European Union's rules on the communication of products and services related to nature conservation, climate or natural resources were amended. In September 2026, the adopted amendments must be implemented in the legal order of the Member States. The introduction of the regulations will entail significant transformations for both producers and distributors and consumers, whose position is clearly strengthened. One of the most important changes will be to make the pursuit of a communication policy using concepts linked to ecology, sustainability, the circular economy or the carbon footprint - conditional on compliance with specific requirements imposed by certification organisations recognised by the public authorities of the Member States. In practice, this means declaring war on ‘pseudo-environmental marketing’ by introducing a so-called ‘blacklist’ of banned unfair practices. The legislative processes aim to eliminate the current situation where labels, tags or logos indicating the ‘environmentally friendly’ nature of a product or service can be included as part of a promotional campaign. Countering the practice of buying into various types of foundations or associations to certify that a product conforms to buyers' preferred characteristics is of great social importance. In fact, a study conducted in 2022 in the European Union, cited later in this article, shows that as many as 56% of consumers in individual countries encountered misleading claims about the alleged environmental qualities of specific products. At the same time, a survey conducted in Poland in 2024 draws attention to the identical level of consumers declaring that they take into account certificates placed on packaging or used in advertising campaigns for the products on offer when making their purchasing decisions. The process of empowering consumers during the ecological transition involves successive legislative processes in the European Union. Preparations are currently underway for the

adoption of directives on environmental claims, which will set out ways of verifying the reliability of voluntary references to a product's environmental performance. Fundamental changes in the legal state will require intensive consumer education activities.

In the media market, the press of local administration functions in various forms - from traditional printed newspapers, through their e-editions, to web TV, radio stations, mobile applications to official or municipal profiles in social media. It is worth considering pointing out that it is precisely this potential that should be exploited in information and education activities aimed at raising the public's level of environmental awareness.

2. Literature review

Greenwashing has been identified for decades (Pendse, Nerlekar, Darda, 2022, Wolniak, Hąbek, 2015) influencing green marketing strategies (Vangeli et al., 2023). The commercialisation of green products is accompanied by misleading buyers by some companies (de Freitas Netto et al., 2020). The very packaging of the product on offer can make unauthorised references to ecology (Boncinelli et al., 2023). Manipulation-based persuasive communication involves artificial intelligence (Moodaley, Telukdarie, 2023), further masking the real economic goals of companies (Pimonenko et al., 2020).

The growth of greenwashing is paradoxically fostered by elaborate environmental reporting systems (Montgomery, Lyon, Barg, 2024) and pressure to have 'green legitimacy' (Zhang et al., 2023) not only among customers, but also shareholders and investors (Megura, Gunderson, 2022) and wider stakeholders (Santos, Coelho, Marques, 2024). This also applies to communicating the circular economy (Opferkuch et al., 2022). Researchers are looking at methods to counteract the practice (Corsini, Frey, 2024) and investigating consumer perceptions of greenwashing (Rahman, Nguyen-Viet, 2023). Addressees - especially younger age groups - being recipients of manipulated messages lose confidence in 'greenwashing' (Vanessa, Ariestya, 2024) and organisations begin to realise the image damage they are exposing themselves to (Becchetti et al., 2023), as the disclosed practice damages the company's reputation (Janz et al., 2024).

Greenwashing is also seen as an obstacle to the green transformation of the European Union (Kmita, 2024). Set environmental goals can be achieved in line with CSR (Kuzior et al., 2022; Starchenko et al., 2021) and credibly reported, rather than resorting to misrepresentation, understatement and manipulation. Hence, the much-anticipated revision of EU law empowering consumers (Keirsbilck, 2024) was precisely in relation to the ecological transition (Spedicato, 2024). The analysed amendment (Presicce, 2024) will require changes in the communication strategies of economic actors (Viitanen, 2024). According to some, it contains regulations that are too detailed (Reale, 2024), but it is seen as a step towards the implementation of principles

of integrity and honesty (Galán Cubillo, 2024), which confirms the need for a transformation of corporate culture based on environmental awareness (Bochko, Kuzior, Karpil, 2024). The Directive 2024/825 discussed in the article will furthermore soon contribute to the creation of a new legal framework - already under development - for advertising, among other things (Evans, 2024).

3. Research method

This article interprets the conclusions from the measurement of structural changes taking place among a group of consumers participating in the cyclical EKObarmeter survey, conducted by the research institute SW Research. The report of the 6th edition of the survey was published in June 2024. Ecobarometer 2024, is a survey that was conducted from 29 April 2024 to 12 May 2024 by SW RESEARCH Agency for Market and Opinion Research using the online interview method (CAWI) on the SW Panel internet panel. A sample of 1,500 people participated, controlled for gender, age and size of place of residence.

The provisions of Directive 2024/825 amending Directive 2005/29 on unfair business-to-consumer commercial practices and Directive 2011/83 on consumer rights were also analysed in detail.

For the purpose of the article, a review of the communications issued by the European Parliament on 'Climate and Environment' and 'Closed Economy' and 'Consumer Rights' was carried out. With a view to suggested application solutions, the social media coverage in cyberspace available to local government units of all Polish cities with poviat rights was presented.

4. Results

The results obtained from the 'EcoBarometer 2024' project confirm that, in the opinion of respondents, the state of the environment is a major problem. This is the opinion of almost 3 in 4 Poles (72%).

It should be noted that the opposite view is held by 24% of respondents, who consider ecology to be an unimportant and overrated sphere, as the Earth (including climate, air, water, soil, etc.) is doing well regardless of, for example, pollution generated by industry or transport.

In the area of economic marketing, environmentalism in the broadest sense is gaining increasing importance. Nearly 70% of consumers (68%) admit that producers' commitment to nature conservation is significant to them. In turn, 46% of purchasers even declare the transfer

of ideas from this sphere into the world of purchasing decisions, as they say that they try to choose such brands of goods, the manufacturers of which are involved in counteracting negative climate change.

Respect for the environment in the creation of products or the delivery of services was important to 66% of consumers of these goods. In the process of commercially 'valuing' environmental awareness, it is worth noting that only 27% of purchasers stated that they would not be able to pay a little more for a product from a brand committed to improving the environment or implementing sustainable management principles. The value of similar declarations may therefore be relevant to the market strategies of producers or distributors of goods or services (including, for example, 'green energy'). Clearly, customers' pro-environmental attitudes are translated into persuasive communication messages used by manufacturers or sellers. But what is noteworthy is the high level of recognition of 'green advertising', with 53% of consumers declaring contact (in the month before the survey was conducted) with an advertisement that used green slogans. Furthermore, 60% of participants declared a positive attitude towards persuasive messages using references to ecology.

Despite these incentives, environmental issues directly translate into an increase in the price of the products and services offered. However, a higher purchase rate is a barrier in this case for as many as 57% of respondents.

It should be noted that the authors of EKObarometer 2024, distinguished among the respondents, categories characterised by characteristic sets of attitudes, beliefs and shared values related to ecology. They then compared the actual state of affairs with the results achieved during last year's and the previous five editions of the project. It turned out that the enthusiasts of the eco-trend decreased (in 2024, a decrease to 24% from 31% in 2020 and identical in 2023), while the number of critics increased slightly (in 2024, an increase to 16% from 15% in 2020 was recorded, although in 2023, the state was only 10%). Taking into account the differences in the year between the surveys, an increase in the number of critics (+6 percentage points) and at the same time a decrease in the number of enthusiasts (-7 percentage points) is evident.

The authors of the ECObarometer interpret this situation in terms of increased environmental awareness. This can be seen from the aforementioned 'green advertisements'. As many as 39% of the survey participants were inclined to agree that they contribute to positively increasing the identification of environmental problems as a sphere of importance for humanity. Meanwhile, 34% of respondents declared a lack of faith in the sincerity of the intentions of the senders of such persuasive messages, where 'eco' themes are used instrumentally. Such a view is confirmed by subsequent analyses. Well, 68% of consumers supported the view that ecological slogans are used only for promotional purposes, 63% agreed that most brands treat ecology only in terms of image enhancement, and 57% expressed concern about the authenticity of well-known environmental activists present in media messages, positing that they use ecology for self-promotion.

The findings lead directly to issues related to the pathology of environmental communication, i.e. greenwashing content. Greenwashing is the false or misleading wording of various types of claims that purport to assure consumers that a company's products, services or activities are environmentally friendly. The percentage of respondents to the 2024 ECObarometer correctly identifying this term was 35%. This represents an increase from 11% in 2019, through 13% in 2022 and 29% in 2023.

Pseudo green marketing is seen as the practice of creating a false impression about the environmental impact of a product, service or organisation, which can mislead consumers or stakeholders. The European Union has prepared legislation to counteract the practice of companies making unsubstantiated claims that they or their products and services are green. 62% of respondents to the EcoBarometer 2024 expressed a positive attitude towards tightening legal solutions aimed at enforcing fairness, credibility and objectivity in environmental and natural resource protection activities and in the process of communicating such activities.

In this context, it is worth presenting the results of ECObarometer 2024 regarding the perception of environmental and social certificates and labelling on packaging.

More than half of the respondents (56%) declared that their presence is important to consumers (sum of the answers 'very important' - 11% and 'I often pay attention, but they are not always decisive' - 45%). The opposite view was held by 35% of the participants in the research project (as a sum of the answers indicating that the certificates 'are rather unimportant to me: I rarely pay attention to them' - 26% and 'they are completely unimportant to me, I do not pay attention to them at all' - 9%). A separate category was made up of consumers choosing the answer that they never check the contents of labels because they are not sure what the information contained therein means anyway (9%).

The number of people emphasising the importance of social and environmental certificates should also be compared with the actual purchasing decisions surveyed. While the percentage of respondents convinced of the importance of this parameter amounted to 56%, real applications of it were reported by 29% (as a sum of the answers: 'almost all the products I choose have such labels' - 5 per cent and "most of the products I choose have such labels" - 24 per cent).

Meanwhile, according to data published in March 2022 by the European Commission, 56% of consumers across the community said they had encountered misleading claims about the alleged environmental qualities of specific products (Empowering Consumers for the Green Transition, EC, 30 March 2022). As many as 86% of EU consumers also wanted more comprehensive information on the sustainability of products. At the same time, it was found that only 35% of labels referring to sustainability were based on verified data ensuring the reliability of the consumer information provided.

In the material disseminating the results of the study, the European Commission highlighted that there are 230 voluntary ecolabels, 901 food labelling schemes and 100 green energy logos in the Community. The factual situation was characterised by difficulties in determining the reliability of such labels.

However, the increase in environmental awareness has been accompanied by the long-known practice of the unauthorised use of environmental phraseology for commercial purposes. The scale of the process is broadened by the need for operators to prepare ESG sustainability reports. The name refers to the areas of analysis contained in this document and primarily concerns the environmental aspect (Environmental) in terms of waste management, biodiversity, climate protection and greenhouse gas emissions, as well as the broader concern for the maintenance of natural resources and the prevention of environmental pollution. The next part of the ESG report focuses on the social sphere (Social) in terms of respect for labour rights, employment policies that ensure human dignity and fairness, sustainable development of communities in the area where the reported business entities are located. The third element deals with Corporate Governance. The governance component deals with the organisational structure and competencies and responsibilities of individual business units, but also with communication with stakeholders and the transparency of the company's operations, the procedures for implementing ethical principles into the procedures used, the management control systems in place and counteracting negative phenomena (such as corruption). It can be concluded that the ESG report defines the company's position with regard to norms, principles and rules for the implementation of activities in the sphere of sustainable development, facilitating the verification of a given company's impact on society and the environment.

Hence, the concept of greenwashing, although it does not yet have a legal definition, is based on a false or misleading statement that the products, services or activities of a given entity are environmentally friendly. The more an organization is subjected to pressure to be neutral for the environment, and at the same time the announced declarations are devoid of effective evaluation, the greater the threat is precisely greenwashing. It may consist in emphasizing the pro-ecological values of a product while simultaneously concealing the overall environmental balance, which should specify, among other things, the energy consumption necessary for its production and the amount of waste generated in the process and contamination or pollution of water, air and soil. Another method of "environmental fraud" consists in placing unconfirmed labels regarding alleged ecological friendliness, which either confirm untruth or are issued by organizations that do not have the ability to verify such statements or companies that do not have any authority as a credible certifying entity (e.g. marketing agencies). A common feature of greenwashing is a hermetic language based on vocabulary incomprehensible to the mass recipient. Sometimes agreements are also formed by producers declaring environmental friendliness, but among the companies implementing the declared values there are producers who ignore these recommendations and at the same time popularize participation in the "green" agreement in advertising messages.

5. Discussion

The conclusions from the “EKObarometer 2024” study indicate the validity of the legislative path adopted by the European Union when implementing regulations on the environmental friendliness of products and services offered.

The declared goal of updating the regulations was to protect consumer rights, as well as the desire to support environmentally friendly decisions. The ultimate effect of applying these legal acts is to create a circular economy that reuses and recycles raw materials. This is part of a broader strategy of the European Commission, which aims to make Europe the first climate-neutral continent by 2050.

Directive 2005/29/EC classifies unfair commercial practices used by businesses towards consumers, the use of which is prohibited throughout the European Union. In 2019, the provisions were amended by Directive 2019/2161, which also amended EU consumer protection regulations in the field of consumer rights, unfair terms in consumer contracts and price information. Then, in 2024, Directive 2024/825 introduced further rules to combat practices that prevent purchasers from making sustainable consumption choices. This concerns Directive (EU) 2024/825 of the European Parliament and of the Council of 28 February 2024 amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers in ecological transition through better protection against unfair practices and better information. The adopted provisions must be implemented into the legal order of the Member States by 27 March 2026 and will apply from 27 September 2026. The update of the Unfair Commercial Practices Directive includes, among others, a ban on pseudo-ecological marketing and deliberate obsolescence of products. Environmental effects have been introduced to the list of product features about which the entrepreneur cannot mislead consumers.

It has been prohibited (amendment listed as point 2a. of Annex I to Directive 2005/29/EC) to publish a product label regarding its sustainability if it is not part of an official certification system recognized by public authorities. The practice of publishing certificates, trademarks or sustainability symbols on labels "assigned" to themselves by producers or advertising agencies acting on their behalf has been declared illegal. The so-called blacklist of unfair commercial practices prohibited under all circumstances has been extended to include making general, vague claims regarding environmental performance (point 4a). Misleading environmental protection claims without providing documented grounds for high ecological performance are therefore prohibited. This set includes various types of marketing practices referring to the respect for natural resources, i.e. labels such as "climate friendly", "low emission", "energy-saving", "biodegradable", etc. This means that previously popular phrases such as "bio", "eco", "green" or "environmentally friendly" must be linked to demonstrating the high environmental efficiency of a given product or manufacturer. The next point (item 4b.) on the list of prohibited practices is the dissemination of statements referring to the ecological values of a given product

as a whole when they apply only to its part. This also applies to statements about the ecological nature of the entire business activity of the entrepreneur if they refer only to a specific type of this activity. It is also prohibited to refer to a neutral, limited or positive impact of a product on the environment in terms of greenhouse gas emissions (item 4c.) such as "limited carbon footprint", if the indicated property is not based on the actual impact of a specific product throughout its service life.

6. Conclusions

The new law will protect buyers from unreliable or false claims regarding the environmental friendliness of products or services. This will be achieved by prohibiting the use of pseudo-ecological marketing and misleading consumers about the durability of products. The adopted update also provides customers with access to data on the expected "lifespan" of purchased devices and the possibilities of their repair. The implementation will be an important complement to the general provisions on combating unfair competition, counteracting unfair market practices or the Act on Competition and Consumer Protection.

From the results of the cited EKObartometr 2024 study, it can be concluded that consumers in Poland are beginning to identify the phenomenon of "green marketing" more and more clearly, while distancing themselves from persuasive communication directed at buyers and based on references to environmental protection.

Amendments to Community law form a series of regulations creating a framework for the legal protection of consumers and introducing solutions in the field of information policy, the beneficiaries of which are precisely buyers of goods and services.

It is therefore worth considering whether public authorities could be involved in communicating the introduced legal solutions to society and popularizing them. As it results from the presented research results (Ecobarometer, 2024), the topics of nature protection, respect for natural resources and circular economy are a popular topic and are treated by respondents as important. Considering the possibilities of effective information policy regarding the issues raised by public administration, it seems that the right one is not the central level, but the local government. Coordination of activities promoting the idea of "certified ecological" products or services can be carried out, for example, by the Ministry of Climate and Environment, engaging in the preparation and provision of substantive materials to local government units. Effective implementation of communication activities can be proposed to the broadly understood local government press. An alternative in the form of promotional campaigns commissioned to commercial media and financed by central government administration bodies seems to be less effective in terms of communication, and ultimately perhaps much more expensive.

Indicating the potential of local government media, it should be emphasized that the current administrative division of Poland distinguishes 2,477 municipalities. The Act of March 8, 1990 on local government, specifying the tasks of local administration in Article 7, paragraph 1, point 17, lists "supporting and promoting the idea of self-government, including creating conditions for the operation and development of auxiliary units and implementing programs to stimulate civic activity". The project of raising awareness of the local community about the role of the new certification system strengthening the position of the consumer and enriching their communication rights rather exhausts the features of a "program to stimulate civic activity".

The largest Polish urban centres, i.e. 66 cities with county rights, which in 2024 had budget revenues of approx. PLN 120 billion, i.e. at the level of approx. 18% of the state budget revenue, have a developed network of local government media. It seems reasonable to include media belonging to local government units in the popularisation of consumer rights or dissemination of ecological awareness treated as "programs stimulating civic activity", i.e. the commune's own task. The effectiveness of these media is evidenced by the fact that only Facebook profiles administered by these cities achieve average social reach of 34% of the number of users corresponding to the number of residents of these cities.

References

1. *Act of 16 April 1993 on combating unfair competition* (Dz.U. 1993, 47, 211).
2. *Act of 23 August 2007 on counteracting unfair market practices* (Dz.U. 2007, 171, 1206).
3. *Act of February 16, 2007 on competition and consumer protection* (Dz.U. 2007, 50, 331)
4. *Area and population within the territorial scope in 2024*, <https://stat.gov.pl>, 10.11. 2024.
5. Becchetti, L., Cucinelli, D., Ielasi, F., Rossolini, M. (2023). Corporate social irresponsibility: The relationship between ESG misconduct and the cost of equity. *International Review of Financial Analysis*, 89, 102833.
6. Bochko, O., Kuzior, A., Karpil, O. (2024). Трансформація корпоративної культури на задах екологічної свідомості. *Bulletin National University of Water and Environmental Engineering*, 1(105), 40-49.
7. Boncinelli, F., Gerini, F., Piracci, G., Bellia, R., Casini, L. (2023). Effect of executional greenwashing on market share of food products: An empirical study on green-coloured packaging. *Journal of Cleaner Production*, 391, 136258.
8. Budget Act for 2024: 18.01.2024 (Dz.U. 2024, poz. 122).
9. Circular Economy. *Commission proposes new consumer rights and a ban on greenwashing*, 30.03.2022: <https://ec.europa.eu/commission>, 8.11.2024.
10. Corsini, F., Frey, M. (2024). Crowdfunding, Fraudfunding, and Greenwashing. In: *Crowdfunding for Environmental Sustainability and the Circular Economy: Empowered Strategies for Sustainable Growth* (pp. 119-140). Cham: Springer Nature Switzerland.

11. de Freitas Netto, S.V., Sobral, M.F.F., Ribeiro, A.R.B. et al. (2020). Concepts and forms of greenwashing: a systematic review. *Environmental Sciences Europe*, 32, 1-12.
12. *EKObarometr Raport – 6* (2024). Warszawa: SW RESEARCH Agencja Badań Rynku i Opinii, p. 238.
13. *Empowering Consumers for the Green Transition* (30.03.2022). <https://ec.europa.eu/commission2099>, 8.11.2024.
14. Evans, L. (2024). The Green Claims Directive: The Future Legal Framework for Advertising with Environmental. *Zeitschrift für das gesamte Lebensmittelrecht (ZLR)*, 343.
15. Galán Cubillo, J. (2024). *Objetivos de desarrollo sostenible, comunicacion y empresas*. Escuela Técnica Superior de Ingeniería de Caminos, Canales y Puertos Universitat Politècnica de València.
16. Janz, F., Jordanow, S., Heidenreich, S., Schäfer, J. (2024). Shades of green deception—An empirical examination into the consequences of greenwashing of innovations. *Creativity and Innovation Management*.
17. Keirsbilck, B. (2024). Empowering Consumers for the Green Transition: Overview of Directive (EU) 2024/825. *Journal of European Consumer and Market Law*, 13(5).
18. Kmita, J. (2024). Greenwashing jako przeszkoda w zielonej transformacji Unii Europejskiej. *Teoria i Praktyka Dydaktyki Akademickiej*, 3(3), 1-12.
19. Kuzior, A., Postrzednik-Lotko, K.A., Postrzednik, S. (2022). Limiting of carbon dioxide emissions through rational management of pro-ecological activities in the context of CSR assumptions. *Energies*, 15(5), 1825.
20. Megura, M., Gunderson, R. (2022). Better poison is the cure? Critically examining fossil fuel companies, climate change framing, and corporate sustainability reports. *Energy Research & Social Science*, 85, 102388.
21. Montgomery, A.W., Lyon, T.P., Barg, J. (2024). No end in sight? A greenwash review and research agenda. *Organization & Environment*, 37(2), 221-256.
22. Moodaley, W., Telukdarie, A. (2023). Greenwashing, sustainability reporting, and artificial intelligence: A systematic literature review. *Sustainability*, 15(2), 1481.
23. Opferkuch, K., Caeiro, S., Salomone, R., Ramos, T.B. (2022). Circular economy disclosure in corporate sustainability reports: The case of European companies in sustainability rankings. *Sustainable Production and Consumption*, 32, 436-456.
24. Pendse, M.K., Nerlekar, V.S., Darda, P. (2022). A comprehensive look at Greenwashing from 1996 to 2021: a bibliometric analysis. *Journal of Indian Business Research*, 15(1), 157-186.
25. Pimonenko, T., Bilan, Y., Horák, J., Starchenko, L., Gajda, W. (2020). Green brand of companies and greenwashing under sustainable development goals. *Sustainability*, 12(4), 1679.
26. Presicce, L. (2024). El legislador europeo contra el greenwashing derivado de la comunicación comercial y la obsolescencia programada: la nueva Directiva para empoderar

- a los consumidores y favorecer la transición ecológica. *Actualidad Jurídica Ambiental*, 2024, 147.
27. Rahman, S.U., Nguyen-Viet, B. (2023). Towards sustainable development: Coupling green marketing strategies and consumer perceptions in addressing greenwashing. *Business Strategy and the Environment*, 32(4), 2420-2433.
 28. Reale, M.C. (2024). Comunicare l'impegno per l'ambiente: le nuove regole europee contro il greenwashing. *Sociologia del diritto*, 1.
 29. Regulation (EU) 2024/1083 of the European Parliament and of the Council of 11 April 2024 establishing a common framework for media services in the internal market and amending Directive 2010/13/EU (European Media Freedom Act).
 30. Report on public consultations on the assumptions for the media law - information from the Ministry of Culture and National Heritage published on November 6, 2024 on the Website of the Republic of Poland, <https://www.gov.pl>, p. 94, 8.12.2024.
 31. *Results in the elections of commune heads, mayors and city presidents*, <https://samorzad2024.pkw.gov.pl>, 8.12.2024.
 32. Santos, C., Coelho, A., Marques, A. (2024). A systematic literature review on greenwashing and its relationship to stakeholders: state of art and future research agenda. *Management Review Quarterly*, 74(3), 1397-1421.
 33. Spedicato, G. (2024). How the EU's Unfair Commercial Practices Directive Can Support Trademark Law in Combating Corporate Greenwashing. *Orizzonti del Diritto Commerciale*, 60.
 34. Starchenko, L., Lyeonov, S., Vasylieva, T., Pimonenko, T., Lyulyov, O. (2021). Environmental management and green brand for sustainable entrepreneurship. *E3S Web of Conferences*, 234, 00015.
 35. Vanessa, J., Ariestya, A. (2024). Green Advertising Effectiveness: Brand Image and Green Trust Among Generation Y and Z. *Jurnal Komunikasi Indonesia*, 13(2), 5.
 36. Vangeli, A., Małecka, A., Mitreğa, M., Pfajfar, G. (2023). From greenwashing to green B2B marketing: A systematic literature review. *Industrial Marketing Management*, 115, 281-299.
 37. Viitanen, E. (2024). *Viherpesu vastuullisuusviestinnän haasteena: uuden EU-sääntelyn vaikutukset yrityksiin*. Liiketalous, Turun ammattikorkeakoulu.
 38. Wolniak, R., Hąbek, P. (2015). Reporting process of corporate social responsibility and greenwashing. *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM*, 3(5), 483-490.
 39. Zhang, W., Qin, C., Zhang, W. (2023). Top management team characteristics, technological innovation and firm's greenwashing: Evidence from China's heavy-polluting industries. *Technological Forecasting and Social Change*, 191, 122522.

CORPORATE VALUES AND PARADOXICAL APPROACH IN STRATEGIC MANAGEMENT

Janusz M. LICHTARSKI¹, Anna WITEK-CRABB²

¹ Wrocław University of Economics and Business, Faculty of Management; janusz.lichtarski@ue.wroc.pl,
ORCID: 0000-0003-2077-6124

² Wrocław University of Economics and Business, Faculty of Management; anna.witek-crabb@ue.wroc.pl,
ORCID: 0000-0003-2801-5952

* Correspondence author

Purpose: The purpose of the study is to examine relationships between organisational values and the paradoxical approach in strategic management.

Design/methodology/approach: The survey (n = 253), based on the CAWI and CATI techniques, was employed to collect empirical data. Analyses included descriptive statistics and Spearman's correlation coefficient. STATISTICA package was used to perform calculations.

Findings: The study suggests that certain corporate values—such as creativity, coherence, balance/ harmony, safety, orderliness, discipline, efficiency, and flexibility —tend to co-occur with both opposing orientations within some of the seven examined strategic dilemmas. These values are particularly conducive to fostering a paradoxical approach in exploration-exploitation and flexibility-optimisation dilemmas. Furthermore, the analysis shows that the strongest alignment with a paradoxical orientation is associated with values corresponding to the more advanced tiers of Spiral Dynamics theory, namely the yellow (integrative-systemic) and turquoise (global-holistic) levels.

Research limitations/implications: The study contributes to theories of organisational culture and paradoxes. First, the study shows the role of corporate values in coping with organisational tensions and paradoxes. Second, it shows the corporate values as facilitators of managerial choices. The study has some limitations concerning the research sample and the methods used. The research sample is limited to a single country. Self-reported data from the respondents may introduce potential bias.

Practical implications: The findings suggest that cultivating organisational values which simultaneously support opposing strategic orientations fosters a culture of paradoxical thinking, enabling managers and employees to handle contradictory environmental demands more effectively.

Originality/value: These findings contribute to a deeper understanding of the organisational factors that support paradoxical thinking and action, offering an original perspective on dealing with strategic paradoxes.

Keywords: corporate values, spiral dynamics, strategic dilemmas, paradoxical approach.

Category of the paper: Research paper.

1. Introduction

For decades, management literature has explored corporate values in various contexts—as independent, dependent or moderating variables. They are presented as a source of company's innovativeness (Kumar et al., 2024), success (Waterman, Peters, 1982) and as factors shaping employees attitudes and self-development (Barrett, 1998; Lebow, Simon, 1997). According to previous studies, corporate values influence change management processes, help to create flexible and international work environment, and build organisational resilience (Barnett, Karson, 1989; Hofstede, 2011). Moreover, organisational values influence how companies interpret and respond to market dynamics, help to manage image crises (Gillingham, Noizet, 2007), and influence the development of inter-organisational relationships (Van de Ven, Ring 2006; Vincze, 2008). Finally, corporate values are associated with sustainable practices (Mitra, 2024) and constitute the core of the *Corporate DNA* (Kransdorff, 2017).

The growing body of research on organisational values resulted in the development of various concepts and theories integrating values in consistent models, e.g. The Barret Model (Barrett, 1998), Schwartz Value Circle (Schwartz et al., 2012), or Spiral Dynamics (Beck, Cowan, 2014). Values constitute a foundation for more complex managerial approaches, e.g. management by values – MBV (Blanchard, O'Connor 1998; Jaakson, 2010). Among various theories and concepts ranking organisational values, for the purpose of the study we adopted the framework of the Spiral Dynamics developed by Beck and Cowan (2014) on the basis of the Graves' theory (1970).

Simultaneously, dynamic and unpredictable environments (VUCA, BANI) pose challenges for managers faced with strategic choices. This leads to multiple tensions between strategic directions and results in managerial paradoxes, such as: individual vs. collective strategy-making (Bonn, 2005; Goldman et al., 2015), competition vs. cooperation (Chen et al., 2007; Das, Teng, 2000; Iriyama et al., 2016; Raza-Ullah et al., 2014), long-term vs. short-term orientation (Das, Teng, 2000; Pajunen, Fang, 2013), exploration vs. exploitation (Raisch, Birkinshaw, 2008; Bonesso et al., 2014), efficiency vs. flexibility (Adler et al., 1999; Das, Teng, 2000; Smith, Lewis, 2011), planning vs. improvisation (Sundaramurthy, Lewis, 2003; Meyer, 2007), and profits vs. purpose/CSR (Smith et al., 2013; Margolis, Walsh, 2003).

Paradoxes are defined in the strategic management literature as contradictory yet interrelated elements that coexist simultaneously and persist over time (Fortes et al., 2023; Smith, Lewis, 2011), and they have become an immanent part of strategic decision-making in dynamic environments (Karhu, Ritala, 2020; Schad et al., 2016; Smith, Lewis, 2011). Although these tensions and paradoxes are known, there is a shortage of empirical research on their relationships with organisational values. This constitutes an interesting research gap that we decided to address in the presented article.

The purpose of the study is to examine relationships between organisational values and paradoxical approach in strategic management. Our main research question is whether and which corporate values support a paradoxical approach in strategic decision-making. Due to the complexity and reciprocity of relationships between corporate values and paradoxes we decided to focus on coexistence without indicating causality. To achieve the goal, we conducted empirical research using a quantitative approach – a survey with quota sampling ($n = 253$). The CAWI/CATI techniques were used to gather empirical data. Performed analyses include descriptive statistics and Spearman's correlation coefficient.

The paper is organised as follows. In the first section, the literature on organisational values, value models, and strategic paradoxes was reviewed. The second section presents research methods, data collection techniques, and research sample description. In the next section, the results of the study were presented and discussed. Finally, the conclusions, research limitations and directions for further research have been highlighted.

2. Theoretical background

2.1. Paradoxes in strategic management

Paradoxes have long been recognised in management studies, yet the concept remains ambiguous and multifaceted, which limits the advancement of theory and empirical research (Berti, Cunha, 2023; Hahn, Knight, 2021).

In the definitions proposed by Smith and Lewis (2011) and Schad et al. (2016), a paradox is seen as a persistent contradiction between interrelated elements that coexist over time. This emphasis on the simultaneity, interdependence, and durability of opposites differentiates paradoxes from dilemmas, which can be resolved through an “either/or”. When opposing demands are equally important and cannot be traded off, tension arises, and a dilemma becomes a paradox (Smith, Lewis, 2011). Tension is therefore a central feature of paradoxes (Karhu, Ritala, 2020), although some authors treat it as an outcome of paradox rather than its essence (Fortes et al., 2023).

The strategic management area is particularly prone to paradoxical tensions as executives must respond simultaneously to competing demands in increasingly complex and volatile environments (Besharov, Smith, 2014; Hahn, Knight, 2021). Research in this field has identified a range of recurring paradoxes (Table 1), including:

- individual vs. collective strategy-making (Bonn, 2005; Sundaramurthy, Lewis, 2003; Goldman et al., 2015),
- competition vs. cooperation (Bengtsson, Kock, 2000; Das, Teng, 2000; Iriyama et al., 2016; Brandenburger, Nalebuff, 1996; Raza-Ullah et al., 2014),

- long-term vs. short-term orientation (Das, Teng, 2000; Pajunen, Fang, 2013),
- exploration vs. exploitation (Raisch, Birkinshaw, 2008; Bonesso et al., 2014),
- efficiency vs. flexibility (Adler et al., 1999; Das, Teng, 2000; Smith, Lewis, 2011),
- planning vs. improvisation (Sundaramurthy, Lewis, 2003; Meyer, 2007),
- profits vs. purpose/CSR (Smith et al., 2013; Margolis, Walsh, 2003).

Table 1.
Strategic paradoxes

No.	Paradox category	Polarity “a”	Polarity “b”
P1	Participation level in strategy-making	Individual	Collective
P2	Attitude toward competitors	Competition	Cooperation
P3	Planning horizon	Long-term	Short-term
P4	Attitude toward change	Exploration	Exploitation
P5	Attitude toward resources	Efficiency	Flexibility
P6	Flexibility level	Planning	Improvisation
P7	Strategic priority	Profits	Purpose (CSR)

Source: Based on Kaleta et al., op.cit., 2022.

The ability to think and act in paradoxical contexts is shaped by multiple factors operating at the individual and organisational levels. Within the organisational domain, culture — and in particular its underlying values — seems to occupy a central position.

2.2. Organisational values

Literature offers various definitions of values. For example, Rokeach (1973) defines values as enduring beliefs that a specific mode of conduct is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence. For Rohan (2000), on the other hand, values are the result of the process an individual goes through in forming a judgement on how to enable the best possible living. Values are durable and often unconscious beliefs about what is good and what is bad, what is wrong and what is right, and in this sense, they influence the attitudes and behaviours of individuals.

Values are analysed not only at the individual, but also at the organisational level. In the second case, they are defined as corporate or organisational values. They are shared by a group of people and shape company culture (Schein, 1990). They are present in all organisations, regardless of their goals, profile, size, or industry. Corporate values are essential for organisations as they shape commitment and behaviour of employees (Barrett, 1998; Lebow, Simon, 1997), are associated with innovativeness (Kumar et al., 2024), sustainable practices (Mitra, 2024), and provide a foundation for decision-making (Schwartz et al., 2012). They serve as a factor that aligns stakeholders around a common vision and mission. By embedding key corporate values into day-to-day operations, companies can enhance employee engagement, strengthen brand reputation, and improve business efficiency.

The key role of organisational values has been reflected in the concept of managing by values (MBV) proposed by Blanchard and O'Connor (1998) and developed and improved by Dolan and Richley (2006). MBV is not only an interesting theoretical construct, but also a useful tool for managers. It shows how to align business practices with core values and create a purpose-driven and ethically responsible organisation.

Corporate values are mutually interrelated and are often integrated and ranked in various sets, models, and theories, e.g. Corporate Values Index, Schwartz Value Circle, or Spiral Dynamics. For example, Corporate Value Index categorises values into 8 groups: professional, combative, behavioural, societal, relational, fulfilling, moral, and social (Corporate Values Index, 2013). Schwartz's value circle presents a set of 19 universal basic values (Schwartz et al., 2012), and the major theoretical achievement of this theory is the arrangement of the identified values in a circle, which allows for the presentation of their proximity and tensions (Illes, Vogell, 2018). Another concept presenting a set of ordered values linked with different developmental stages is Spiral Dynamics (Beck, Cowan, 2014), depicted in the next section in detail.

2.3. The concept of Spiral Dynamics

In our study, we refer to the Spiral Dynamics framework, an interesting concept based on Graves' existence levels of individuals and societies, that was adopted to organisational context by Beck and Cowan (2014). Spiral Dynamics presents a variety of values and explains the evolution of value systems in a multi-stage spiral framework. Each stage in the model is associated with a particular belief system and a way of perceiving the environment. Values characteristic of each level shape leadership styles, organisational structures, routines, and strategic choices. The levels and values selected for the examination are presented in Table 2.

Table 2.

Spiral Dynamics levels and characteristic corporate values under study

	Level/Stage	Description	Characteristic Values
1	Beige (Survival-Instinctive)	Basic survival focus; driven by instincts, hunger, shelter, and reproduction.	Survival
2	Purple (Tribal-Magical)	Values tradition, rituals, and ancestral wisdom; common in early human societies and tribal or clan cultures.	Safety Tradition
3	Red (Egocentric-Power)	Focuses on dominance, discipline, and strength; often seen in warlords or authoritarian leadership.	Authority Dominance Discipline
4	Blue (Order-Absolute Truth)	Seeks structure, hierarchy, discipline, and moral absolutes; common in religious institutions and traditional bureaucracies.	Orderliness Righteousness Honesty
5	Orange (Achievement-Strategic)	Values innovation, quality, success, and measurable outcomes; seen as the key mode of business in Western societies.	Success Efficiency Quality

Cont. table 2.

6	Green (Community- Relativistic)	Focuses on empathy, egalitarianism, and social justice; critical of excessive materialism and competition.	Trust Cooperation
7	Yellow (Integrative- Systemic)	A flexible and adaptive perspective that recognises the need for different perspectives and solutions.	Creativity Learning Flexibility
8	Turquoise (Global-Holistic)	Advanced level that integrates complexity, harmony, and interconnectedness.	Balance/Harmony Responsibility Coherence

Source: (Beck, Cowan, 2014; Butters, 2015).

The theory of Spiral Dynamics suggests that individuals and organisations progress through the eight levels, from Beige to Turquoise, but not always in a fixed or linear order. Several factors contribute to this variability. First, companies can exhibit multiple levels simultaneously due to their complexity and internal differentiation. Second, organisations may skip certain levels during rapid transformation or regress in response to environmental pressures and long-term crises (Butters, 2015; McDonald, 2010). Spiral Dynamics is used as a framework in management science to analyse cultural change, organisational transformation, and growth potential (Nykyforchyn, 2022). Spiral Dynamics is also recognized as a component of Wilber's Integral Theory (Donkers, 2016), explaining and supporting development of leadership skills. We used this framework cautiously, as a conceptual, not a theory-building inspiration, as we were aware of some controversies and critique around this approach, e.g. referring to insufficient empirical evidence, or elitism and hierarchical bias (Butters, 2015), as well as lack of validated tools for measurement (Merk at al., 2017). However, despite the theoretical shortcomings of this concept, it has been successfully used in the past in heuristic, discussion-building contexts (Van Marrewijk, Werre, 2003; Ferreira, 2023), guiding the analysis of diverse, co-existing value logics.

3. Research Methods

3.1. Research goal and design

The study aims to examine relationships between organisational values and the paradoxical approach in strategic management. Specifically, we look to answer whether and which corporate values support a paradoxical approach in strategic decision-making.

Based on the literature, we identified and examined twenty corporate values and seven strategic paradoxes. Then we looked for correlations, identifying those values that present a statistically significant correlations with the two opposite ends (polarities) in a given dilemma, thus supporting the “both/and” paradoxical mindset. The literature and empirical study were carried out in 2022-2023 as part of the research project *Compass of Strategy*, performed by

a research team from the Department of Strategic Management at Wroclaw University of Economics and Business, of which the Authors are members. The data collection was carried out in cooperation with the market and public opinion research institute *IMAS International*.

3.2. Methods and Techniques

The empirical study was preceded by a literature review on strategic dilemmas and paradoxes, as well as organisational values. In the empirical study, we employed the quantitative approach with a survey as the main research method. We used questions with 7-point Likert scales to measure variables.

We used quota sampling and addressed the questionnaire to company owners and managers responsible for strategy formulation and implementation. Due to the instability of organisational culture, limited organisational complexity, and measurement and variability issues (e.g. risk of domination of individual-level values), we decided to exclude micro companies (up to 9 employees) from the research sample. To collect empirical data, we used both the CAWI and CATI techniques. All incomplete responses were removed from the final procedure. The correlative analyses are based on Spearman's correlation coefficient. Statistical calculations were performed using the StatSoft Inc. STATISTICA.

3.3. Research Sample Description

The research sample comprised $n = 253$ companies operating in Poland, including 188 small (10-50 employees), 65 medium-sized (51-250 employees) and 9 large enterprises (over 250 employees), and was designed to reflect the size distribution of enterprises in the population. The studied companies operated across various sectors, specifically production ($n = 58$), services ($n = 123$), and trade ($n = 42$), with an additional category for mixed-profile activities ($n = 30$). Each company was represented by a senior management representative with a minimum of 5 years of experience in the position and a significant influence on the formulation and implementation of corporate strategy. Table 3 presents selected characteristics of the respondents.

Table 3.

Characteristics of the respondents

Position		Education (profile)		Gender	
Owner/Co-owner	45,8%	Humanities	16,6%	Female	39,5%
President of the Board	19,4%	Technical	33,6%	Male	60,1%
Other Board Member	11,1%	Economy and Finance	43,9%	Prefer not to say	0,4%
CEO/Managing Director	15,8%	Other	5,9%		

Source: authors' own.

Respondents declared to have full (83.8%) and partial (16.2%) autonomy in formulating and implementing strategy of the company, including decision-making and taking actions towards competitors.

4. Results

In our research we aimed to examine the relationships between organisational values and paradoxical approach in strategic decision-making. Specifically, we measured the importance of the twenty corporate values (as listed in Table 2), as well as the organisational preferences within the seven strategic dilemmas (as listed in Table 1). We aimed to check if there are any specific corporate values that are associated with paradoxical approach in strategic management, represented by a similar and high preference for both contradictory polarities of at least two strategic dilemmas. This would indicate a relatively stable paradoxical mindset in which a company chooses simultaneously both contradictory options.

Of the twenty values in total, we chose only those that showed significant correlations with both polarities of at least two strategic paradoxes (Table 4).

Table 4.

Correlations of corporate values with both polarities of at least two strategic dilemmas (paradoxical approach)

Value	SD Level	P1a	P1b	P4a	P4b	P5a	P5b	P6a	P6b
safety	2	-	-	0.428**	0.179*	0.232**	0.187*	-	-
discipline	3	0.216*	0.217*	0.349**	0.195*	-	-	-	-
orderliness	4	0.247**	0.170*	0.394**	0.214*	0.245**	0.179*	-	-
quality	5	-	-	0.410**	0.222**	0.152*	0.152*	-	-
effectiveness	5	-	-	0.333**	0.158*	0.160*	0.167*	0.211**	0.245**
flexibility	7	-	-	0.333**	0.200*	0.184*	0.226**	-	-
creativity	7	-	-	0.309**	0.355**	0.221**	0.301**	-	-
balance	8	-	-	0.386**	0.330**	0.221*	0.191*	-	-
coherence	8	-	-	0.303**	0.299**	0.235*	0.257**	-	-

Table note:

SD: Spiral Dynamics (as described in Table 2)

P1: Participation level in strategy making paradox; P1a: individual, P1b: collective

P4: Attitude toward change paradox; P4a: exploration, P4b: exploitation

P5: Attitude toward resources paradox; P5a: efficiency, P5b: flexibility

P6: Flexibility level paradox; P6a: planning, P6b: Improvisation

* $p < .05$.

** $p < .01$.

“–” indicates that no statistically significant correlation was found.

Source: authors' own.

This way we identified nine values – i.e. safety, discipline, orderliness, quality, effectiveness, flexibility, creativity, balance and coherence, that seem to support a paradoxical approach in strategic decision-making. The first three of these values: safety, discipline and orderliness, represent less advanced levels of the Spiral Dynamics framework, and can be considered conservative, focused on securing the basic functioning of the organisation. The other six, however, refer to more mature levels of value development in the organisation and prioritise achievement and strategy (values: quality, effectiveness), integrity and systems

approach (values: creativity, flexibility) and holistic and global mindset (values: balance, coherence). Values that correlate with the paradoxical approach in strategic decision-making represent most levels of the Spiral Dynamics framework, with the exception of level 1 (survival-instinctive) and level 6 (community-relativistic). However, predominance of more advanced-level values in this group may suggest that companies that function within a more mature value logic (prioritising systemic, holistic and strategic approach) are better prepared to manage the uncertainty of the environment and contradictory challenges in strategy-making.

To further examine this proposition, we created a product term by multiplying the two correlation coefficients for each strategic dilemma to check which values are most associated with the paradoxical approach, understood as simultaneous preference for both polarities. This approach reflects an interaction effect, where the highest values occur when both correlations are simultaneously high. In other words, it refers to situations where neither polarity dominates, consistent with the idea that a paradoxical approach emerges when both options are developed in tandem rather than in isolation. As a result, we identified values particularly important for a paradoxical approach in strategic decision-making, that is, flexibility, balance and coherence. All of them refer to level 7 or 8 in the Spiral Dynamics framework and are aligned with mature values logic.

Out of the seven strategic paradoxes, two turned out to be most sensitive to values. The attitude to change polarities (exploration vs exploitation) and the attitude towards resources polarities (flexibility vs. optimisation) most frequently simultaneously correlated with corporate values (Table 4). These paradoxes are known from literature and empirical studies (Lichtarski et al., 2025) as ones that often require organisational ambidexterity, so the result is consistent with previous studies.

5. Discussion and conclusions

The goal of the study was to examine relationships between organisational values and paradoxical approach. Particularly, we wanted to find out whether and which corporate values support a paradoxical approach in strategic decision-making. The study shows that certain corporate values—such as safety, order, discipline, efficiency, flexibility, creativity, coherence, and balance—tend to co-occur with both opposing orientations within the seven examined dilemmas. These values are particularly conducive to fostering a paradoxical approach. Simultaneously, some values like survival, honesty, quality, responsibility and success do not show any correlations – even with one of the opposing ends within the dilemma.

Furthermore, the analysis shows that the strongest alignment with a paradoxical orientation is associated with values corresponding to the more advanced stages of Spiral Dynamics theory, namely the Yellow and Turquoise levels. Values that show the strongest relationship to paradoxical approach in decision-making are flexibility, balance and coherence.

An interesting finding is the absence of statistically significant relationships for the Green level values, particularly trust and cooperation. Although these values are commonly associated with openness, dialogue and collective problem solving, they were not related to simultaneous support for both poles of the analysed strategic tensions. One possible explanation is that Green-level values facilitate relationships and consensus rather than embracing contradictions. In contrast, paradoxical thinking may require a stronger integrative and systemic perspective, represented by the Yellow and Turquoise levels, where opposing strategic demands are recognised as complementary rather than reconciled through agreement. This interpretation, however, requires further empirical investigation.

Despite the contribution to the paradox literature this study has several limitations. First, the findings rely on self-reported data, which may be affected by individual response bias, subjective perceptions, and social desirability. Moreover, each company was represented by a single key informant. Although all respondents occupied senior managerial positions with substantial responsibility for strategy formulation and implementation, their assessments may not fully reflect organisational values shared across the entire company. Future research could reduce this limitation by collecting data from multiple respondents within each organisation and triangulating managerial perceptions with additional organisational data. Second, the research sample is limited to companies operating in Poland and is dominated by small and medium-sized enterprises. Consequently, the findings should be interpreted with caution when generalising them to other institutional contexts or to larger organisations with more complex structures and governance mechanisms. Finally, the correlational design of the study does not allow causal inferences regarding the relationships between organisational values and the paradoxical approach. Future studies could employ longitudinal or experimental designs to examine the direction and underlying mechanisms of these relationships.

Acknowledgements

The study is as part of the research project *Compass of Strategy*, carried out in 2022-2023 by a research team from the Department of Strategic Management at Wroclaw University of Economics and Business, of which the Authors are the members.

References

1. Adler, P.S., Goldoftas, B., Levine, D.I. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science*, Vol. 10, Iss. 1, pp. 43-68.
2. Barnett, J.H., Karson, M.J. (1989). Managers, values, and executive decisions: An exploration of the role of gender, career stage, organizational level, function, and the importance of ethics, relationships and results in managerial decision-making. *Journal of Business Ethics*, Vol. 8, pp. 747-771.
3. Barrett, R. (1998). *Liberating the Corporate Soul: Building a visionary organization*. New York/London: Routledge.
4. Beck, D.E., Cowan, C.C. (2014). *Spiral dynamics: Mastering values, leadership and change*. John Wiley & Sons.
5. Bengtsson, M., Kock, S. (2000). "Coopetition" in business networks - to cooperate and compete simultaneously. *Industrial Marketing Management*, Vol. 29, No. 5, pp. 411-426.
6. Berti, M., Cunha, M.P.E. (2023). Paradox, dialectics or trade-offs? A double loop model of paradox. *Journal of Management Studies*, Vol. 60, Iss.4, pp. 861-888.
7. Besharov, M.L., Smith, W.K. (2014). Multiple institutional logics in organizations: Explaining their varied nature and implications. *Academy of Management Review*, Vol. 39, Iss. 3, pp. 364-381.
8. Blanchard, K.H., O'Connor, M.J., Ballard, J. (1997). *Managing by values*. Berrett-Koehler Publishers.
9. Bonesso, S., Gerli, F., Scapolan, A. (2014). The individual side of ambidexterity: Do individuals' perceptions match actual behaviors in reconciling the exploration and exploitation trade-off? *European Management Journal*, Vol. 32, Iss. 3, pp. 392-405.
10. Bonn, I. (2005). Improving strategic thinking: a multilevel approach. *Leadership and Organization Development Journal*, Vol. 26, Iss. 5, pp. 336-354. <https://doi.org/10.1108/01437730510607844>
11. Brandenburger, A., Nalebuff, B. (2021). The rules of co-opetition. *Harvard Business Review*, Vol. 99, Iss. 1, pp. 48-57.
12. Butters, A. (2015). A brief history of Spiral Dynamics. *Approaching Religion*, Vol. 5, Iss. 2, pp. 67-78. <https://doi.org/10.30664/ar.67574>
13. Chen, M.J., Su, K.H., Tsai, W. (2007). Competitive tension: The awareness-motivation-capability perspective. *Academy of Management Journal*, Vol. 50, Iss. 1, pp. 101-118.
14. Das, T.K., Teng, B.S. (2000). Instabilities of strategic alliances: An internal tensions perspective. *Organization Science*, Vol. 11, Iss. 1, pp. 77-101.
15. Dolan, S.L., Richley, B.A. (2006). Management by values (MBV): a new philosophy for a new economic order. *Handbook of business strategy*, Vol. 7, Iss. 1, pp. 235-238.

16. Donkers, H. (2016). Integral Dynamics, A new integration of Wilber's integral theory and spiral dynamics. *International Journal of Humanities and Social Science*, Vol. 6, Iss. 9, p. 6.
17. Ferreira, A. (2023). Dilemmas, conflicts, and worldview diversity: Exploring the relevance of Clare Graves's legacy for planning practice and education. *Journal of Planning Education and Research*, 43(2), pp. 195-206. <https://doi.org/10.1177/0739456X20920703>
18. Fortes, M.V.B., Agostini, L., Wegner, D., Nosella, A. (2023). Paradoxes and tensions in interorganisational relationships: A systematic literature review. *Journal of Risk and Financial Management*, Vol. 16, Iss. 1, p. 35.
19. Gillingham, D., Noizet, J. (2007). A response model for the public relations management of critical incidents. *Disaster Prevention and Management: An International Journal*, Vol. 16, Iss. 4, pp. 545-550.
20. Goldman, E.F., Scott, A.R., Follman, J.M. (2015). Organisational practices to develop strategic thinking. *Journal of Strategy and Management*, Vol. 8, Iss. 2, pp. 155-175. <https://doi.org/10.1108/JSMA-01-2015-0003>
21. Graves, C.W. (1970). Levels of existence: An open system theory of values. *Journal of humanistic psychology*, Vol. 10, Iss. 2, pp. 131-155.
22. Hahn, T., Knight, E. (2021). The ontology of organizational paradox: A quantum approach. *Academy of Management Review*, 46(2), pp. 362-384.
23. Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede model in context. *Online readings in psychology and culture*, Vol. 2, Iss. 1.
24. Illes, K., Vogell, C. (2018). Corporate values from a personal perspective. *Social Responsibility Journal*, Vol. 14, Iss. 2, pp. 351-367.
25. Iriyama, A., Kishore, R., Talukdar, D. (2016). Playing dirty or building capability? Corruption and HR training as competitive actions to threats from informal and foreign firm rivals. *Strategic Management Journal*, Vol. 37, Iss. 10, pp. 2152-2173.
26. Jaakson, K. (2010). Management by values: are some values better than others? *Journal of Management Development*, Vol. 29, Iss. 9, pp. 795-806.
27. Kaleta, A., Witek-Crabb, A., Lichtarski, J.M., Ignacy, J., Rojek-Nowosielska, M., Sołoducho-Pelc, L. (2022). Perspektywa paradoksów w zarządzaniu strategicznym. *Przegląd Organizacji*, 2, pp. 11-20.
28. Karhu, P., Ritala, P. (2020). The multiple faces of tension: dualities in decision-making. *Review of Managerial Science*, Vol. 14, Iss. 3, pp. 485-518.
29. Kransdorff, A. (2017). *Corporate DNA: Using organizational memory to improve poor decision-making*. Routledge.
30. Kumar, S., Raj, R., Salem, I., Singh, E.P., Goel, K., Bhatia, R. (2024). The interplay of organisational culture, transformational leadership and organisation innovativeness: Evidence from India. *Asian Business & Management*, Vol. 23, Iss. 2, pp. 180-210.

31. Lebow, R., Simon, W.L. (1997). *Lasting change: the shared values process that makes companies great*. John Wiley & Sons.
32. Lichtarski, J.M., Ignacy, J., Witek-Crabb, A. (2025). Top Management Responses to Paradoxes: Exploring the Context of Strategic Choices for Organisational Sustainability. In: *Strategic Innovation and Sustainability: Rethinking Management in the Future of Business*, Routledge
33. Margolis, J.D., Walsh, J.P. (2003). Misery loves companies: Rethinking social initiatives by business. *Administrative Science Quarterly*, Vol. 48, Iss. 2, pp. 268-305.
34. McDonald, I. (2010). *Introduction to Spiral Dynamics*. <https://spiraldynamicsintegral.nl/wp-content/uploads/2013/09/McDonald-Ian-Introduction-to-Spiral-Dynamics-1007.pdf>, 18.09.2015.
35. Merk, J., Rosinski, M., Konopka, R., Piekarski, J. (2017). The Motivational Value Systems Questionnaire (MVSQ): Psychometric analysis and validation. *Frontiers in Psychology*, 8, Article 1691. <https://doi.org/10.3389/fpsyg.2017.01691>
36. Meyer, R. (2007). *Mapping the mind of the strategist: a quantitative methodology for measuring the strategic beliefs of executives*. ERIM Electronic Series Portal: <http://hdl.handle.net/1765/1>, No. 106.
37. Mitra, S. (2024). Investigating the effect of organisational values on sustainable practices and the moderating role of family influence in Indian SMEs. *IIMB Management Review*, Vol. 36, Iss. 2, pp. 99-112.
38. Nykyforchyn, M. (2022). Technology of spiral dynamics in the context of determining the determinants of strategic development. *Financial and credit activity: problems of theory and practice*, Vol. 3, p. 44.
39. Pajunen, K., Fang, L. (2013). Dialectical tensions and path dependence in international joint venture evolution and termination. *Asia Pacific Journal of Management*, Vol. 30, pp. 577-600.
40. Raisch, S., Birkinshaw, J. (2008). Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of Management*, Vol. 34, Iss. 3, pp. 375-409.
41. Raza-Ullah, T., Bengtsson, M., Kock, S. (2014). The coopetition paradox and tension in coopetition at multiple levels. *Industrial Marketing Management*, Vol. 43, Iss. 2, pp. 189-198.
42. Rohan, M. (2000), A rose by any name? The values construct. *Personality and Social Psychology Review*, Vol. 4, No. 3, pp. 255-277.
43. Rokeach, M. (1973). *The nature of human values*. Free press.
44. Schad, J., Lewis, M.W., Raisch, S., Smith, W.K. (2016). Paradox research in management science: Looking back to move forward. *Academy of management annals*, Vol. 10, Iss. 1, pp. 5-64.

45. Schein, E.H. (1990). Organizational Culture: What it is and How to Change it. In: *Human resource management in international firms: Change, globalization, innovation* (pp. 56-82). London: Palgrave Macmillan UK.
46. Schwartz, S.H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beierlein, C., ..., Konty, M. (2012). Refining the theory of basic individual values. *Journal of personality and social psychology*, Vol. 103, Iss. 4, pp. 663-688.
47. Smith, W.K., Gonin, M., Besharov, M.L. (2013). Managing social-business tensions: A review and research agenda for social enterprise. *Business Ethics Quarterly*, Vol. 23, Iss. 3, pp. 407-442.
48. Smith, W.K., Lewis, M.W. (2011). Toward a theory of paradox: A dynamic equilibrium model of organizing. *Academy of Management Review*, Vol. 36, No. 2, pp. 381-403.
49. Sundaramurthy, C., Lewis, M. (2003). Control and collaboration: Paradoxes of governance. *Academy of Management Review*, Vol. 28, Iss. 3, pp. 397-415.
50. Van de Ven, A.H., Ring, P.S. (2006). Relying on trust in cooperative inter-organizational relationships. In: *Handbook of trust research*. Edward Elgar Publishing.
51. Van Marrewijk, M., Werre, M. (2003). Multiple levels of corporate sustainability. *Journal of Business ethics*, 44(2), pp. 107-119.
52. Vincze, Z. (2004). Foreign-Market Expansion in Newly-Emerging Markets: Finnish Companies in the Visegrád Countries-Results of a Grounded Theory Analysis. *Journal of East-West Business*, Vol. 9, Iss. 3-4, pp. 107-135.
53. Waterman, R.H., Peters, T.J. (1982). *In search of excellence: Lessons from America's best-run companies*. New York: Harper & Row.

THE ROLE OF STRATEGIC ALLIES IN SHAPING AN INNOVATIVE EDUCATIONAL OFFER OF A NON-PUBLIC UNIVERSITY

Jacek LIS

University College of Enterprise and Administration in Lublin; j.lis@wspa.pl, ORCID: 0009-0005-9235-0052

Purpose: The aim of the article is to determine the role played by strategic allies in shaping the innovative educational offer of a non-public university with a practical profile on the example of the University College of Enterprise and Administration in Lublin (WSPA).

Design/methodology/approach: The study employs a mixed-method approach combining three CAWI survey studies conducted among key stakeholder with a desk research analysis of university documentation. Quantitative analysis includes descriptive statistics, Cronbach's alpha for scale reliability, and Spearman correlations for selected variables. The research focuses on evaluating the intensity, depth, and effectiveness of cooperation between the university and its socio-economic environment.

Findings: Strategic allies enhance the practical and innovative character of the educational offer, but their involvement in co-responsibility and visibility to students remains limited.

Research limitations/implications: The study is limited by its case study nature (single institution) and a small sample of deans, which restricts generalizability. Additionally, some data gaps (e.g., internships and continuation of cooperation) reduce the scope of quantitative analysis. Future research should focus on increasing partner involvement in learning outcomes assessment, improving visibility of cooperation for students, and examining transitions from internships to employment.

Practical implications: The findings suggest that universities should deepen partner co-responsibility in curriculum design, strengthen communication of partnerships to students, and expand mechanisms such as internships and joint projects. Enhancing these aspects can improve graduate employability and strengthen the competitive position of the university in the educational market.

Social implications: The study highlights the importance of stronger university–industry cooperation in aligning education with labor market needs, which may improve graduates' employability and contribute to regional socio-economic development. It also supports the role of universities in fulfilling their “third mission” through engagement with society and business.

Originality/value: The paper offers a multi-stakeholder perspective on the role of strategic allies in educational innovation.

Keywords: strategic allies, non-public university, practical profile, socio-economic environment.

Category of the paper: Research paper.

Introduction

Universities in the Republic of Poland, in accordance with the Act of 20 July 2018 “Law on Higher Education and Science”, are divided into public and non-public universities (the Act, 2018) - commonly called private universities. They may be academic universities – conducting programs with an academic profile – if they conduct scientific activity and have a scientific category A+, A or B+ in at least one scientific or artistic discipline, or vocational universities (programs with a practical profile), if they conduct education taking into account the needs of the socio-economic environment and do not conduct scientific activity (the Act, 2018). The practical profile of a university means, in accordance with paragraph 64, section 2, point 1 of the Act, that “studies are conducted in a practical profile, in which more than half of ECTS points are assigned to classes shaping practical skills”. The fact of implementing the study program through classes that shape practical skills, i.e. exercises, workshops, laboratories, project classes, distinguishes this type of university from a university with a general academic profile, where study programs place greater emphasis on classes related to the scientific activity of the university. In this article, the author focuses on a non-public university with a practical profile.

Having the status of a practically educating university implies the possibility of shaping and implementing study programs in close cooperation with the socio-economic environment (Lis, 2025). Within this article, the author focuses on a specific group of strategic allies belonging to the microenvironment, commonly referred to as the socio-economic environment of the university, whose participation in the functioning of the university takes place on the basis of everyday cooperation. This socio-economic environment is the entirety of stakeholders who may be interested in participating in academic life – both directly and indirectly, through various forms of influence such as student internships, study visits, consultations and construction of study programs, conducting classes in higher education, etc.

The necessity of a broad and lasting connection between the university and the academic environment with the sphere of business (entrepreneurship) brings benefits to all parties involved in cooperation. In business, one can test the usefulness of knowledge and ideas, business experiences may result in ideas for new research. For the university – as an institution – the connection with business may be a source of financing, scientific inspiration and prestige (WSPA, 2008). Taking into account close cooperation with the environment, a non-public university with study programs of a practical profile must reconcile in its functioning two logics: academic logic and business logic. Academic logic means the necessity of having high-quality study programs that must meet rigorous evaluation criteria of the Polish Accreditation Commission – having appropriate teaching staff, facilities and technical infrastructure. Business logic means that the university is an enterprise offering a specific type of service that must be sold on the educational services market, competing with other universities (both public

and non-public). In order to gain a client, it must seek a competitive advantage – added value at the intersection of business and academic logic, which will allow it to stand out on the market. This added value is an innovative educational offer, whose character causes it to belong both to the academic world (a study program adopted according to strictly defined procedures, which must meet rigorous criteria and equip the student with a specific set of knowledge, skills and competences) and the business world (it is co-created with the business environment, responds to its needs and determines the attractiveness of the university and allows achieving the university's economic goals).

In this article, the author will determine the role played by strategic allies in shaping an innovative educational offer of a non-public university with a practical profile on the example of the University College of Enterprise and Administration in Lublin – the oldest non-public university in Lublin, founded in 1998, offering 11 fields of study at bachelor's, engineering and master's levels, of which 100% are programs with a practical profile (WSPA, 2026).

Innovative educational offer

Innovative education, according to UNESCO, refers to teaching and learning approaches that incorporate new ideas, technologies and methods to enhance the educational experience (UNESCO, 2026). An innovative educational offer at a higher education institution with a practical profile includes study programs available in the university's offer (at bachelor's, engineering, master's levels, conducted in Polish), which are oriented towards practical development of students' knowledge, skills and competences and which are co-created with the participation of partners from the socio-economic environment of the university in response to needs reported by the labor market (employers, entrepreneurs), who thanks to this approach influence academic programs (Vuoriainen et al., 2024). Co-creation includes creating from scratch the entire study program, module or individual subjects as well as modifying existing programs/modules/subjects by modifying their individual elements and content.

An innovative educational offer uses innovative solutions used in business or administration. In the literature, specific features of an innovative educational offer can be found. They are presented in Table 1.

Table 1.
Features of an innovative educational offer

Feature	Short characteristic
Responds to changing needs of the environment	Reviews programs in terms of future competences; study fields/development paths are related to digitalization, use of artificial intelligence (AI), automation and co-creation of learning outcomes with industries
Is the result of close cooperation with the socio-economic environment	Formalized cooperation with enterprises and institutions, transfer of knowledge and good practices, practical solutions
Takes into account student evaluations regarding processes at the university	Students are treated not only as recipients of educational services but also as a source of evaluation and co-creators of the entrepreneurship/teaching ecosystem at the university
Combines educational and scientific missions	Operates “in the spirit of entrepreneurship” – integrating education and research for innovation
Implements the “third mission”	Through cooperation with the socio-economic environment – society and business and actions such as knowledge transfer/ academic engagement projects for regions and branches are implemented
Is oriented towards student outcomes	Programs are student-centered and oriented towards learning outcomes to fit the offer better to learner’s needs (active methods, project work, effects validation)
Programmatically autonomous	Building unique programs in response to needs of socio-economic environment. Learning effects audits, consistency, quality maintenance systems, eliminating „copying” of general characteristics
Includes students as co-creators of processes	Builds a culture of cooperation and knowledge sharing – process goes both directions (university support <-> student engagement). Implemented through ambitious activities (tutoring/ mentoring), practices, learning with the use of project method, using ICT tools
Uses modern technologies	Responsibly implements AI tools as part of an “innovative university”

Source: Own elaboration basing on: Chernaya et al., 2023; Łochnicka, 2023; Pisarski, 2024; Piotrowska, 2024; Łuźniak-Piecha et al., 2023; Tereshchenko et al., 2024; Mytnik et al., 2024; Bastý et al., 2025; Amiri et al., 2025.

Innovative educational offer includes also the integration of industry projects and mentorship into academic curricula, which is an effective strategy for enhancing student learning and professional readiness (Navneet et al., 2024). Investment in lecturers from industry, who can bring the latest knowledge to the classroom and ensure that curriculum remain up to date is also of a great importance (OECD, 2022). In this context, the close cooperation and exchange between university and socio-economic environment is crucial: lecturers from industry bring specialist, up-to-date knowledge from specific sector which is an competitive advantage for the university as well as students can learn directly from their possible future employers (Grebski et al., 2023).

Research methodology

In this study, a number of logically connected stages were carried out enabling the achievement of the assumed research objective. First, the research problem was formulated: What role do strategic allies play in shaping the innovative educational offer of WSPA in Lublin? Based on it, the research question was formulated: how do the main stakeholders of the

university – deans, students and strategic allies evaluate the innovativeness of the educational offer of a non-public university on the example of WSPA.

The following research hypotheses were formulated:

- H1.** In the opinion of WSPA deans, cooperation with partners supports strengthening the practical and up-to-date character of the educational offer and deeper co-responsibility for the program and learning outcomes.
- H2.** WSPA partners highly evaluate the organizational quality of cooperation, responsiveness, usefulness of study programs and their real participation in co-creating programs and learning outcomes.
- H3.** WSPA students highly evaluate the practical dimension of education and the participation of practitioners, actively participate in activities with partners and know partner institutions well.

To verify the above hypotheses, quantitative methods based on the analysis of survey data with the use of descriptive statistics were applied. A survey study was conducted (CAWI, anonymous in nature) using original questionnaires addressed to three groups of university stakeholders:

- a) deans managing fields of study (11 persons – all WSPA deans) – 32 questions divided into 6 sections. The variables analysed were: fields of study, number of allies and their sectoral structure, items assessed on a Likert scale (1-5) – 5 thematic blocks, categorical/ordinal questions. In the analysis, descriptive statistics were applied (M, SD, median, quartiles, min-max) as well as scale reliability analysis (Cronbach's α). For relationships between variables, Spearman correlations (ρ) were used. Due to the small sample size ($N = 11$), interpretations of significance tests were treated as exploratory; the significance level was assumed at $\alpha = 0.05$.
- b) strategic allies – business institutions, non-governmental organisations, public institutions with which the university has active cooperation agreements – an invitation was sent to 167 entities (all those with whom the university conducts cooperation). 43 responses were obtained, the questionnaire consisted of 27 questions divided into 5 sections. The analysed variables were: types of organisations and areas of activity, duration of cooperation with the university, field/fields of cooperation and forms of cooperation (multiple-choice questions). The key part consisted of items assessed on a 1-5 scale (Likert scale), grouped into four areas. Descriptive analysis was applied (means, standard deviations, medians and distributions of responses) as well as scale reliability analysis (Cronbach's alpha coefficient).

- c) WSPA students – full-time and part-time, studying in all fields (except for the WSPA branch in Wodzisław Śląski) – an invitation was sent to 2174 students, 229 responses were obtained, the questionnaire consisted of 26 questions divided into 5 sections. The analysed variables were: binary and multiple-choice questions concerning participation in activities with partners, 15 items assessed on a five-point Likert scale and an open question about the most valuable activity with a partner. In the quantitative part, descriptive statistics and internal reliability analysis (Cronbach's α) were applied.

The study used survey-based quantitative methods to assess how deans, partners, and students perceive the innovativeness of WSPA's educational offer, with a focus on cooperation with strategic allies. The results were analyzed using descriptive statistics and reliability measures, providing an exploratory verification of the hypotheses regarding the role and evaluation of such cooperation.

Research results

The survey addressed to WSPA Deans was completed by 11 respondents. The overall assessment of cooperation with strategic allies was very high – the arithmetic mean (M) amounted to 4.33, standard deviation SD = 0.68 (scale 1-5) with a clear concentration of responses in the upper range of the scale (61.2% of responses = 5). The structure of strategic allies – cooperation with entities from the business sector and public institutions was most often declared (in both cases 72.7% of fields had at least one ally in a given sector). Cooperation with administration/local government units was declared by 54.5% of deans, while with non-governmental organisations (NGOs) by 45.5%. This is presented in Table 2.

Table 2.

Percentage of fields having at least one ally in a given sector

Sector of allies	n (≥ 1)	%
Business	8	72,7
Administration/ local government units	6	54,5
NGO	5	45,5
Public institutions	8	72,7

Source: own elaboration.

The assessment of cooperation on the Likert scale concerned issues (question blocks 6, 7, 8, 11, 14) of the intensity of cooperation, the depth of co-creation of the programme and teaching, innovation in the educational offer, innovation in teaching, and implementation and socio-economic effects. In total, 242 Likert responses were collected (22 items x 11 fields). The distribution of responses indicates a ceiling effect: 61.2% of responses were a rating of 5, and 20.7% a rating of 4.

For each block, an index was calculated as the average of the items from the block. The reliability of the indices was assessed using Cronbach's α (Table 3 below).

Table 3.

Descriptive statistics of block indices and reliability (Cronbach's α)

Evaluated dimension	k	M (SD)	Me (Q1-Q3)	Min-Max	Cronbach's α
Regularity and embedding of cooperation (6)	5	4,62 (0,40)	4,60 (4,40-5,00)	3,80-5,00	0,61
Co-creation of the programme and co-responsibility (7)	5	3,98 (0,68)	4,00 (3,60-4,30)	2,60-5,00	0,81
Updating the offer and agility of changes (8)	5	4,18 (1,24)	4,80 (3,80-5,00)	1,00-5,00	0,95
Practical dimension of teaching (11)	3	4,58 (0,76)	5,00 (4,50-5,00)	2,67-5,00	0,95
Internships/placements and the feedback loop (14)	4	4,43 (0,90)	4,50 (4,50-5,00)	2,00-5,00	0,94
Overall result (average of 22 items)	22	4,33 (0,68)	4,55 (4,32-4,64)	2,41-4,91	0,95

Source: own elaboration.

The highest averages were obtained in the areas of: regularity and embedding of cooperation (block 6) and the practical dimension of teaching (block 11). The lowest average was obtained by block 7 (co-creation of the programme and co-responsibility). Reliability was high for most blocks ($\alpha \approx 0.81-0.95$), with moderate reliability of block 6 ($\alpha = 0.61$).

WSPA Deans rated highest (Top 3) the linking of cooperation with the development strategy of the field and the university ($M = 4.91$, $SD = 0.3$, 100% for ratings 4-5), continuity and predictability of actions (stability of cooperation) and improving the quality and currency of teaching thanks to cooperation with allies (in both cases $M = 4.73$, $SD = 0.65$, 90.9% for ratings 4-5). The lowest ratings (Bottom 3) concerned co-investing by allies in education (e.g. equipment – $M = 3.36$, $SD = 1.21$, 63.6% for ratings 1-3), participation of allies in the evaluation of learning outcomes ($M = 3.73$, $SD = 0.9$, 36.4% for ratings 1-3) and the real character of changes (significant changes in the content of education/competences acquired by students – $M = 3.82$, $SD = 1.4$, 36.4% for ratings 1-3). This means that cooperation is intensive at the level of contacts, classes and internships, whereas it less often includes co-responsibility for assessment or resource contribution.

Questions 9, 10, 12, 13 were categorical/ordinal in nature and concerned updating the offer, joint projects carried out and the participation of practitioners in the educational process. The results are presented in Table 4 below.

Table 4.

Updating of the offer, joint projects, participation of practitioners

9.1. How many new/modified elements of the offer were implemented in the last academic year (2024/2025) in the field?		
Category	n	%
1-2	5	45,5
3-4	1	9,1
5-6	3	27,3
7 and more	2	18,2

Cont. table 4.

9.2. How many of them were initiated directly by allies?		
Category	n	%
1-2	6	54,5
3-4	4	36,4
7 and more	1	9,1
10.1. How much time on average elapsed from reporting to the need to implementing the change?		
Category	n	%
< 3 months	3	27,3
3-6 months	6	54,5
9-12 months	2	18,2
12.1. How many projects in the academic year are carried out at the request of an ally?		
Category	n	%
0	4	36,4
1-2	4	36,4
3-4	3	27,3
13.1. What percentage of classes in the academic year are taught by practitioners?		
Category	n	%
1-10%	1	9,1
21-30%	2	18,2
31-40%	1	9,1
41% and more	7	63,6

Source: own elaboration.

More than half of deans (54.5%) declared that in the last academic year the number of changes initiated by allies was 1-2. The time of implementation of the change most often fell within the range of 3-6 months (54.5%). In relation to projects carried out at the request of an ally, 36.4% of fields indicated the value 0, and 27.3% – 3-4 projects in the academic year. The participation of practitioners in teaching was high: 63.6% of fields indicated the category 41% and more.

The survey study was supplemented with a desk research analysis of the documentation of the WSPA Centre for Quality of Education in Lublin and the WSPA Career Planning Centre. The intensity of cooperation was described using the following indicators, presented in Table 5 (concerning the academic year 2024/2025)

Table 5.

Indicators used to assess the intensity of WSPA's cooperation in Lublin with the socio-economic environment in the academic year

Area	Name of the indicator	Value of the indicator
Scale and frequency of cooperation	number of active partners	191
	number of joint activities carried out within individual fields (total)	57
Durability and continuity of cooperation	number of years of cooperation carried out	4
Involvement of resources	number of students who participate in cooperation	2174
	number of teaching hours carried out by practitioners from the environment	2137
	number of purchased equipment, software	0

Cont. table 5.

Scope of participation in teaching processes	number of programmes reviewed by partners	11
	number of jointly implemented internship programmes	70
	number of joint fields conducted in cooperation with partners	11
Results of cooperation	number of students carrying out internships with partners during studies	70

Note: Figures base on the stat from 31.12.2025. For the purpose of adopting a uniform calculation method for all fields of study, only members of the Advisory Councils operating within the study programs were taken into account. It was assumed that 1 student completing an internship with a partner = 1 internship program. By joint programs, the author understands fields of study in which the university consults curricula within advisory councils with the participation of socio-economic environment.

Source: Own elaboration.

The depth of cooperation was also subjected to a desk research analysis of WSPA using the following indicators, presented in Table 6 (concerning the academic year 2024/2025).

Table 6.

Indicators used to assess the depth of WSPA's cooperation in Lublin with the socio-economic environment

Area	Name of the indicator	Value of the indicator
Co-creation of study programmes	number of updated study programmes	5
	number of modified/new specialisations launched jointly with partners	11
Co-investing in education	number of equipment purchased for the university by allies	0
	number of studios/laboratories created and (co-)financed by partners	4
Created organisational frameworks of cooperation	number of permanent cooperation structures (e.g. advisory councils, joint internship programmes, dual studies)	11

Source: Own elaboration.

On the basis of the above table, it can be concluded that the cooperation model concentrates more on expert knowledge and co-designing education than on financial support.

The desk research analysis also concerned classes conducted by practitioners from the socio-economic environment in individual fields of study. The results of the analysis are presented in figure 1.

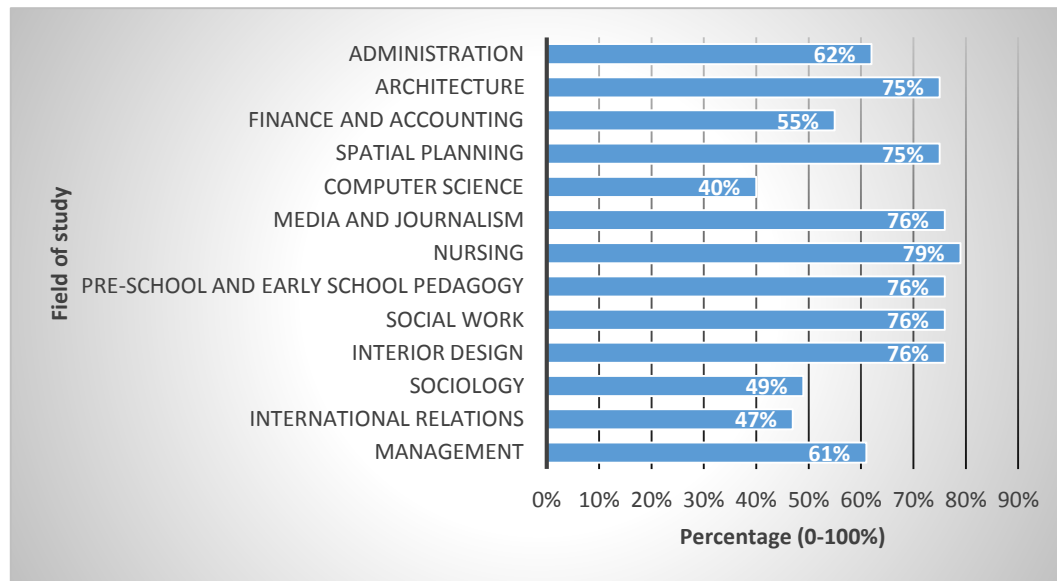


Figure 1. Percentage of classes conducted by business practitioners.

Source: Own elaboration.

The survey addressed to strategic allies – partners from the socio-economic environment was completed by 43 respondents. Business partners dominated in the sample (21 entities, which constitutes 48.8%), followed by NGOs (10 entities, which constitutes 23.3%) and public administration (9 entities, which constitutes 20.9%). Partners from the healthcare sector constituted 4.7% (2 entities), and education 2.3% (1 entity).

With regard to the duration of cooperation with WSPA, the range of 3–5 years was selected most often (58.1%), followed by 0–2 years (16.3%), 6–10 years (14%), above 10 years (9.3%), 1 respondent gave the answer no data (2.3%). The above results mean that most university partnerships are based on long-term cooperation.

Table 7 presents the division of respondents into individual fields of study within which they cooperate with the university (multiple-choice question).

Table 7.

Fields of study within which cooperation is carried out

Field of study	Number of responses obtained	Percentage of respondents
Computer science	10	23,3%
Architecture	9	20,9%
Interior design	8	18,6%
Management	7	16,3%
Administration	7	16,3%
Media and journalism	5	11,6%
Pre-school and Early School Pedagogy	5	11,6%
International Relations	3	7,0%
Finance and Accounting	3	7,0%
Social work	3	7,0%
Nursing	2	4,7%

Source: Own elaboration.

Among the most frequently selected forms of cooperation (multiple-choice question), the highest percentage of responses was obtained for internships and placements (58.1%), carrying out teaching classes (48.8%), organisation of popularisation events (conferences, seminars – 44.2%), and advisory councils (30.2%). Other forms of cooperation obtained one response each (2.3%) – support in workshops, presence at job fairs, promotion of activities for persons with disabilities, implementation of arrangement at a temporary exhibition, congress and fairs, and making software available.

Table 8 below presents the results of four scales built as the average of items in a given area. The highest rating was given to the quality of cooperation and the intention to continue it ($M = 4.40$), the lowest – the influence and involvement of the partner in the educational process ($M = 3.14$). The reliability of the scales measured by Cronbach's coefficient was good to very good ($\alpha = 0.798-0.869$).

Table 8.

Summary of scales in four areas

Scale (area)	M	SD	Me	% ≥ 4	α
Influence and involvement of the partner in the educational process (depth of cooperation – questions 6.1-6.5)	3.14	1.25	2.80	32.6	0.857
Matching the offer to the market and the university's responsiveness (innovativeness of the offer in relation to labour market needs – questions 7.1-7.4)	3.87	0.80	3.75	48.8	0.837
Quality of cooperation and intention to continue (practical education, questions 11.1-11.4)	4.40	0.60	4.50	81.4	0.798
Internships/placements and employment potential (educational effects, students' competences questions 12.1-12.4)	3.92	0.84	4.00	58.1	0.869

Source: Own elaboration.

Analysis at the item level indicates that the highest ratings concerned the quality of cooperation with WSPA staff (question 11.2; $M = 4.65$), willingness to develop cooperation in the following years (question 11.4; $M = 4.49$) and the perceived beneficial nature of the cooperation model (question 11.3; $M = 4.37$). The lowest ratings were recorded in the area of involving partners in the evaluation of educational results (question 6.4; $M = 2.74$) and consultative activity concerning syllabuses and programmes (question 6.2; $M = 3.00$).

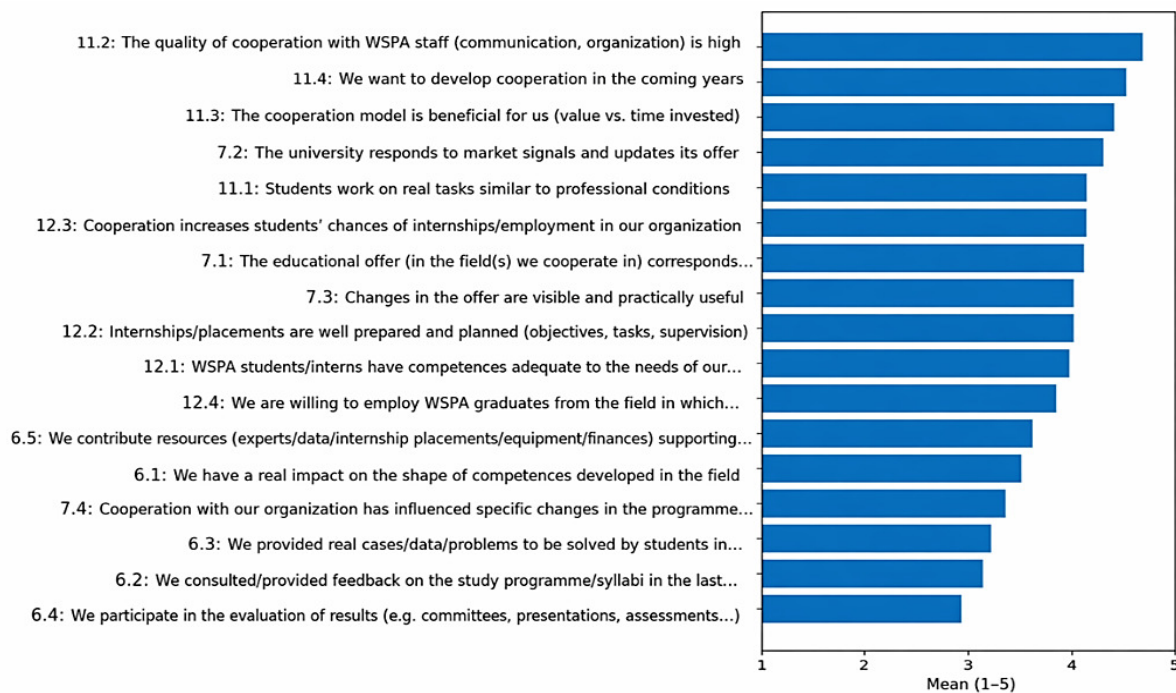


Figure 2. Mean ratings of items (scale 1-5), arranged in ascending order.

Source: Own elaboration.

In the question regarding reporting needs concerning shaping specific competences within the last 12 months, the answer “YES” was marked by 11 partners (25.6%), and “NO” – by 32 partners. Among partners who reported needs ($n = 11$), partial implementation was reported most often (36.4%) or full implementation (27.3%), while 27.3% indicated that implementation is in progress, and 9.1% – that the needs were not implemented. The declared time from reporting to reaction/implementation of the change most often amounted to 3-6 months (45.5%). In the whole sample, more than half of responses indicated “no changes” (55.8%), which can be interpreted as no reports or no implementations in the analysed period.

Comparisons of scale results between the three main types of organisations (Business vs NGO vs Administration; $n = 40$) did not show significant differences (Kruskal-Wallis test; all $p \geq 0.588$). Significant differences were revealed, however, depending on the activity of partners in the area of reporting competence needs (Table 9). Partners who had reported needs in the last 12 months obtained higher results in the area of influence/involvement (section 6 questions) and responsiveness/matching of the offer (section 7 questions). The effect size was large ($r \approx 0.50$ - 0.56).

Table 9.

Comparison of scale results depending on reporting needs

Scale	M (YES)	M (NO)	p	r
Influence/ involvement (6)	4.36	2.72	<0.001	0.56
Responsiveness (7)	4.55	3.64	<0.001	0.503
Cooperation quality (11)	4.66	4.3	0.177	0.204
Internships/ placements (12)	4.16	3.84	0.312	0.155

Source: Own elaboration.

In the case of partners conducting internships/placements, higher ratings were noted in the area of internships/placements and employment potential (section 12; $p = 0.012$; $r = 0.38$) as well as a higher declared willingness to employ graduates (item 12.4; $M = 4.12$ vs 3.28 ; $p = 0.021$; $r = 0.34$). Table 10 compares scale of results depending on conducting internships/placements, and Table 11 presents willingness to employ graduates and conducting internships/placements.

Table 10.

Comparison of scale results depending on conducting internships/placements

Scale	M (internships YES)	M (internships NO)	p	r
Influence/ involvement (6)	3.35	2.86	0.226	0.186
Responsiveness (7)	3.98	3.72	0.392	0.131
Cooperation quality (11)	4.45	4.32	0.522	0.098
Internships/ placements (12)	4.21	3.53	0.012	0.381

Source: own elaboration.

Table 11.

Willingness to employ graduates (12.4) and conducting internships/placements

Variable	M (internships YES)	M (internships NO)	p	r
Willingness to employ (12.4)	4.12	3.28	0.021	0.340

Source: Own elaboration.

The survey addressed to WSPA Students was completed by 229 respondents (out of 2174 WSPA students, which constitutes 10.53% of the total number of students). The characteristics of the research sample were presented in Table 12 below.

Table 12.

Characteristics of the research sample – survey addressed to WSPA students

Indicator	Result
Full-time studies	123 (53.7%)
Part-time studies	101 (44.1%)
Year I	90 (39.3%)
Year II	87 (38.0%)
Year III	35 (15.3%)
Years IV-V	12 (5.2%)

Source: Own elaboration.

Figure 3 presents the distribution of respondents by fields of study.

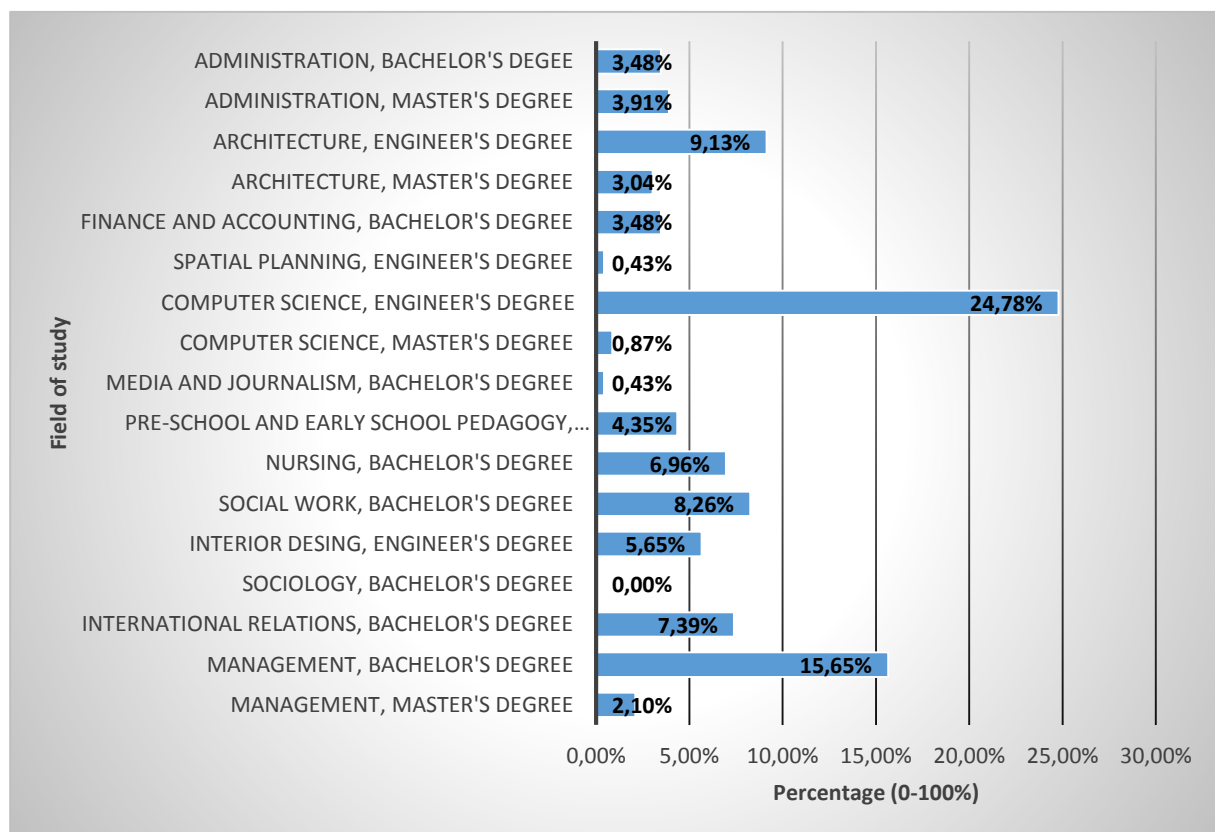


Figure 3. Respondents by fields of study.

Source: Own elaboration.

The key indicators of participation and exposure to partners are as follows: only 33.2% of respondents ($n = 76$) declared participation in activities with university partners. The implementation of projects or case studies based on real problems of partner organisations was rare (10.5%, $n = 24$), and an additional 27.9% ($n = 64$) of respondents were not able to determine unequivocally whether they had such experience. 8.3% of the respondents completed internships with a WSPA partner ($n = 19$), while work in an industry consistent with the field was declared by 29.7% ($n = 68$). A very large number of respondents (65.10%, $n = 149$) were not able to indicate the name of any WSPA partner.

The assessment of Likert scale items indicates a clear asymmetry between the general assessment of the practicality of education and the direct visibility of university partners. Students rated highly: the number of practical classes ($M = 4.09$), the usefulness of classes in relation to solving real problems ($M = 3.84$), the feedback received during classes, which allows the improvement of professional competences ($M = 3.84$), conducting classes by practitioners in a way useful for future work ($M = 3.83$) and the currency and compliance of content with the market situation ($M = 3.79$). At the same time, they rated poorly the amount of classes that are carried out jointly with the participation of university partners ($M = 2.61$), real contact with partners during classes ($M = 2.33$). The weakest result was knowledge of specific partners cooperating with a given field ($M = 2.26$).

All 4 analysed areas (exposure to cooperation with allies, currency and market orientation of the programme, practical dimension of education, preparation for work thanks to partnerships) achieved good or very good internal reliability (α from 0.840 to 0.923). The highest average result was obtained by the scale of the practical dimension of education ($M = 3.90$), while the lowest – by the scale of exposure to partners ($M = 2.40$). In practice, this means that students assess the usefulness of classes and the practical teaching style relatively highly, but this does not automatically translate into a sense of frequent and recognisable contact with external partners. Students declaring participation in activities with partners rated significantly higher exposure to partners ($M = 3.24$ vs 1.98), the currency and market orientation of the programme, and preparation for work thanks to partnerships. Differences in the overall practical dimension of education did not reach statistical significance, which suggests that the practical character of classes may also be present outside formally noticed cooperation with partners.

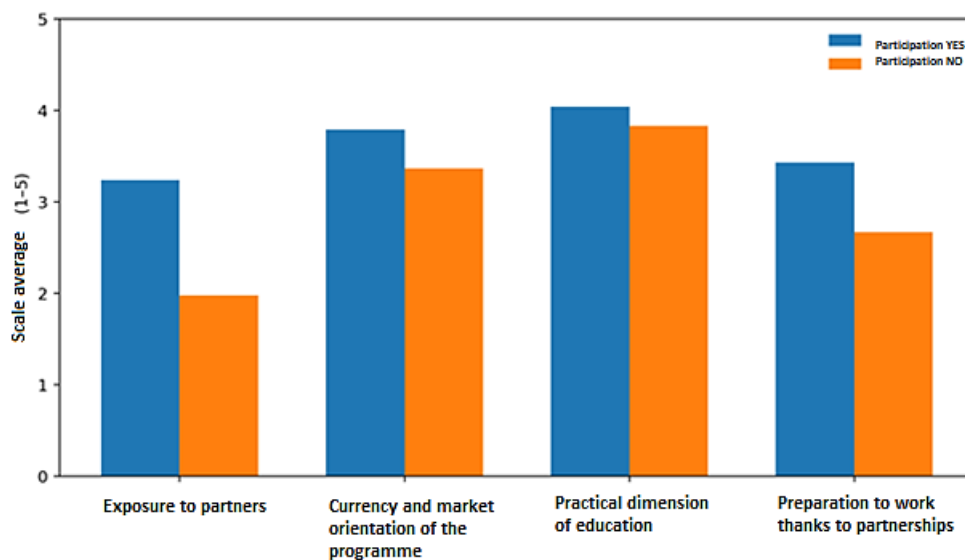


Figure 4. Differences between students participating and not participating in activities with partners.

Source: Own elaboration.

As many as 149 persons (65.1%) were not able to indicate any partner, while only 41 persons (17.9%) gave at least three partners. Self-assessment of knowledge about partners was moderately strongly linked to the actual ability to name them. In practice, this means that the problem of awareness of partnerships is not exclusively declarative – it is reflected in the actual difficulty of recognising cooperating institutions. Among the most frequently spontaneously mentioned partners were Sii, Lingaro, Homo Faber, Capgemini and the Lublin City Office. The distribution of responses was, however, dispersed, and the frequencies low, which suggests the lack of one strongly communicated ecosystem of partners at the level of the whole university.

The analysis of the block of questions concerning implementation effects (internships, placements, preparation for entering the labour market) indicated that perceived preparation for work was most strongly determined by two factors: the currency and market orientation of the programme and exposure to partners. After taking them into account, the declared participation in activities with partners itself ceased to be statistically significant. This is an important interpretative conclusion: the effectiveness of partnerships is determined not so much by the mere fact of participation, but by the degree to which these experiences are integrated with the programme and perceived as market-useful.

Discussion and conclusions

The results of the study conducted among WSPA deans partially confirm hypothesis H1 – they indicate a high, declarative quality of cooperation of fields with strategic allies. Particularly strong are the relational and strategic aspects (regularity, stability, linkage with strategy) as well as the practical component of teaching (participation of practitioners, use of data and problems of partners). At the same time, areas requiring deeper partnership (co-investing and participation in the evaluation of learning outcomes) remain relatively the weakest and may constitute a development priority. The results suggest that expanding the network of allies and increasing their role as a source of impulses for change may support a higher assessment of programme updating and the practicality of education.

The results of the study conducted among partners partially confirm hypothesis H2 – they indicate a very positive picture of the university's relations with partners in the organisational and communication dimension: the majority of respondents highly assess the quality of cooperation with staff, the usefulness of the cooperation model and declare willingness to develop it. At the same time, the area concerning the real influence of partners on the educational process was assessed moderately, and particularly low ratings were given to participation in the evaluation of results and consultative activity concerning syllabi and programmes.

Comparative results suggest that deeper forms of engagement – especially the implementation of teaching classes – are associated with a significantly higher perception of partners' influence and the responsiveness of the university. A similar pattern applies to partners reporting competence needs: in this group, the ratings of influence/involvement and responsiveness are clearly higher. This may reflect both greater activity of this group and better functioning cooperation channels (or greater awareness of these channels).

In the part concerning internships/placements, attention is drawn to the large percentage of responses indicating no admissions in the last 12 months. At the same time, partners conducting internships/placements rate the area of employment potential higher and more often declare

willingness to employ graduates. This indicates the importance of internships as a mechanism for building pathways for students' transition to the labour market.

The results of the study conducted among students partially confirm hypothesis H3. On the one hand, students highly assess the practical character of classes and the usefulness of working with practitioners, which indicates that the university builds a teaching environment perceived as relatively close to professional realities. On the other hand, the formal and conscious presence of partners in students' experience remains limited: partners are poorly recognisable, rarely spontaneously mentioned, and participation in organised activities is declared only by a minority of the sample.

Such an arrangement of results suggests that the practicality of education may be achieved through the style of conducting classes and orientation towards application, even if students do not interpret this as systemic cooperation with external partners. For the university, this means the need to better "make partnerships visible" – through clear maps of partners at the level of the field, signing and communicating projects carried out with organisations, more frequent case studies with clearly indicated origin, and better feedback on the effects of cooperation.

Limitations: a small sample of deans, the study had the character of a case study of one non-public university with a practical profile (WSPA in Lublin) and should not be automatically generalised to the entire sector. In the study of partners and students, some responses were descriptive or indicated a lack of data, which limited the possibility of full quantification of some effects, especially in the area of internships and continuation of cooperation after placements. From the perspective of further research, it seems justified to deepen research: on the visibility of partnerships in students' experience, on the participation of partners in the evaluation of learning outcomes, and on the transition of students from internships to employment.

References

1. *Advancing the entrepreneurial university. Lessons learned from 13 HEInnovate country reviews.* Retrieved from: https://www.oecd.org/en/publications/advancing-the-entrepreneurial-university_d0ef651f-en.html, 23.04.2026.
2. Amiri, S.M.H., Islam, M.M., Kabir, S.H., Mamun, M.S.A., Akter, N. (2025). Innovative Approaches to Education Policy: Lessons from Global Practices. *Addaiyan Journal of Arts, Humanities and Social Sciences*, 7(3).
3. Bastý, R., Kropczyński, J., Halse, S., (2025). Empowering faculty in creative and cultural disciplines: AI literacy and image generator in higher education. *Journal of Information Technology Education: Innovations in Practice*, 24.

4. Chernaya, I.P., Masyuk, N.N., Prosalova, V.S., Bodunkova, A.G., Bushueva, M.A. (2023). University 4.0 concept: educational and scientific policies, innovative development of vocational education and training. *Front. Educ.*, 8, 1125361.
5. Grebski, W., Grebski, M.E. (2023), Profesor dla studenta czy student dla profesora??? *Biblioteka Nauki*, vol. 12, iss. 1.
6. Lis, J. (2025). The „MATCH” project – cooperation between universities, local government and business for the development of entrepreneurship and creativity in Lublin – part one (overview of co-operation). *Zarządzanie Innowacyjne w Gospodarce i Biznesie, Czasopismo naukowe o problemach współczesnego zarządzania, nr 1(40)*.
7. Łochnicka, D. (2023). *Przedsiębiorczość akademicka – istota, znaczenie, uwarunkowania rozwoju*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
8. Łuźniak-Piecha, M., Golińska, A., Żukowska, K., Brdulak, J., Rogiński, M., Nieznańska-Cwynar, A. (2023). Studenci jako współtwórcy procesu edukacji - ocena wpływu wybranych czynników na kształtowanie kultury dzielenia się wiedzą na uczelniach wyższych. *e-mentor*, 1(98).
9. Matejun, M., Nowicki, M. (2013). Organizacja w otoczeniu - od analizy otoczenia do dynamicznej lokalizacji. In: A. Adamik (Ed.), *Nauka o organizacji. Ujęcie dynamiczne*. Warszawa: Oficyna a Wolters Kluwer business.
10. Mytnik, J., Wikel, B., Kaczmarek, M. (2024). A learning community model: the Center for Innovative Education supporting academic didactics at Gdańsk University of Technology, Poland. *Global Journal of Engineering Education*, 26(2).
11. Navneet, K.P., Rudra, P.S. (2024). Enhancing academic outcomes through industry collaboration: our experience with integrating real-world projects into engineering courses. *Discover Education*, 3, 217.
12. Pastuszak, Z., Selwa, A. (Eds.) (2008). *Wyższa Szkoła Przedsiębiorczości i Administracji w Lublinie, 10 lat, 1998-2008*. Lublin, p. 12.
13. Piotrowska, D. (2024). *Efekty uczenia się – sukces czy porażka?* Retrieved from: <https://miesiecznik.forumakademickie.pl/czasopisma/fa-12-2024/efekty-uczenia-sie-sukces-czy-porazka%E2%80%A9/>, 16.02.2026.
14. Pisarski, L. (2024). Przedsiębiorczy uniwersytet publiczny. Spojrzenie z perspektywy regulacji prawnych. *Annales Universitatis Mariae Curie-Skłodowska Lublin, Polonia, Vol. LXXI, 1, Sectio G*.
15. Tereshchenko, E., Salmela, E., Melkko, E., King Phang, S., Happonen, A. (2024). Emerging best strategies and capabilities for university–industry cooperation: opportunities for MSMEs and universities to improve collaboration. A literature review 2000-2023. *Journal of Innovation and Entrepreneurship*, 13, 28.
16. UNESCO. Retrieved from <https://www.unesco.org/en/query-list/i/innovative-education#term-definition>, 23.04.2026.

17. Ustawa z dnia 20 lipca 2018 r. Prawo o szkolnictwie wyższym i nauce, Dz.U. 2018, poz. 1668, p. 7.
18. Vuoriainen, A., Rikala, P., Heilala, V., Lehesvuori, S., Oz, S., Kettunen, L., Hamalainen, R. (2025). The six C's of successful higher education-industry collaboration in engineering education: a systematic literature review. *European Journal of Engineering Education*, 50, 1, 26-50.

INTEGRATION OF INFORMATION RESOURCES IN INTERORGANIZATIONAL COLLABORATION STRATEGIES

Sylvia ŁĘGOWIK-ŚWIĄCIK

Czestochowa University of Technology, Department of Finance, Banking and Accounting;
s.legowik-swiacik@pcz.pl, ORCID: 0000-0002-3963-9499

Purpose: The aim of the article is to explain the significance of information resources in the context of the collaboration strategies pursued by enterprises operating within an interorganizational network. The study seeks to identify the benefits derived from information resources within the value structure generated through interorganizational cooperation and to determine whether the assessment of these benefits varies depending on the enterprise's business profile, size, and level of engagement in the network.

Design/methodology/approach: The article adopts a quantitative approach grounded in the relational and strategic perspective of interorganizational networks. The empirical study, conducted among 401 enterprises, applied descriptive statistics, the chi-square (χ^2) test with Yule's ϕ coefficient, and the Mann-Whitney U test.

Findings: The research findings indicate that improved access to information was the highest-rated benefit of interorganizational cooperation among all the analyzed variables. This suggests that information is perceived by enterprises as the most important resource generated through collaboration with market partners. The results demonstrate that the informational dimension of cooperation constitutes a key mechanism strengthening market position, integrating relational value, and enhancing the enterprise's capacity for development.

Research limitations/implications: The cross-sectional design and reliance on subjective assessments limit causal inference and the observation of changes over time; therefore, future research should incorporate longitudinal, sectoral, and qualitative analyses.

Practical implications: The findings indicate that interorganizational relationships constitute an important source of strategic information resources, with informational benefits increasing through partner integration and stronger network engagement.

Social implications: Effective collaboration based on information exchange may foster the creation of a more stable, integrated, and adaptive business environment, as well as enable enterprises to better align their activities with market needs.

Originality/value: The article highlights the informational dimension of collaboration strategy as a key source of value in interorganizational networks, showing that access to information resources is the most significant perceived benefit of network cooperation and strengthens with greater partner integration.

Keywords: interorganizational networks; collaboration strategy; information exchange.

Category of the paper: Research article.

1. Introduction

Contemporary enterprises operate under conditions of increasing environmental complexity, intensifying market volatility, and the progressive specialization of resources and competencies. Under such circumstances, an organization's ability to independently acquire, process, and utilize information resources is increasingly proving insufficient. Consequently, particular importance is attached to collaboration strategies implemented within interorganizational networks, where value is created not only through access to material resources, but also through the flows of information, knowledge, and experience among partners (Dyer, Nobeoka, 2000). Classical approaches to organizational networks viewed the network as a form of coordination situated between market and hierarchy, characterized by the creation of durable patterns of exchange, including information exchange (Dhanaraj, Parkhe, 2006). This perspective was further developed by the relational view concept, according to which competitive advantage may arise from interorganizational knowledge-sharing routines, resource complementarities, and the joint learning of partners, rather than solely from assets controlled by a single enterprise (Lavie, 2006). Consequently, the informational dimension of collaboration should be perceived not as a by-product of relationships, but as one of the key mechanisms of value creation (McHugh, 2013).

Despite the growing interest in interorganizational relationships, a research gap remains evident. Existing studies have relatively often focused on general sources of relational advantage, mechanisms of knowledge sharing within specific configurations-particularly in supply chains and innovation networks-or on the broadly understood effects of cooperation (Li, Sikora, Shaw, Tan, 2006; Cheng, 2011). Considerably less attention has been devoted to information resources as a key component of value created and integrated within interorganizational networks (Mentzas et al., 2006), and even less to their relationship with such characteristics as the enterprise's business profile, size, and actual level of engagement in network relationships (Dhanaraj, Parkhe, 2006).

In response to the identified research gap, the following research question was formulated: do interconnections and relationships with market partners, developed within the framework of a collaboration strategy in an interorganizational network, enable enterprises to gain better access to information, and if so, does the assessment of this benefit depend on the enterprise's business profile, size, and level of network engagement? This question leads to the main objective of the article, which is to explain the significance of information resources in the context of collaboration strategies pursued by enterprises operating within interorganizational networks and to determine whether the perception of this value varies according to selected enterprise characteristics and the level of engagement in relationships with partners. The adopted approach is strategic-relational in nature and is based on the assumption that information resources constitute not only an outcome of cooperation, but also a prerequisite for

generating further value-creating effects, such as improved market recognition, increased flexibility, better alignment with customer needs, and the strengthening of an enterprise's competitive position (Li et al., 2006; Zakrzewska-Bielawska et al., 2023).

The theoretical scope of the article encompasses four interrelated areas: interorganizational network theory, the relational view approach, issues related to the integration and exchange of information and knowledge between organizations, and the stream of research on firms' relational capabilities. The substantive scope focuses on the informational dimension of collaboration strategy, understood as an enterprise's ability to acquire, utilize, and strengthen access to information through relationships with market partners. Empirically, the article refers to enterprises operating within interorganizational networks and examines the significance of this benefit in the context of variations in assessments depending on organizational characteristics and the level of relational engagement. This perspective makes it possible not only to deepen the understanding of value creation mechanisms within networks, but also to clarify the role of information in the structure of strategic outcomes generated through interorganizational cooperation.

2. Collaboration Strategy of Enterprises within an Interorganizational Network in the Context of Information Resource Flows

Contemporary enterprises are increasingly less likely to build their competitive position solely on the basis of resources confined within their internal organizational boundaries. Under conditions of growing environmental complexity, market turbulence, and progressive specialization, particular importance is attached to the ability to operate within relational arrangements in which value is created not only by the organization itself, but also by the quality and intensity of its connections with other entities. In this context, the information resources of enterprises operating within interorganizational networks should be regarded as one of the key components of strategic effectiveness, as they determine both the accuracy of recognizing environmental changes and the ability to coordinate activities with market partners (Lavie, 2006; Dhanaraj, Parkhe, 2006).

This significance stems primarily from the fact that an interorganizational network is not merely a structure of formal connections, but rather a space for the flow of resources such as information, knowledge, experience, and market relationships (Dhanaraj, Parkhe, 2006). Relationships established between enterprises enable access to information resources that, under conditions of independent operation, would be difficult to obtain, costly, or available too late to be effectively utilized in the decision-making process. From this perspective, information within an interorganizational network performs the function of a strategic resource that determines the ability to identify market opportunities, develop innovation, and build

organizational adaptability (Cheng, 2011). Research on interorganizational cooperation indicates that it is precisely through network relationships that enterprises gain access to dispersed knowledge and information, which become the foundation for learning, innovation, and increased adaptability (Chen et al., 2014).

At the same time, the literature increasingly emphasizes the relational and competence-based nature of the ability to utilize information within network arrangements (Dhanaraj, Parkhe, 2006). Mere participation in interorganizational relationships is insufficient. What becomes crucial is whether an enterprise is capable of developing and leveraging relationships in a manner that supports knowledge mobilization, information flows, and the coordination of activities with partners. In innovation networks, particular importance is attached to orchestrating innovation networks, the core of which lies precisely in managing knowledge mobility (Czakoń, 2010). The transformation of contacts with partners into tangible developmental and market outcomes requires relational capability, which emerged from the development of the networking capability concept, understood as a complex organizational ability to initiate, develop, and exploit business relationships (Mitrega et al., 2012; Mitrega et al., 2017). This stream of research is reflected in studies identifying communication, information exchange, transparency, and trust as key attributes of interorganizational relationships (Klimas et al., 2023). From this perspective, the construct underlying strategy and determining the manner in which relationships with partners are built and utilized is relational orientation (Zakrzewska-Bielawska, Czakoń, Kraus, 2023), which implies that information resources within collaboration strategies possess both a relational and a strategic character, as they depend on the quality of interorganizational ties and on the enterprise's orientation toward value creation through relationships.

The literature also emphasizes that information resources directly influence the level of integration and coordination of activities within interorganizational arrangements (Cheng, 2011). The higher the quality of information exchange, the greater the partners' ability to synchronize and integrate processes, respond more rapidly to disruptions, and reduce costs resulting from erroneous decisions and information asymmetry (Li, Sikora, Shaw, Tan, 2006). This is particularly evident in supplier relationships, strategic alliances, and innovation networks, where efficient information flows determine not only operational effectiveness, but also the capacity to jointly generate new solutions. From this perspective, trust constitutes one of the fundamental conditions for effective information sharing between organizations, as it increases partners' willingness to disclose and utilize information resources (Li et al., 2006).

Interorganizational cooperation fosters not only access to resources such as information, but also the creation of relational value, which emerges through the complementarity of competencies, partnerships, and the ability to jointly utilize organizational potential. Consequently, value creation and appropriation in enterprises are increasingly associated with the development of partnerships, access to complementary resources, and the use of

technological solutions supporting interorganizational collaboration, thereby strengthening the strategic importance of relationships in enterprise development processes (Dyduch, Cyfert, Zastempowski, 2024). At the same time, information resources acquired through the use of business analytics in the context of Industry 4.0 enhance process visibility, improve decision quality, and increase organizational resilience (Wolniak, 2024), confirming that information resources constitute one of the key mechanisms of integration, coordination, and adaptation within interorganizational arrangements. These conclusions reinforce the view that the informational dimension of cooperation is not only relational, but also competence-based in nature, as it requires specific organizational and managerial capabilities from enterprises.

Research on interorganizational networks emphasizes that relationships with market partners contribute both to a better understanding of customer needs and to improved access to information, which in turn strengthens enterprises' market position and enhances their ability to respond to environmental demands (Łęgowik-Świącik, Kostrzewska, 2024). From this perspective, interorganizational relationships may play an important role in building enterprise resilience and achieving economies of scale, thereby indirectly confirming the strategic significance of information resources generated through cooperation (Łęgowik-Świącik, 2025). This means that information is not merely an element supporting operational activity, but becomes the binding force of network relationships and one of the main carriers of value created through collaboration. Such an approach opens the way for a more precise identification of the role of information within the value structure generated by cooperation, as well as for the empirical verification of whether its significance is universal or dependent on specific enterprise characteristics and the quality of network participation. Only then can the information exchanged between partners become useful, reliable, and practically applicable. Consequently, information resources within collaboration strategies should be understood more broadly than as a simple transfer of data, as they also encompass the ability to select, interpret, jointly process, and utilize information in a manner that strengthens decision-making processes and enables better exploitation of market opportunities.

In summary, the information resources of enterprises operating within interorganizational networks should be perceived as the capability to acquire, share, and utilize information in a manner that supports coordination of activities, reduction of uncertainty, joint learning, and the creation and integration of relational value. Their significance lies in enabling enterprises to operate more effectively in conditions of a complex and dynamic environment while simultaneously enhancing their ability to exploit the potential embedded in relationships with partners. Consequently, a collaboration strategy lacking a clear informational dimension remains incomplete, whereas a strategy that consciously develops this dimension becomes a tool for building sustainable competitive advantage, organizational resilience, and greater effectiveness of the entire network arrangement.

3. Research Methodology

The adopted research methodology was quantitative in nature and embedded in the perspective of studies on interorganizational networks, understood as relatively stable arrangements of cooperative relationships among autonomous enterprises (Lavie, 2006; Dhanaraj, Parkhe, 2006). This approach is consistent both with the classical understanding of networks as an intermediate form between market and hierarchy and with the relational perspective, according to which value can be created at the intersection of organizational boundaries through access to partners' complementary resources, knowledge, and competencies. In this context, the selection of a research procedure aimed at identifying the benefits derived from information resources within the structure of generated value, as well as assessing these benefits in relation to differences associated with the enterprise's business profile, size, and level of network engagement, makes it possible to capture both the overall perception of benefits and the variation in assessments depending on selected organizational characteristics.

The empirical material comprised 401 enterprises operating within interorganizational networks. The research instrument was a structured questionnaire survey, which included, on the one hand, demographic questions concerning enterprise characteristics such as size and dominant business profile, and, on the other hand, a set of 20 statements treated as variables in the analysis, referring to the value generated through cooperation with market partners. Responses were provided using a five-point Likert scale, where 1 indicated complete disagreement and 5 indicated complete agreement with the statement. In the descriptive part of the analysis, the mean and standard deviation were used to establish a hierarchy of assessments and identify the relative strength of approval for individual statements. The literature recognizes such an approach as acceptable in survey research based on five-point Likert items, particularly when the inferential component relies on nonparametric procedures or tests appropriate for categorical data (Sullivan, Artino, 2013; de Winter, Dodou, 2010).

The research procedure was conducted in three stages. In the first stage, descriptive statistics were applied by calculating means and standard deviations for all 20 variables, which were grouped into five synthetic categories of value. This stage served an organizing and diagnostic function, as it enabled the identification of which benefits of network cooperation were rated highest by respondents and which were evaluated relatively lower. In the second stage, the chi-square (χ^2) test of independence was employed to examine the relationships between the assessment of cooperation value and the enterprise's business profile as well as enterprise size. The selection of this procedure was justified by the fact that the analyzed relationships concerned categorical variables presented in contingency tables. The χ^2 test makes it possible to determine whether the distribution of responses differs significantly across the compared

categories of entities (McHugh, 2013; Hazra, Gogtay, 2016). As a complement to the test, Yule's ϕ coefficient was also examined as a measure of association strength (Akoglu, 2018).

In the third stage of the analysis, the Mann-Whitney U test was conducted to compare assessments formulated by two independent groups of enterprises: entities with lower and higher levels of engagement in the interorganizational network. The groups were divided according to the median overall assessment of engagement ($Me = 4.050$). The choice of this test was methodologically appropriate because the compared data were ordinal in nature, and the Mann-Whitney U procedure does not require the assumption of normal distribution while maintaining high usefulness in the analysis of two independent samples (Nachar, 2008; Sullivan, Artino, 2013). The adoption of this procedure made it possible to determine whether more intensive participation in network relationships is associated with significantly higher evaluations of the value created through cooperation, and thus whether the level of engagement differentiates the perception of strategic and operational outcomes. Results meeting the condition of $p < 0.05$ were considered statistically significant. The reliability of the research instrument was assessed using Cronbach's alpha coefficient, which enables the evaluation of the internal consistency of a scale and is widely used in social and organizational research (Taber, 2018).

The proposed methodology is consistent with the research objective, as it combines the diagnosis of assessment levels, the analysis of relationships between enterprise characteristics and the perception of benefits, and the comparison of groups differing in their level of network engagement. From the perspective of methodological rigor, an important advantage of this procedure is the combination of simple descriptive measures with tests appropriate for ordinal and categorical data, which increases the validity of inference and reduces the risk of overinterpretation of the results. At the same time, it should be noted that the study is based on respondents' self-assessments and has a cross-sectional character, meaning that it explains the coexistence of assessments well, but does not provide a basis for causal inference.

4. Research Results

The research findings obtained for the variable referring to the belief that mutual connections and relationships with market partners enable better access to information indicate the particular importance of information resources in cooperation under conditions of enterprises operating within interorganizational networks. In light of the descriptive statistics, the analyzed variable achieved the highest mean value among all examined components of cooperation value ($M = 4.466$; $SD = 0.692$), which allows the conclusion that access to information is perceived by respondents as one of the most significant outcomes of implementing collaboration strategies with market partners. At the same time, the relatively

low standard deviation indicates considerable consistency in assessments and, therefore, a high level of agreement among respondents regarding the perception of this benefit. This means that, within the studied population, information is perceived not only as an operational resource, but also as a strategic resource that strengthens the enterprise's ability to respond to environmental volatility and make more accurate managerial decisions (Table 1).

Table 1.

Findings on the Significance of the Informational Dimension of Enterprise Collaboration Strategy in an Interorganizational Network

Area of Analysis	Indicator/Result	Outcome	Interpretation in the Context of the Informational Dimension of Collaboration Strategy
Subject of analysis	Variable 2	<i>Mutual connections and relationships with market partners enable better access to information</i>	The variable describes the informational dimension of cooperation and refers to the perception of information as a strategic benefit resulting from participation in an interorganizational network.
Descriptive statistics	Mean (M)	4.466	The highest mean among all 20 analyzed variables. This indicates that the surveyed enterprises consider access to information to be the most important outcome of network cooperation.
	Standard deviation (SD)	0.692	The low level of variation in responses indicates considerable agreement among respondents regarding this benefit.
Distribution of responses	Rating 5	227	A very high share of the highest ratings confirms the strong belief among respondents in the importance of network relationships for access to information.
	Rating 4	140	Together with rating 5, this indicates the dominance of positive responses.
	Rating 3	28	A small share of neutral responses.
	Rating 2	6	A marginal share of low ratings.
	Rating 1	0	No strongly negative responses were recorded.
Overall positive assessment	Share of ratings 4 and 5	approx. 91.5%	The result confirms that access to information is widely perceived as a fundamental value of cooperation within networks.
χ^2 test of independence - enterprise business profile	χ^2	2.161	No significant relationship was found between the enterprise's business profile and the assessment of improved access to information.
	p	0.340	Statistically insignificant result ($p > 0.05$). Informational benefits are cross-sectoral in nature.
	Yule's ϕ	0.073	Very weak strength of association. The business profile does not significantly differentiate the perception of the informational value of cooperation.
χ^2 test of independence - enterprise size	χ^2	1.063	No significant relationship was found between enterprise size and the assessment of access to information.
	p	0.789	Statistically insignificant result ($p > 0.05$). The significance of information is assessed similarly by enterprises of different sizes.
	Yule's ϕ	0.051	Negligible strength of association. Organization size is not a significant factor differentiating the assessment of informational benefits.

Cont. table 1.

Mann-Whitney U test - level of network engagement	Mean for enterprises with lower engagement	4.356	Less engaged enterprises also highly assess the importance of access to information, although less strongly than more network-active firms.
	Mean for enterprises with higher engagement	4.567	The higher rating indicates that more intensive participation in network relationships increases the perceived informational value of cooperation.
	Z	-2.330	The result indicates statistically significant differences between the compared groups.
	p	0.0198	Statistically significant result ($p < 0.05$). The level of network engagement differentiates the assessment of informational benefits.
Synthetic conclusion	Position of the variable in the overall study	Highest-rated cooperation benefit	The informational dimension of collaboration strategy constitutes a key component of value generated within interorganizational networks.
Strategic significance	Final interpretation	-	Better access to information strengthens the enterprise's ability to recognize environmental changes, respond to market needs, build competitive position, and develop long-term strategic effectiveness.

Source: authors' own calculations.

Further analysis aimed to determine whether the assessment of this aspect of cooperation varies depending on enterprise characteristics. The results of the chi-square (χ^2) test of independence did not reveal a statistically significant relationship between the assessment of improved access to information and the enterprise's business profile ($\chi^2 = 2.161$; $p = 0.340$). A similar conclusion applies to the strength of association measured by Yule's ϕ coefficient, whose value ($\phi = 0.073$) should be considered very low. The obtained results indicate that, regardless of whether the enterprise operates in the manufacturing, service, or trade sector, the role of network cooperation in improving access to information is assessed in a similar manner. Thus, informational benefits may be regarded as cross-sectoral in nature and as a relatively universal component of value generated within interorganizational relationships (Figure 2).

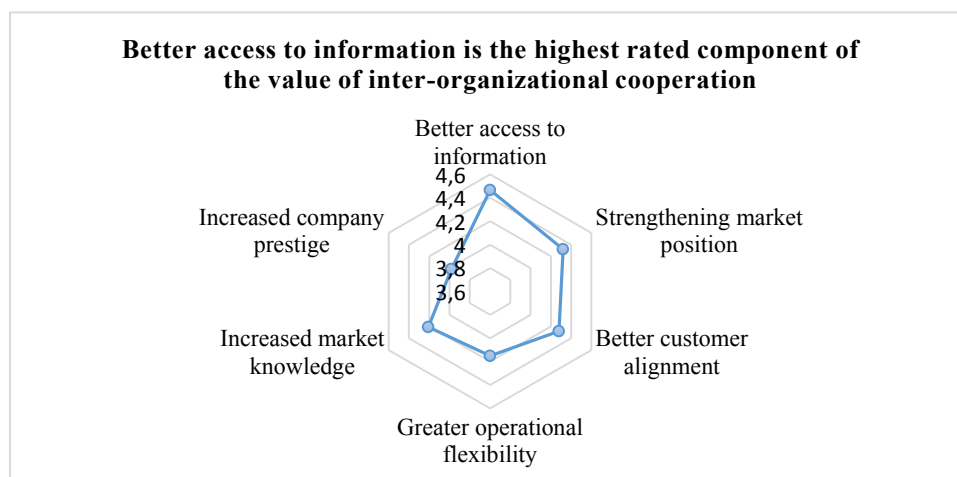


Figure 2. Structure of Cooperation Benefits in Interorganizational Networks.

Source: authors' own calculations.

A similar pattern emerges from the analysis taking enterprise size into account. In this case as well, no statistically significant relationship was identified ($\chi^2 = 1.063$; $p = 0.789$), while the value of the ϕ coefficient ($\phi = 0.051$) confirms a negligible strength of association. This means that both smaller and larger enterprises perceive the importance of network participation for improving access to information in a comparable manner. From the perspective of strategic management, this finding is significant because it suggests that the informational effects of cooperation are not determined by the scale of operations, but rather result from participation in cooperative relationships itself and from the quality of interactions undertaken with partners.

A different result was obtained in the analysis of variations in assessments according to the enterprise's level of engagement in the interorganizational network. The Mann-Whitney U test revealed statistically significant differences between the groups of entities with lower and higher levels of engagement ($Z = -2.330$; $p = 0.0198$). The mean assessment of the analyzed variable was higher among enterprises more strongly engaged in network relationships (4.567) than among entities with a lower level of engagement (4.356). The obtained result allows the conclusion that the intensity of participation in cooperation structures strengthens the perception of informational benefits. In other words, it is not merely the presence within the network itself, but rather the actual degree of engagement in relationships with partners that determines the scale of benefits resulting from the flow of information, knowledge, and experience.

The reliability of the research instrument was assessed using Cronbach's alpha coefficient. The overall scale achieved a Cronbach's alpha value of 0.553, indicating moderate internal consistency. The highest reliability was obtained for the scale related to innovative solutions ($\alpha = 0.751$), while the remaining subscales showed lower levels of consistency, reflecting the multidimensional and heterogeneous nature of value generated through interorganizational cooperation.

Consequently, it should be concluded that improved access to information constitutes one of the key manifestations of value generated through the implementation of collaboration strategies within interorganizational networks. These benefits are widely perceived and relatively independent of the enterprise's basic structural characteristics, such as business profile or size. At the same time, their perception increases with the level of engagement in network relationships, indicating that the strategic effectiveness of cooperation results not merely from formal participation in a network, but primarily from the active co-creation of relationships, the integration of benefits derived from information resources, the intensity of interactions, and the ability to utilize information exchange mechanisms in managerial processes.

5. Discussion

The obtained empirical research results confirm that information resources, considered in the context of enterprise cooperation within interorganizational networks, should be regarded as one of the key components of relational value. This is evidenced by the fact that the variable referring to the statement that mutual connections and relationships with market partners enable better access to information achieved the highest mean score among all analyzed benefits ($M = 4.466$; $SD = 0.692$). This indicates that the surveyed enterprises perceive information as one of the most significant outcomes of implementing collaboration strategies within interorganizational networks. This result is consistent with the existing literature, which emphasizes that interorganizational networks function as structures enabling the flow of knowledge, information, and market interpretations, thereby supporting organizational learning, integration and coordination of activities, and the enhancement of enterprises' adaptive capabilities (Lavie, 2006; Dhanaraj, Parkhe, 2006).

The empirical research findings simultaneously indicate that informational benefits are universal and relationally pervasive, as their assessment did not differ significantly either by enterprise business profile ($\chi^2 = 2.161$; $p = 0.340$; $\phi = 0.073$) or by enterprise size ($\chi^2 = 1.063$; $p = 0.789$; $\phi = 0.051$). The obtained result suggests that the significance of access to information is not determined by the organization's basic structural characteristics, but rather stems from the very nature of network cooperation. In this respect, the study confirms findings indicating that communication, integration, information exchange, transparency, and trust constitute fundamental attributes of interorganizational relationships, regardless of industry or enterprise scale (Klimas, Czakon, 2022). This means that information may be treated as a common element of value created within networks, rather than as a benefit generated only for selected types of enterprises.

Particular attention should be paid to the fact that the assessment of improved access to information differed significantly depending on the enterprise's level of engagement in the interorganizational network. Enterprises more strongly engaged in network relationships rated these benefits higher than entities with lower levels of engagement (4.567 versus 4.356; $Z = -2.330$; $p = 0.0198$). This result indicates that mere formal participation in a network is not a sufficient condition for fully exploiting the informational potential of cooperation. Rather, the key factors are the intensity of participation, relational activity, and the enterprise's ability to develop and maintain ties with partners. Such an interpretation is consistent with the networking capability concept, according to which enterprise effectiveness in business relationships depends on its ability to initiate, develop, integrate, and utilize relationships in a manner conducive to knowledge and information transfer (Mitre ga, Forkmann, Ramos, Henneberg, 2012; Mitre ga, Forkmann, Zaefarian, Henneberg, 2017). It is also supported by research demonstrating that trust, cooperation, and relational embeddedness constitute

fundamental conditions for effective knowledge sharing between organizations (Chen, Lin, Yen, 2014). From this perspective, the conducted study fills an identified research gap by demonstrating that informational benefits occupy a key position within the value structure of cooperation, possess a cross-sectoral and cross-scale character, and intensify with the level of relational engagement. Consequently, the study clarifies not only whether network cooperation facilitates better access to information, but also under what conditions this potential is activated. The obtained findings also correspond with more recent research on the functioning of enterprises within interorganizational networks, which indicates that relationships with market partners support both the recognition of customer needs and improved access to information, while strengthening enterprises' market position (Łęgowik-Świącik, Kostrzewska, 2024). The present study extends these findings by providing confirmation that information is not merely one of the benefits of cooperation, but, in the perception of the surveyed enterprises, constitutes its most strongly recognized outcome, the intensity of which depends primarily on the level of engagement in network relationships.

Consequently, it may be concluded that the conducted empirical research reinforces the relational and network-based approach to enterprise strategy. The findings demonstrate that the advantages derived from cooperation are not limited solely to access to material resources or cost-related effects, but are to a significant extent based on the quality and intensity of information resource flows. The novelty of the study lies in the empirical clarification of the position of informational benefits within the value structure of cooperation and in demonstrating that their significance increases with active participation in the network. Thus, the identified research gap has been addressed by showing that information resources constitute a dimension of collaboration strategy that is structurally universal yet relationally conditioned, and that their significance does not depend on enterprise size or business profile, but rather on the actual level of engagement in the interorganizational network.

6. Conclusion

The conducted research confirmed that the benefits derived from information resources within the collaboration strategies of enterprises operating in interorganizational networks constitute an important mechanism for creating and integrating relational value and strengthening enterprise competitiveness. The obtained results indicate that, among the analyzed effects of cooperation, improved access to information received the highest evaluation ($M = 4.466$; $SD = 0.692$), which allows information to be regarded as the most important benefit achieved through relationships with market partners. This means that participation in a network is not limited to the realization of operational objectives, but also supports the acquisition of knowledge about the market, customers, and changes in the environment. The study also

demonstrated that informational benefits coexist with higher evaluations of such effects as strengthening market position, better alignment with customer needs, greater operational flexibility, increased knowledge of the market and customers, and enhanced enterprise prestige. This indicates that information is not a separate outcome of cooperation, but rather a factor that initiates and reinforces subsequent areas of value creation.

An important finding is also that the significance of informational benefits did not differ substantially either by the enterprise's business profile or by its size. This demonstrates the universal character of the informational dimension of cooperation, regardless of industry or enterprise scale. The lack of significant differences suggests that the informational benefits derived from network cooperation are universal in nature and are perceived similarly regardless of enterprise size or industry. Their significance is determined primarily by participation in and the quality of interorganizational relationships rather than by the structural characteristics of the organization. At the same time, it was found that a higher level of engagement in network relationships is associated with a higher assessment of access to information. This means that the informational potential of cooperation results not merely from membership in a network itself, but from active participation in relationships, the intensity of interactions, and the willingness to exchange knowledge.

The scientific value of the article lies in presenting the benefits derived from information resources not merely as one of the relational benefits, but as a key element of the value structure generated within interorganizational networks. The results suggest that access to information initiates a mechanism of mutually reinforcing effects, including better market recognition, integration of relational value, greater flexibility, stronger customer orientation, and the strengthening of market position. Informational benefits enhance organizational resilience by enabling faster recognition of market changes, reducing decision-making uncertainty, and improving responsiveness to environmental disruptions. Under the conditions of Industry 4.0 transformation, access to information and the ability to integrate it also support the development of organizational flexibility, process adaptability, and a more sustainable, knowledge-based model of enterprise operation. Thus, information becomes an active factor of development and an important condition for enterprise sustainability and resilience.

The practical significance of the study lies in indicating that managers should treat network relationships as a source of strategic knowledge rather than merely a tool for achieving short-term economic effects. In terms of practical implications, it is worth emphasizing the need to develop formal and informal communication channels, shared data exchange platforms, and regular coordination meetings among network partners. Equally important are building trust, integrating processes, and strengthening long-term partner engagement, as these factors support more effective information flows and the use of knowledge in decision-making processes.

However, the limitations of the study should also be acknowledged. The research was cross-sectional in nature, based on respondents' declarations, and does not allow for causal inferences. Therefore, further research using longitudinal and qualitative approaches appears justified, as it would enable a more comprehensive explanation of the mechanisms underlying the creation and utilization of informational benefits.

In conclusion, the benefits derived from the information resources of enterprises cooperating within interorganizational networks are of fundamental importance for value creation, strengthening competitive position, and building the organization's long-term development capability. Information is not only the highest-rated outcome of cooperation, but also a factor initiating further relational and strategic benefits. In this sense, it performs an integrative function across the various dimensions of network cooperation outcomes.

References

1. Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*, 18(3), 91-93. DOI: 10.1016/j.tjem.2018.08.001
2. Chen, Y.H., Lin, T.P., Yen, D.C. (2014). How to facilitate inter-organizational knowledge sharing: The impact of trust. *Information & Management*, 51(5), 568-578. <https://doi.org/10.1016/j.im.2014.03.007>
3. Cheng, J.H. (2011). Inter-organizational relationships and information sharing in supply chains. *International Journal of Information Management*, 31(4), 374-384. <https://doi.org/10.1016/j.ijinfomgt.2010.09.004>
4. Czakon, W. (2010). Dynamiczne podejście do zarządzania. *Acta Universitatis Lodziensis, Folia Oeconomica*, 234, pp. 3-10. <http://hdl.handle.net/11089/243>
5. de Winter, J.C.F., Dodou, D. (2010). Five-point Likert items: t test versus Mann-Whitney-Wilcoxon. *Practical Assessment, Research, and Evaluation*, 15(1), Article 11. DOI: 10.7275/bj1p-ts64
6. Dhanaraj, C., Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review*, 31(3), 659-669. <https://doi.org/10.5465/amr.2006.21318923>
7. Dyduch, W., Cyfert, S., Zastempowski, M. (2024). Value creation and value capture in energy sector organizations: evidence from Poland. *Polish Journal of Management Studies*, 29, 97-118. DOI: 10.17512/pjms.2024.29.1.06.
8. Dyer, J.H., Nobeoka, K. (2000). Creating and managing a high-performance knowledge-sharing network: The Toyota case. *Strategic Management Journal*, 21(3), 345-367. [https://doi.org/10.1002/\(SICI\)1097-0266\(200003\)21:3<345::AID-SMJ96>3.0.CO;2-N](https://doi.org/10.1002/(SICI)1097-0266(200003)21:3<345::AID-SMJ96>3.0.CO;2-N)

9. Hazra, A., Gogtay, N. (2016). Biostatistics series module 4: Comparing groups - categorical variables. *Indian Journal of Dermatology*, 61(4), 385-392. DOI: 10.4103/0019-5154.185700
10. Klimas, P., Czakon, W. (2022). Species in the wild: A typology of innovation ecosystems. *Review of Managerial Science*, 16(1), 249-282. <https://doi.org/10.1007/s11846-020-00439-4>.
11. Klimas, P., Stańczyk, S., Sachpazidu, K., Stanimir, A., Kuźmiński, Ł. (2023). The attributes of inter-organizational relationships: Which fifteen of them really matter to software developers? *Industrial Marketing Management*, 110, 1-16. <https://doi.org/10.1016/j.indmarman.2023.02.004>.
12. Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review*, 31(3), 638-658. <https://doi.org/10.5465/AMR.2006.21318922>
13. Łęgowik-Świącik, S. (2025). The role of inter-organisational relationships in enhancing business resilience and achieving economies of scale. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, 234. <https://doi.org/10.29119/1641-3466.2025.234.12>
14. Łęgowik-Świącik, S., Kostrzewska, J. (2024). Understanding customer needs in shaping socially responsible enterprises in inter-organizational networks. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, 204, 376-390. <https://doi.org/10.29119/1641-3466.2024.204.22>
15. Li, J., Sikora, R., Shaw, M.J., Tan, G.W. (2006). A strategic analysis of interorganizational information sharing. *Decision Support Systems*, 42(1), 251-266. <https://doi.org/10.1016/j.dss.2004.12.003>
16. McHugh, M.L. (2013). The chi-square test of independence. *Biochemia Medica*, 23(2), 143-149. DOI: 10.11613/BM.2013.018
17. Mentzas, G., Apostolou, D., Kafentzis, K., Georgolios, P. (2006). Inter-organizational networks for knowledge sharing and trading. *Information Technology and Management*, 7(4), 259-276. <https://doi.org/10.1007/s10799-006-0276-8>
18. Mitreğa, M., Forkmann, S., Ramos, C., Henneberg, S.C. (2012). Networking capability in business relationships: Concept and scale development. *Industrial Marketing Management*, 41(5), 739-751. <https://doi.org/10.1016/j.indmarman.2012.06.002>
19. Mitreğa, M., Forkmann, S., Zaefarian, G., Henneberg, S.C. (2017). Networking capability in supplier relationships and its impact on product innovation and firm performance. *International Journal of Operations & Production Management*, 37(5), 577-606. <https://doi.org/10.1108/IJOPM-11-2014-0517>
20. Nachar, N. (2008). The Mann-Whitney U: A test for assessing whether two independent samples come from the same distribution. *Tutorials in Quantitative Methods for Psychology*, 4(1), 13-20. DOI: 10.20982/tqmp.04.1.p013

21. Song, Y.I., Woo, W., Rao, H.R. (2007). Interorganizational information sharing in the airline industry: An analysis of stock market responses to code-sharing agreements. *Information Systems Frontiers*, 9(2-3), 309-324. <https://doi.org/10.1007/s10796-007-9026-7>
22. Sullivan, G.M., Artino, A.R. (2013). Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education*, 5(4), 541-542. DOI: 10.4300/JGME-5-4-18.
23. Taber, K.S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273-1296. <https://doi.org/10.1007/s11165-016-9602-2>
24. Wolniak, R. (2024). Global supply chain coordination – the business analytics usage in Industry 4.0 conditions. *Silesian University of Technology Scientific Papers. Organization and Management Series*, 196, 577-591. <https://doi.org/10.29119/1641-3466.2024.196.39>
25. Zakrzewska-Bielawska, A., Czakon, W., Kraus, S. (2023). Relational orientation in B2B strategies: Measurement scale development and validation. *Journal of Business Research*, 160, 113791. <https://doi.org/10.1016/j.jbusres.2023.113791>

THE ROLE OF COMMUNICATION IN THE MANAGEMENT OF A SERVICES COMPANY IN THE SILESIAN REGION

Aneta MADYDA

University of Bielsko-Biala; amadyda@ubb.edu.pl, ORCID: 0000-0002-1723-305X

Purpose: This paper aims to determine the impact of communication on organizational leadership. It highlights the role of the manager as a key figure in the enterprise and examines how their relationships with superiors and subordinates influence managerial effectiveness. It also explores what managers can do to perform their duties more effectively. To achieve the research objective, the general hypothesis was formulated: communication facilitates company management, and its high quality increases employee efficiency.

Design/methodology/approach: The study was conducted in a company located in the Silesian Region, which operates a nationwide network of nearly 250 customer service points. A diagnostic survey method was used, with a questionnaire as the primary research tool. An electronic survey consisting of 17 research questions and 6 demographic (metric) questions was administered to 170 employees working in the service company.

Findings: The collected empirical data confirm the general hypothesis that communication facilitates company management and that its high quality enhances employee efficiency.

Research limitations/implications: The study has a pilot nature. Its purpose was to verify the planned research procedure, including the selection of surveyed enterprises and the research tools used. The pilot study tested not only the research process but also the clarity of the questions and the quality of the responses provided by participants. The results confirmed the importance of the issue under investigation. It is recommended to expand the study by increasing the number of surveyed employees in service companies within the Silesian Region.

Practical implications: It is recommended that company management regularly provide training for both employees and themselves in the field of communication. Emphasis should be placed on overcoming communication barriers, interpreting verbal and non-verbal signals, and, most importantly, building relationships and trust. Such initiatives should ultimately enhance employees' skills and competencies.

Originality/value: This paper addresses a gap in research concerning the role of communication in the management of service enterprises in the Silesian Region.

A novel contribution of this study is the demonstration that employees are aware of the importance of effective communication in both personal and professional life.

Keywords: communication, management, service enterprise.

Category of the paper: empirical research.

1. Introduction

This paper addresses a gap in the literature concerning the role of communication in the management of service enterprises in the Silesian Region.

A key contribution of this study is the demonstration that employees are aware of the importance of effective communication in both personal and professional contexts. Furthermore, organizations must recognize that ineffective communication can hinder success, whereas strong interpersonal relationships among employees contribute to improved efficiency. A communicative manager, by fostering positive relationships with employees, can enhance their motivation and strengthen their commitment to the organization.

2. Communication in the organization

In human life, there are many processes without which it is difficult to function properly. One of them is communication, which accompanies people in their everyday lives. Activities such as speaking, exchanging text messages or emails, and even simple gestures are all elements of communication. Due to the daily repetition of these activities, many individuals perceive this process as easy and intuitive, often considering themselves proficient in this area. But is this really the case?

What, in fact, is communication? It turns out that defining this concept precisely is neither simple nor obvious. The term “communication” is broad and multifaceted, and numerous definitions can be found in the literature.

Charles Cooley was among the first to introduce a definition of communication into scientific literature. According to him, this process encompasses not only spoken conversation but also facial expressions, body posture, gestures, and even tone of voice (Budzynski, 2002, p.109).

According to Wilbur Schramm, communication is a tool through which society exists and, by its very nature, distinguishes humans from other living beings (Dobek-Ostrowska, 2004, p. 13). Cheryl Hamilton defines communication as the process by which people share thoughts, ideas, and feelings with one another in a way that is mutually understood (Hamilton, 2011, p. 26).

Bogusława Dobek-Ostrowska has undertaken to create a universal definition of communication, which is difficult to disagree with. The author (Dobek-Ostrowska, 2004, p. 13) states that communication is a process that takes place between individuals, groups, or institutions. Its purpose is to exchange ideas, share knowledge, and convey information. This process occurs at different levels, uses diverse means, and produces specific effects.

The communication process can be divided into six types, which differ in function, number of participants, and frequency of occurrence. The foundation of this complex structure is intrapersonal communication, which many people are not aware of. It is the internal dialogue within each person, including stimuli coming from the body, such as hunger or pain. Why is it described as a dialogue rather than a monologue? This biological and psychological process involves both receiving messages and responding to them, similar to a question-and-answer exchange.

The second most frequent type is interpersonal communication, which is also the most complex. It occurs when two people communicate through words, gestures, feelings, or thoughts. John Stewart, in his book *Bridges Instead of Walls*, defines it as the kind or quality of contact that occurs when two or more individuals are willing and able to meet, sharing aspects of their uniqueness—such as their choices, reflections, and individuality—while being aware of and responding to their partner's personal presence.

In simpler terms, interpersonal communication is contact that occurs when each person involved both speaks and listens in a way that maximizes personal understanding (Piątek, 2014, p. 54).

It is worth noting that organizational communication is closely linked to the fundamental functions of management: planning, organizing, motivating, and controlling. Managers perform these functions to a large extent through the communication process (Ober, 2013, p. 258).

Furthermore, communication forms the foundation for building interpersonal relationships among an organization's stakeholders. Effective communication requires appropriate skills, knowledge of communication forms, an understanding of the barriers and determinants of information flow, as well as the use of tools that facilitate the exchange of messages (Smolağ, Ślusarczyk, 2018, p. 3).

Another type that also involves contact between individuals is group communication, which is responsible for the flow of information within small groups, such as a family, a circle of friends, or a team of employees. There are also larger groups, such as associations or local communities; despite the greater number of members, the communication process still takes place through direct interaction between individuals. This form is referred to as intergroup communication.

However, this type of communication has revealed certain challenges, such as limited control over the message and reduced effectiveness. As a result, a more formalized level of communication has developed—organizational or institutional communication. In this form, the roles of sender and receiver are more clearly defined, arbitrariness is reduced, and greater emphasis is placed on norms and standards.

The final type, situated at the top of the communication pyramid, is mass communication. It emerged with the invention of the first mass medium—the book—in the mid-15th century. Today, this form has expanded to include cinema, radio, television, and the Internet, and it involves the largest number of participants (Dobek-Ostrowska, 2004, p. 19).

Types of communication can also be classified according to form, with the most common distinction being between verbal and non-verbal communication. These are forms of interpersonal communication. Verbal communication includes both spoken and written language, with language serving as its primary medium. For verbal communication to be effective, all participants must understand the sounds and symbols being used (Piątek, 2014, p. 56).

Verbal communication is a fundamental form of communication; however, it is not the most prevalent, as it is often complemented—and sometimes surpassed—by non-verbal communication. It is estimated that up to 65% of communication is non-verbal. This form supports verbal messages through gestures and other cues, helping to illustrate and reinforce the information being conveyed. In essence, non-verbal communication includes all forms of message transmission that do not involve words but still enable the flow of meaning (Piątek, 2014, p. 58).

3. Barriers to communication

The communication process does not always proceed as intended. In many interpersonal situations, various impediments, obstacles, and errors may arise. These difficulties are often caused by communication barriers, which can include personality traits of both the sender and the receiver, an inappropriate choice of communication channel, unexpected noise, or a lack of clarity and precision in constructing the message.

Nowadays, cultural barriers are among the most common. These include a lack of respect for other people's beliefs, values, and symbols. Insufficient awareness of historical context or the use of messages that may be considered offensive in a given culture can reduce the effectiveness of communication or lead to complete misunderstanding. Such obstacles are particularly evident in international communication, where a topic or message may be perceived as inappropriate or offensive by the recipient, even if it is entirely natural to the sender.

Stereotypes, negative attitudes, and prejudices are psychological factors that can similarly hinder the effective flow of information. When new ideas are introduced, employees may respond with skepticism or resistance, which can further disrupt the communication process (Stewart, 1998, p. 115).

Even the environment itself can create obstacles to effective communication. These are known as physical barriers and include factors such as lighting, temperature, and the surrounding environment.

The way a message is expressed can also pose challenges. An inappropriate tone, poor choice of words, grammatical or linguistic errors, as well as non-verbal elements such as facial expressions and gestures, can all disrupt communication. Katarzyna Piątek identifies several common problematic behaviors, including:

- criticizing,
- giving orders,
- insulting,
- judging,
- praise combined with evaluation,
- threatening,
- moralizing,
- excessive questioning,
- giving unsolicited advice,
- changing the subject (Piątek, 2014, p. 63).

All participants in the communication process should be aware of these potential mistakes and strive to avoid them. Beata Rzepka lists some of the most significant communication errors, such as:

- misunderstandings,
- language differences,
- differences in perception,
- conflicting intentions and emotions,
- inconsistency between verbal and non-verbal communication,
- lack of confidence,
- differences resulting from roles or positions (Rzepka, 2012, pp. 22-23).

Communication errors may also arise from simple issues, such as a slip of the tongue by the sender or the receiver not hearing the message properly. These are very common but relatively easy to correct—for example, by repeating the message. A similar but more complex issue is a lack of knowledge of a language or dialect. This can become a significant barrier when two people are unable to understand each other. In such situations, non-verbal communication—such as gestures or facial expressions—may help, although these too can be interpreted differently depending on the context.

Another common issue in communication is the difference in perception—people may interpret the same message in different ways. This can result from diverse life experiences and value systems. One way to minimize this problem is to clarify the message and make an effort to better understand the person with whom we are communicating.

Every message is accompanied by certain emotions and intentions. If these are not aligned with the content of the message, they can create significant barriers to effective dialogue. Hidden intentions or an inappropriate tone of voice may distort the meaning of the message, sometimes even conveying the opposite of what the sender intended. It is important to

remember that mismatched emotions and intentions can undermine trust and reduce the effectiveness of communication.

When communicating verbally, it is essential to ensure consistency with non-verbal cues. If verbal and non-verbal communication are not aligned, the recipient may lose trust. For example, during an important conversation, a lack of eye contact may be interpreted as dishonesty or hidden intentions. Communication that maintains consistency between verbal and non-verbal elements is significantly more effective than communication in which such consistency is lacking (Rzepka, 2012, p. 25).

Poor decisions and inappropriate behavior can also lead to a loss of trust between communicators. Trust enhances the efficiency of communication, while its absence often results in misunderstandings.

The final issue concerns differences in positions or social roles (Wachowiak, Gregorczyk, Grucza, Ogonek, 2004, p. 94). Communication between individuals at different hierarchical levels or with varying areas of expertise may result in messages that are not entirely sincere, and intentions may be interpreted differently. Those in higher positions or with greater knowledge may adopt a condescending attitude, while those in lower positions may lack confidence and openness.

According to Katarzyna Piątek, the presence of such barriers significantly affects the quality of communication. She states that “in many cases it leads to misunderstandings and tensions that can cause conflict, so it is worth learning to overcome these limitations” (Piątek, 2014, p. 65). In contrast, Zbigniew Nęcki argues that disruptions in the communication process may, but do not necessarily, lead to an interpersonal crisis (Nęcki, 2000, p. 165).

Effective communication within an organization fosters a positive atmosphere and supports the achievement of goals. It is also a key factor in increasing employee engagement, as it helps reduce fears and resistance to change. Moreover, good communication ensures that employees feel valued not only for performing their duties but also for their personality, initiative, and creativity (Aniszewska, Gielnicka, 1999, p. 71).

Employees expect to receive information from their superiors regularly and want to actively participate in the life of the organization. This makes them feel respected and appreciated, which in turn promotes a responsible attitude toward their duties and work. Management should communicate clear and understandable messages regarding values, plans, intentions, achievements, results, and proposals, while also taking employees' opinions into account. Engaging employees in discussions strengthens their sense of involvement, acceptance, and contribution to the organization's success.

Employees want to be informed about issues that affect their work and to have the opportunity to express their views. It can therefore be concluded that without effective communication.

4. Communication channels in the organization

Such a complex process as communication, encompassing numerous forms, types, barriers, and a wide range of influencing factors, requires appropriate tools for the transmission of information. These tools are varied—some have existed in society for a long time, while others are modern solutions that have emerged alongside technological development. They are referred to as communication channels.

A communication channel can be defined as one of the elements that constitute the communication process. It enables the transfer of information from the sender to the receiver. In other words, it is a medium that allows communication between two individuals or a group of participants. Bogusława Dobek-Ostrowska defines a communication channel as follows: “A channel is understood as the path of the message and the means of transport by which the message travels from the sender to the receiver. People in direct communication can use all five sensory channels, such as hearing (verbal symbols), sight (non-verbal signals), as well as touch, smell, and taste. In indirect communication, these channels are reduced to sight and hearing” (Dobek-Ostrowska, 2004, p. 17).

There are two forms of communication in an organization: formal and informal communication, which often intermix with one another. Formal communication can also be described as business or official communication. It refers to messages that are documented, recorded, and official, and it primarily reflects the hierarchy within an organization.

The formal flow of information usually follows predefined rules and procedures. It may also be cyclical in nature, such as periodic meetings or quarterly reports. It ensures control over communication by determining the order in which information is transmitted and to whom employees report. A significant disadvantage of this form is the relatively long time it takes for information to reach employees at the lowest levels of the hierarchy. This delay may lead to gossip and speculation—such communication is referred to as informal communication.

Informal communication is sometimes called “grapevine communication”. It does not follow predefined rules or hierarchical structures, and messages are often implicit and largely emotional. Its advantage is the speed of information flow, as it arises spontaneously among individuals or groups within the organization. It can support good interpersonal relations; however, it may also be potentially harmful to the organization. The frequency of informal communication increases in situations that generate strong emotions among employees and cause anxiety, such as layoffs or promotions.

Neither form of communication should be ignored. Proper and frequent formal communication helps to minimize excessive informal communication. Carol K. Oyster notes that “The formal network describes the kind of communication that should occur in a group, and the informal network shows how it really is”.

The channels themselves can be divided into two groups: oral and written. Written channels are, as the name suggests, all forms of communication produced through both traditional and electronic methods, which currently dominate in organizations. This form is used when there is no need for an immediate response, when the message is complex, or when it should be documented. It also has the advantage of reaching a large number of recipients regardless of their location—for example, an email from the company’s Board of Directors to all employees.

Unfortunately, due to the lack of face-to-face contact, written communication may be less effective and may not fully convey true intentions, as it lacks non-verbal cues, which help to reinforce the message. Written channels in an organization may include:

- letters,
- business notes,
- emails,
- instant messaging,
- multimedia presentations,
- work and task management systems,
- company intranet,
- company newspaper,
- SMS messages,
- faxes.

Oral channels can be divided into direct (where communication takes place “tête-à-tête”, such as meetings, briefings, and gatherings) and indirect (such as video chats or telephone calls). The advantage of this communication channel is the possibility of receiving immediate feedback, which allows for faster agreement and decision-making. Direct contact also enables the use of non-verbal communication, which complements the verbal message and allows for better interpretation of the speaker’s intentions. It also makes it possible to express emotions, for example when informing someone about a promotion.

Depending on the level of technological development of the organization, oral communication tools may include traditional face-to-face conversations, telephone calls, speeches, presentations and meetings, voice messages, teleconferencing, videoconferencing, and video recordings.

It is important to choose the appropriate communication channel for each message. When selecting it, one should consider the needs and expectations of the recipient, the importance of the information being transmitted, and the characteristics of the message itself. If the message is complex, the recipient should be able to return to it multiple times.

5. Interpersonal communication in the organization

Behind the success of any organization are its people, and for them to be effective and engaged in their work, they must be satisfied with their jobs. What contributes to job satisfaction? Certainly, good relationships within the organization. Communication is the foundation of interpersonal processes in an organization, such as motivating, controlling, delegating, and informing. Without it, teamwork could not exist, and decision-making processes would always be individual, as they would lack necessary discussion and verification.

Good interpersonal relationships are essential for high work efficiency and proper customer service. Employees who establish and maintain close interpersonal relationships with their supervisors, co-workers, and customers have a different perspective on their work compared to those whose relationships are poor (Hamilton, 2011, p. 106).

A satisfied employee is an asset to the employer. Such a person, due to positive interpersonal relations, feels trust and security, and therefore expresses opinions and shares feelings more openly. When such relationships are maintained, the likelihood of conflicts, misunderstandings, and hidden intentions is very low. However, if interpersonal communication in an organization is at a low level, disruptions and suspicion may arise during interactions, which does not benefit the company.

Regardless of their position in the organizational hierarchy, good relationships with co-workers increase efficiency. Positive relationships are important at every level, both in vertical and horizontal communication. When there is a good atmosphere within a team, employees are more willing to communicate with one another, and their creativity, commitment, and sense of security increase, as they can often rely on each other not only at work but also outside of it. As a result, higher job security contributes to reduced employee turnover.

In 1999, Lou Harris conducted a study on supervisor–employee relations. The results showed that employees dissatisfied with their relationship with their supervisors were four times more likely to look for another job than those who were satisfied.

In her book, Cheryl Hamilton cites research showing that 40% of managers who have just taken up their positions do not remain in them for more than 18 months. The main reason is “the failure to establish good relationships with subordinates and peers” (Hamilton, 2011, p. 106). This demonstrates how important good relationships are for the success of an organization. The question then arises: what can be done to develop and maintain such relationships?

In order for relationships to be long-lasting and stable, they should satisfy both sides of the communication process, which means they must be based on trust and clear expectations between individuals. The problem is that many expectations remain unspoken until they are violated.

Proper interpersonal communication within an organization allows supervisors to build strong relationships with employees, which can result in increased motivation, gaining insight into employees' opinions about the organization, understanding their expectations, and providing important direct information. This, in turn, leads to a greater sense of security among employees. In order to properly motivate employees, a manager should present and explain the vision of the future and emphasize the importance of the subordinate's work (Lichtarski, 1997, p. 195).

However, positive effects of interpersonal communication are not limited to supervisors. When employees have good relationships with their managers, they are more likely to express their feelings, report problems and needs, and stay informed about what is happening within the organization. Thus, the importance of interpersonal communication in an organization is significant. Without effective communication among employees, no organization can function efficiently or remain stable. The flow of information must be smooth, and employees must be able to communicate effectively with one another and correctly interpret both verbal and non-verbal messages from their co-workers.

6. Non-verbal communication in the organization

Interpersonal communication plays a crucial role in an organization. For it to be effective, both the sender and the receiver must understand each other's body language—that is, non-verbal messages should be correctly interpreted by both parties. A significant number of people are unaware that body language can be responsible for the failure of business negotiations. The way the sender presents a message has a strong impact on how it is received and interpreted. Non-verbal cues also influence how the sender is perceived by the receiver.

It takes approximately the first four seconds for a recipient to form a favourable or unfavourable opinion about the sender; this is known as the halo effect. Such initial judgments are difficult to change, which is why it is important to make a positive first impression.

Non-verbal communication itself takes many forms, and its elements may be interpreted differently across cultures and social groups. If verbal and non-verbal communication are inconsistent, the recipient may feel uncertain, and the sender may be perceived negatively.

Where can non-verbal messages be observed in organizational communication? Everywhere. All levels of an organization, when communicating with one another, transmit non-verbal messages through various channels, such as gestures, touch, facial expressions, eye contact, tone of voice, physical distance, body posture, paralinguistic sounds, and clothing.

In any organization, situations such as meetings are filled with non-verbal communication. This begins with greetings—such as a handshake—continues with seating arrangements at the table, and extends to dress code and gestures. Individuals in managerial positions who are not

appropriately dressed, lack confidence, or are, for example, not punctual, may lose recognition and respect in the eyes of colleagues. As a result, their chances of success within the organization decrease. Employees at lower levels should also pay attention to their non-verbal communication (Hamilton, 2011, p. 187). A lack of confidence, poor handling of conflict, or lack of eye contact may be perceived negatively by higher-level managers, who may, for instance, block promotion opportunities or even decide to terminate cooperation for such reasons.

A very important aspect is the ability to correctly interpret these messages. If members of an organization accurately read non-verbal cues, the effectiveness of communication increases. When communication within a company is effective, it contributes to a positive atmosphere and greater employee engagement, which in turn supports organizational success.

Unfortunately, non-verbal communication is often unconscious, meaning that conversations do not always produce the intended outcome, which is particularly important in business and strategic contexts. In his book, FBI Special Agent Joe Navarro argues that skillfully interpreting non-verbal messages can significantly increase the success of communication: “Nothing should be left to chance in formal meetings—that is why you need to activate your non-verbal radar. With the knowledge that everything has been properly prepared, once you are in the conference room, be sure to relax and observe, paying special attention to signs of discomfort—which may indicate controversial issues—as well as reassuring behaviours that may reveal your interlocutor’s weaknesses” (Navarro, 2011, p. 112).

Non-verbal information is constantly transmitted and plays a significant role in the functioning of an organization. Mastering these elements of communication and applying them appropriately can significantly increase organizational efficiency. Success within a company, such as effective communication between employees, can contribute to success in the marketplace. Organizations should ensure that individuals in senior positions are able to properly interpret and convey non-verbal information, as their standing among employees can positively influence overall company morale.

7. Communication in the management of a service enterprise operating in the Silesian Region

The research is based on a literature review spanning several disciplines, including organizational communication and strategic management (Zaumane, Leščevica, 2023; Brockhaus, Zeffass, 2022; Verma, Ansari, Jain, 2022). These studies emphasize that effective communication has a direct impact on business development, employee morale, and an organization’s ability to survive in challenging conditions. They also provide

a comprehensive body of knowledge on how professional communication departments can strengthen the market and operational position of modern enterprises.

The literature review demonstrated the relevance and importance of the research problem concerning the role of communication in business management. Based on the review, no studies were found that addressed the implementation of such research in Silesian service companies.

The purpose of this study was to assess the role of communication in the management of a service enterprise.

The company whose employees were surveyed has been operating on the Polish market for more than a decade, offering financial services throughout Poland. The survey was conducted among employees working in the Silesian region.

In order to achieve the research objective, a general hypothesis was formulated: communication facilitates company management, and its high quality increases employee efficiency.

An electronic survey consisting of 17 research questions and 6 demographic questions was conducted. The study included 170 employees working at the company. Respondents were asked to evaluate how they perceive communication within the selected organization. The survey began on January 18, 2024, and was completed on January 31, 2024.

The aim of the survey was to determine the level of communication within the company. It examined which communication channels are used and whether employees feel informed about what is happening in the organization. The quality of workplace relationships was assessed, and employees were asked to identify communication problems.

The survey included both single-choice and multiple-choice questions. Of the 200 surveys distributed, 171 respondents agreed to participate. One questionnaire was completed incorrectly, which resulted in 170 correctly completed surveys being included in the analysis.

7.1. Survey results

The surveyed company has a system for inducting new employees into the workplace. At the time of hiring, 125 employees were assigned a mentor to familiarize them with the company's rules, while 45 received induction materials. None of the respondents were left without support.

According to 100 respondents, not all information is communicated to employees, while the remaining 70 stated that they have access to all necessary information. Overall, 50% of respondents expressed a negative opinion about communication in the company. As many as 105 people do not feel adequately informed, while 65 employees believe they are well informed.

The best-rated relationship is that between employees and supervisors. In contrast, relationships between departments were assessed negatively, with as many as 85 respondents believing that communication between teams is at a low level. The worst-rated relationship is that between management and subordinates—only 25 people rated this relationship positively, while as many as 110 expressed reservations about contact with top management.

As the survey results show, the most commonly used communication tools in the company are electronic and internet channels, meetings and phone calls, printed materials, as well as integration events and company gatherings.

According to respondents, the communication process should be improved; only 15 people believe that communication within the organization does not require improvement.

The surveyed company does not lack tools for proper communication—this barrier was indicated by only 10 respondents. Likewise, interpersonal relations between employees are not considered a major problem. However, communication barriers are mainly caused by gossip, lack of trust, delays in information flow, misinformation, and, above all, information blocking by superiors.

As many as 110 respondents identified information blocking by superiors as the most significant communication barrier in the company.

The responses confirmed the hypothesis that proper communication leads to increased work efficiency. As many as 165 employees are aware that good relationships increase efficiency, while only 5 respondents disagreed.

For 155 respondents, internal communication is important, while 15 are uncertain about its significance.

Regarding preferred communication forms, responses were evenly split: 50% prefer written communication, while the other 50% prefer oral communication.

The traditional “tête-à-tête” conversation was the most frequently chosen option, indicated by 80 employees, followed by telephone conversations (54) and presentations and meetings (51). Videoconferencing (16), teleconferencing (11), and video recordings (6) were also mentioned. Speeches and voice messages were not selected.

A total of 159 respondents pay attention to non-verbal messages, while 11 do not. The most important non-verbal cues include eye contact, body posture, voice intonation, gestures, and clothing. Touch as a form of non-verbal communication was not indicated by any respondent.

Regarding methods of overcoming communication barriers, almost all respondents indicated cooperation as the most common approach (161 people), while 127 selected compromise. The methods of avoidance, competition, and submission were indicated by 9 respondents.

The majority of employees in the surveyed company have not received any communication training (121), while the remaining 49 have completed communication courses. Seventeen people attend training once a year, and 32 receive training on a quarterly basis.

7.2. General conclusions from the study

The results of the survey indicate that communication in the examined company is at a moderately developed level, although it is perceived unevenly by employees. While the organization has implemented onboarding procedures and provides various communication

tools, a significant proportion of respondents still feel insufficiently informed and point to shortcomings in internal information flow.

One of the key findings is the strong differentiation in the quality of relationships within the organization. The best-rated communication occurs between employees and direct supervisors, which suggests relatively effective day-to-day operational communication. In contrast, communication between departments and especially between management and subordinates is assessed negatively, indicating hierarchical and structural barriers in information flow.

Employees mainly rely on electronic communication channels, meetings, and telephone contact, which confirms the growing importance of digital communication in organizational practice. At the same time, respondents show a clear preference for both written and oral forms of communication, which suggests the need for a balanced communication strategy adapted to different situations and needs.

A significant problem identified in the study is the presence of communication barriers, particularly information blocking by superiors, as well as gossip, lack of trust, and delays in information flow. These factors negatively affect employees' sense of inclusion and transparency within the organization.

Despite these difficulties, the majority of respondents recognize the importance of good interpersonal relations and confirm that effective communication increases work efficiency. This supports the study's hypothesis that high-quality communication positively influences employee performance and organizational functioning.

Another important conclusion is the relatively low level of formal communication training among employees. Since most respondents have not participated in communication-related courses, this may limit their ability to effectively manage interpersonal interactions and overcome communication barriers.

Overall, the study shows that although the company has a functional communication system, there is a clear need for improvement—particularly in information transparency, interdepartmental communication, and management openness. Strengthening these areas could significantly enhance employee satisfaction, trust, and organizational efficiency.

8. Recommendations

Every new employee in the company either receives a set of induction materials or is assigned a mentor responsible for familiarizing them with organizational procedures and company culture.

A major strength of the company is the relationship between employees and between employees and their supervisors. Managers maintain good contact with their subordinates, thereby building a family-like atmosphere, which is one of the organization's core values.

However, interdepartmental communication is weaker. The results indicate a positive atmosphere within teams, but communication beyond immediate groups is more difficult, which limits the development of interdepartmental relations.

Employees clearly lack contact and dialogue with top management. This contributes to limited openness among lower-level staff and increases concerns about their future. The flow of information is insufficient, and employees do not feel adequately informed, which leads to gossip and a sense of mistrust toward higher-level management. The main communication problem in the organization is the blocking of information by superiors.

The most common ways of overcoming communication barriers in the company are cooperation and compromise, which reflect generally positive interpersonal relations. Employees value their relationships with supervisors, and half of them believe that their opinions are taken into account.

The company supports employee communication by using an intranet system and an internal messaging platform. Given the large number of employees nationwide, these tools help maintain effective internal communication. A range of digital tools, such as instant messaging, intranet, email, and videoconferencing, facilitates communication and allows employees to solve problems quickly.

Despite the availability of electronic communication channels, half of the employees prefer oral communication. In particular, telephone conversations are often preferred over written e-mails.

Although many employees have not received formal communication training, the majority recognize that good interpersonal relationships increase efficiency, and that both internal communication and non-verbal communication play an important role in workplace interactions.

Managers, specialists, and office workers pay particular attention to eye contact and tone of voice, which confirms that non-verbal communication complements verbal communication.

Employees unanimously indicated that communication within the company requires improvement. Decision-making responsibility for implementing changes lies with the Board of Directors, which plays a key role in the organization, while employees represent its most valuable asset. Therefore, the company should begin by conducting an internal study on communication to confirm and further analyse the identified problems.

The most important information in the company should be communicated by the Board of Directors, which should play a more active and transparent role in internal communication. Given employees' perceptions of management relations, the Board should regularly communicate changes taking place within the company and ensure openness regarding ongoing processes. This would help reduce the problem of information blocking by superiors. Employees want to be informed about the company's plans, current situation, successes, failures, and the causes of potential difficulties.

Considering the nature of the organization, video messages from management addressed to employees could be introduced, distributed via the intranet. These communications should include clear information about planned changes, specific implementation steps, and organizational goals. Survey results should also be made available to employees, so they can see that management operates transparently and that changes are intended to bring positive outcomes.

Training workshops would also have a positive impact on communication within the company. Management should periodically train both employees and themselves in communication skills. It is important to strengthen techniques for overcoming communication barriers, interpreting verbal and non-verbal messages, and—most importantly—building trust and relationships. The expected outcome of such training would be improved employee competencies and communication skills.

Managers should regularly keep employees informed about company matters. An information policy should be developed to ensure that all employees receive key information in a timely manner, which would also help reduce gossip within the organization. The company should communicate its current situation, results, successes, and achievements.

Employee integration is a key element in strengthening interdepartmental relations and maintaining effective internal communication. Organizing internal events, competitions, or team-building activities, including group trips, could further strengthen employee relationships.

Successful organizations are those that communicate effectively. Implementing change in organizations is a complex process, often involving social rather than technical challenges. The implementation of improvement plans requires proper problem diagnosis, determination of its scale, selection of appropriate methods of change, and addressing employee concerns. Since many employees naturally resist change, managers should not completely reject existing practices but should respect past solutions while proposing improvements for the future. If communication quality improves significantly and the organization continues to support good relationships and employee achievements, it may achieve better results and increased employee efficiency.

9. Summary

Communication is a process that accompanies us every day. For communication to be effective, it must be maintained at a high level. The survey results show that people are aware that many aspects of both personal and professional life depend on well-functioning communication. Organizations must therefore recognize that a lack of effective communication can hinder success.

Efficiency increases with the quality of interpersonal relationships among employees. A communicative manager can, through good relationships with employees, increase their motivation and commitment to the company. Managers can also eliminate problems by applying appropriate techniques, which can be developed and strengthened through training and workshops. Therefore, organizations should invest in the training of both employees and managers.

References

1. Aniszewska, G., Gielnicka, I. (1999). *Firma to ja. Firma to my*. Gdańsk: Ośrodek Doradztwa i Doskonalenia Kadr.
2. Brockhaus, J., Zerfass, A. (2022). Strengthening the role of communication departments: A framework for positioning communication departments at the top of and throughout organizations. *Corporate Communications: An International Journal*, 27(1), 53-70. <https://doi.org/10.1108/CCIJ-02-2021-0021>
3. Budzyński, W. (2002). *Wizerunek firmy: kreowanie, zarządzanie, efekty*. Warszawa: Poltext.
4. Dobek-Ostrowska, B. (2004). *Podstawy komunikowania społecznego*. Wrocław.
5. Hamilton, C. (2011). *Skuteczna komunikacja w biznesie*. Warszawa: PWN.
6. Lichtarski, J. (1997). *Podstawy nauki o przedsiębiorstwie*. Wrocław: Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu.
7. Navarro, J. (2011). *Mowa ciała w pracy*. Warszawa: Katka.
8. Nęcki, Z. (2000). *Komunikacja międzyludzka*. Kraków/Kluczbork: Antykwa.
9. Ober, J. (2013). Funkcja i rola efektywnej komunikacji w zarządzaniu. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, Z. 65. Katowice: Wydawnictwo Politechniki Śląskiej.
10. Oyster, C.K. (2002). *Grupy. Seria: Psychologia Społeczna*. Poznań: Zysk i S-ka.
11. Piątek, K. (2014). *Komunikacja w konflikcie*. Bielsko-Biała: Wydawnictwo Naukowe Akademii Techniczno-Humanistycznej.
12. Rzepka, B. (2012). *Efektywna komunikacja w zespole*. Warszawa: Samo Sedno.
13. Smoląg, K., Ślusarczyk, B. (2018). Komunikacja wewnętrzna – innowacyjny aspekt współczesnego zarządzania organizacją. *Studia i Prace WNEiZ US, Nr 52/2*. Szczecin: Wydawnictwo Uniwersytetu Szczecińskiego.
14. Stewart, A.M. (1998). *Uprawnianie w biznesie, czyli jak z tym samym zespołem osiągnąć więcej*. Warszawa: Business Press.

15. Verma, A.K., Ansari, S.N., Bagaria, A., Jain, V. (2022). The role of communication for business growth. A comprehensive review. *World Journal of English Language, Vol. 12(3)*. Sciedu Press, pp. 164-164.
16. Wachowiak, P., Gregorczyk, S., Grucza, B., Ogonek, K. (2004). *Kierowanie zespołem projektowym*. Warszawa: Difin.
17. Zaumane, I., Leščevica, M. (2023). Functional responsibility for internal management and its integration in contemporary businesses. *International Journal of Organizational Analysis, 31(5)*, 1492-1512. <https://doi.org/10.1108/IJOA-06-2021-2822>

THE POTENTIAL OF SMALL TOWNS TO FOSTER BUSINESS DEVELOPMENT AND LOCAL ENTREPRENEURIAL ECOSYSTEMS

Marcin MAJEWSKI^{1*}, Aleksandra SZTUK²

¹ Wrocław University of Economics and Business; marcin.majewski@ue.wroc.pl, ORCID: 0000-0003-3116-9020

² Wrocław University of Economics and Business; aleksandra.sztuk@ue.wroc.pl, ORCID: 0000-0002-1845-0363

* Correspondence author

Purpose: The article identifies characteristics that foster entrepreneurship and support startup-oriented entrepreneurial ecosystems.

Design/methodology/approach: A qualitative approach based on interviews was used. The research tool was based on Spigel's entrepreneurial ecosystem model, expanded to include factors specific to small territorial units, identified through a literature review. 32 start-up representatives from small towns, medium and large cities participated in the interviews.

Findings: Around 75% of respondents from small towns report a favorable business climate. Key advantages include local relationships, social capital, a business-friendly climate, and lower operating costs. This means that the entrepreneurial climate in small towns is primarily based on social capital, relationships, and cost factors rather than industry specialization.

Research limitations: The main limitation is the small sample size typical for qualitative approach, which limits the generalizability of findings.

Practical implications: Entrepreneurs operating in small cities should actively use social capital and local networks as sources of customers, partners, and business support.

Originality/value: The paper combines the perspective of the entrepreneurial ecosystem, start-ups and small towns, an area still unexplored in the literature.

Keywords: entrepreneurial ecosystem, small towns, start-up.

Category of the paper: Research paper.

1. Introduction

According to the population-based classification of territorial units used by the Central Statistical Office and adopted in the literature (e.g., Heffner, 2016; Zadęcka, 2018), small towns are defined as units with city rights and a population of fewer than 20,000. There are currently approximately 600 small towns in Poland, representing nearly 60% of all towns in the country. Small towns play a significant role in the national settlement structure, serving as a crucial link between rural areas and larger urban centers. They also contribute to territorial cohesion,

balanced regional development, and the mitigation of spatial inequalities, which are key objectives of contemporary regional policy.

Despite their importance, for many years there has been little interest in research on small territorial units in the scientific and business communities (Okulicz-Kozaryn, 2017). Only in recent years has there been a significant increase in the number of scientific studies on smaller towns. Research on small towns is increasingly becoming interdisciplinary, engaging representatives from fields such as geography, sociology, economics, urban planning, management, and territorial marketing (Przesmycka, 2025). However, much of this research remains fragmented and predominantly descriptive, with limited integration into broader theoretical frameworks such as entrepreneurial ecosystems or regional innovation systems. This creates a noticeable gap in understanding how small towns function as environments for entrepreneurship development.

Due to limited financial, human, and expert resources, small towns are unable to fully implement the investment, marketing, and revitalization strategies successfully employed by large urban centers. This does not, however, mean that they cannot effectively compete for the attention and interest of key audiences. A city's competitiveness largely depends on the ability of local authorities to undertake development initiatives, often burdened with risk, as well as on the competence level of those responsible for their implementation (Getz, 2017). Limited human and organizational resources often result in a lack of knowledge and tools needed to conduct creative promotional activities tailored to the specificities and unique characteristics of a given city (Richards, Duif, 2019). However, properly identifying and leveraging unique characteristics can constitute a significant competitive advantage. In this context, endogenous development factors, social capital, and local institutional capacity become particularly important determinants of competitiveness in small towns.

Domestic and foreign investors remain important target groups in small towns' marketing efforts. Small urban centers possess several attributes that distinguish them from larger cities, making them particularly attractive from an investment and business perspective. This article aims to identify the characteristics of small towns that foster entrepreneurship and assess them from the perspective of creating entrepreneurial ecosystems that support the development of startups. By doing so, the study contributes to the ongoing discussion on the spatial diversification of entrepreneurial ecosystems and extends existing research beyond large metropolitan areas, which are typically overrepresented in the literature.

However, despite the growing body of research on small towns, existing studies still provide limited insight into whether small towns can create conditions supportive of start-up development and entrepreneurial ecosystems comparable to those observed in metropolitan areas (Spigel, 2017; Okulicz-Kozaryn, 2017). Previous research has mainly focused either on descriptive analyses of small towns or on entrepreneurial ecosystems in large urban centers, leaving smaller territorial units relatively underexplored (Przesmycka, 2025). Moreover, studies emphasize the role of social capital, local networks, and institutional capacity in local

development processes (Richards, Duif, 2019; Getz, 2017), but there is insufficient knowledge regarding which of these factors are perceived by entrepreneurs as the most important for start-up development in small towns. Finally, comparative analyses between the entrepreneurial climate of small towns and that of larger cities remain limited in the literature.

These research gaps provided the basis for formulating the following research questions:

1. Are Polish small towns perceived as an environment conducive to the establishment and development of startups?
2. What factors most significantly shape the entrepreneurial climate in small Polish towns?
3. Does the entrepreneurial climate in small Polish towns differ from that in large cities?

The remainder of the paper is structured as follows. The next section reviews the literature on the conditions of entrepreneurship in small towns. This is followed by a presentation of the research methodology. The subsequent sections present and discuss the empirical findings. The paper concludes with key findings, practical implications, and directions for future research.

2. Development of entrepreneurship in small towns

2.1. Conditions of small towns that favor entrepreneurship

The investment attractiveness of small towns differs somewhat from that of larger urban centers, stemming from both the specific characteristics of local communities and the management style of local governments (Richards, Duif, 2019). Differences in the functioning of investors across smaller territorial units can be observed, related to the organization of local economic ecosystems. Factors supporting the development of business ventures in such towns align with the concept of entrepreneurial ecosystem domains, including human capital, the market, institutional support, culture, finance, and public policy (Isenberg, 2010). From the perspective of local governments, appropriately highlighting and communicating these elements is crucial, as it promotes the location and attracts investors.

In small towns, entrepreneurs operate in lower business density (Markowicz, 2016), which, in practice, translates into less competition and favors the development of new ventures, especially in the initial stages of their operations. An additional advantage is the lower cost of acquiring real estate and commercial space, which results from limited demand and lower levels of competition compared to large urban centers (Roundy, 2017).

In small territorial units, communication systems based on collaboration and information exchange can function particularly effectively, partially compensating for the lack of specialized knowledge resulting from fewer specialized management staff (McDermott, 2016).

This allows potential investors and local entrepreneurs to quickly obtain information and answers to inquiries, which is an important element of a favorable investment climate.

From the perspective of marketing communications and image-building, particularly in small towns, a territorial entity's image is one of the most important intangible assets influencing investment decisions. External investors are more likely to choose cities where local authorities demonstrate ambition, competence, and awareness in implementing development plans (McDonald, Bailly, 2017). Pro-investment attitudes among local government representatives reduce the risk of misunderstandings, delays, and a lack of support from investors' perspectives. At the same time, active engagement in establishing and maintaining relationships increases the likelihood of attracting investment in a given city.

Importantly, such initiatives do not require significant financial outlays, and their effectiveness depends primarily on the number and nature of priority issues within a given local government unit. Therefore, administrators of smaller cities can engage more in building direct contacts with investors than those in large urban areas, where the number of ongoing issues limits the ability to tailor approaches to external partners.

It is worth emphasizing that the European Union is currently undertaking several initiatives to improve the quality of life of residents of small towns and rural areas (Przesmycka, 2024). One of the key instruments in this regard is the EU Cohesion Policy 2021-2027, which introduces new priorities and mechanisms for financing local development. Its overarching goals include digital transformation and strengthening social and economic resilience. As part of its cohesion policy, the EU supports programs that support local economies, job creation, and social integration, which can provide an additional development stimulus for small towns seeking new ways to build investment attractiveness.

2.2. Limitations of small towns related to the development of entrepreneurship

Despite the numerous advantages inherent to small towns, they face several barriers that significantly limit their potential and hinder development. Small territorial units most often face barriers that focus on three fundamental areas (Farelnik, 2018, p. 104):

Social:

- migration of people, especially young people,
- limited opportunities for education, training, and skills development,
- limited number and type of services.

Economic:

- low level of innovation,
- limited availability of investment areas,
- disparities in local government budgets.

Spatial:

- often neglected areas and historical monuments,
- urban wastelands,
- poor recognition and attractiveness of recreational and tourist areas.

In the social sphere, one of the most serious threats to the development of small towns remains population outflow, particularly of young people. This phenomenon constitutes a significant barrier to development, primarily due to the limited number of jobs available in local labor markets (Zadęcka, 2018). An additional factor contributing to migration is the insufficient educational opportunities in small towns, which encourage residents to leave their homes not only at the stage of pursuing higher education, but often as early as secondary school (Józefowicz, 2024). Small-town authorities have limited options for countering these processes. Therefore, some researchers argue that strategic and marketing activities should focus more on attracting new potential residents, especially educated individuals who could constitute significant human capital, rather than on developing local educational opportunities to improve the competencies and qualifications of current residents (Bacolod, Blum, Strange, 2009).

A significant element shaping a city's image is its offering, understood as the range and structure of available urban products and services (Florek, Glińska, Kowalewska, 2009). The level of social development largely depends on residents' ability to meet their needs in their place of residence, utilizing available urban offerings. In the context of city management and the implementation of sustainable development principles, residents are considered by many authors to be a key stakeholder group (Zdon-Korzeniowska, 2011; Kesgin, Murthy, Pohland, 2019). At the same time, organizing social life in small towns is significantly more difficult than in large cities. The limited availability of public and commercial services contributes to exclusion from the urban offerings residents expect. This situation necessitates using services in larger urban centers, which, in the long term, may lead to a gradual outflow of people from small towns.

In the economic context, the development potential of small towns is significantly lower than that of larger urban centers (Stawasz, 2016). These limitations stem, among other things, from a shortage of financial and material resources that could support the implementation of diverse investments of varying scales (Stawasz, 2016). An additional factor hindering the economic development of small towns is staffing shortages in local governance structures. The insufficient number and limited competencies of management staff hinder the implementation of innovative and creative initiatives that could contribute to the attractiveness and competitiveness of territorial units (Richards, Duif, 2019).

From a national policy perspective, small towns are not treated as a priority area for development intervention (Czarnecki, 2013). Consequently, they are often overlooked in the process of formulating coherent strategies and support programs at the national level, which constitutes one of the key barriers to their development (Józefowicz, 2024). The lack of a systematic approach to small-town issues deepens existing development disparities and limits

their ability to compete with larger centers. At the same time, entrepreneurship is currently considered one of the key indicators for assessing a city's significance and its role in the regional structure (Nowak, Lusarczyk, 2010). Small-town authorities recognize the need to strengthen entrepreneurial attitudes among residents and to undertake various activities to stimulate local entrepreneurship. However, in recent years, there has been a significant decline in residents' willingness to start and develop their own businesses. This phenomenon is a consequence of, among other things, unfavorable macroeconomic conditions, such as high inflation, as well as growing competition from cheap discount chains, which limit the profitability of small, local enterprises (Kulawiak, 2022).

In the spatial sphere, a characteristic problem of many small towns is inefficient spatial development, manifested, among other things, by the occurrence of urban wastelands and degraded areas. Small towns encounter difficulties in limiting the inappropriate use of space, which results, among other things, from a lower level of institutional and planning preparation for comprehensive spatial transformation processes than in larger cities (Renn, 2013; Zadęcka, 2018).

Moreover, many small towns, due to poorly constructed development and territorial marketing strategies, struggle with a lack of a distinct local identity. Insufficient use of resources to create an attractive image leads to a lack of uniqueness and, consequently, a limited ability to stand out from competing centers. This results in low recognition of small towns both regionally and nationally (Richards, Duif, 2019).

2.3. Factors that foster the growth of startups in small towns

Innovative entrepreneurship is developing particularly rapidly in regional clusters or industrial districts (Schäfer, Brenning, 2024). A high concentration of companies and institutions in their immediate vicinity results in localized learning, which refers to the way knowledge and skills spread and are reinforced within a specific geographic area (van der Wouden, Youn, 2023). It is in large cities that the largest startup ecosystems are located. However, this does not mean that these are the only places conducive to the development of innovative entrepreneurship.

In the era of product digitization, the growing importance of services in the economy, and the emergence of virtual organizations, the physical location of startups is becoming less and less decisive for many business processes. Small cities, as locations for innovative business activity, have a range of advantages over large cities. For this reason, it is important to comprehensively examine the factors that foster the development of startups in small cities from the perspective of enterprises, which can be defined as:

- startups launched under conditions of high uncertainty (Ries, 2011),
- seeking a scalable business model (Blank, 2013),
- based on new technologies (Skala, 2017),
- in the early stages of development, up to 5 years old (European Commission, 2012).

2.4. Spiegel's model as an analytical framework for studying startup ecosystems

Spiegel's model of entrepreneurial ecosystems is one of the key concepts regarding the formation and development of startups (Spiegel, 2017). The author of the concept defines an entrepreneurial ecosystem as a set of interrelated cultural, social, and material attributes. Together, they create an environment conducive to the creation and survival of new companies. In this view, an ecosystem is not merely a collection of institutions, but primarily a relational structure in which entrepreneurs operate within networks of norms and collaboration, surrounded by infrastructure and resources. Spiegel divides the attributes of the ecosystem into three main categories comprising a total of 10 aspects, which are:

1. Cultural attributes:

- a culture of entrepreneurship,
- local success stories, and business traditions.

2. Social attributes:

- networking and mentoring,
- access to talent,
- access to investment capital,
- local leadership.

3. Physical attributes:

- higher education institutions and research organizations,
- business support services (incubators, accelerators),
- physical and technical infrastructure,
- public policies and regulations.

Despite its versatility, this model was designed primarily for developed entrepreneurial ecosystems in large cities. In the case of small towns, many elements of this model function differently, and some of them require reinterpretation and supplementation with factors typical of small towns. Based on the literature, three typical characteristics of small towns were identified that were not included in Spiegel's model: low business operating costs, social capital and local cooperation networks, and quality of life and social stability.

2.5. Low operating costs

The primary advantage small towns have over large cities is lower operating and living costs. Start-ups in Poland are most often financed with the founders' own funds, so reducing their living costs directly increases the company's budget (Majewski, 2025). Compared to large urban centers, small cities offer cheaper office space, affordable labor costs, and more favorable prices for professional services (Medina et al., 2023). These conditions lower the barrier to market entry and subsequently support financial liquidity by reducing expenses. This is a particularly important aspect from the perspective of startups, which face financial challenges in the pre-launch phase and liquidity issues in the launch phase (Stam, Schutjens, 2004).

Startups are companies that do not always know their business model or their customers, and therefore their operations in the early stages are based on iteration and continuous experimentation (Skala, 2017). Lower fixed costs for a young, innovative company mean the ability to test and iteratively develop business models without the risk of costs as high as those in major cities. As a result, startups can devote more time to the experimentation and prototyping stages, and ultimately to product validation. This is an environment more conducive to lean startups, which supports organic growth not necessarily reliant on internal capital (Becker, Endenich, 2023). The literature treats low operating costs as a significant trade-off for the benefits of being located in a larger city (Stam, 2015). Affordable infrastructure, including office space, serves as a key factor in attracting entrepreneurs seeking conditions for stable and long-term growth, rather than merely rapid market expansion. As a result, small cities become attractive environments for companies that value low operating costs, organizational flexibility, and the ability to scale their operations gradually.

2.6. Social capital and local networks of cooperation

In this study, social capital is understood as the set of trust-based relationships, norms of reciprocity, and informal cooperation mechanisms embedded within local communities (Huggins, Thompson, 2015). It should be distinguished from relational proximity, which refers to the ease and frequency of direct interpersonal interactions resulting from geographical and social closeness in small towns (Boschma, 2005). Institutional support, in turn, relates to formal actors and mechanisms such as local authorities, business support organizations, and public initiatives supporting entrepreneurship. In small towns, informal interactions occur more frequently, stemming from direct contact in public spaces or during community initiatives (Lebrun et al., 2021). Networks of relationships there are dense and personalized, making communication faster and more open, which leads to a higher level of trust. This is particularly important for startups, as they gain access to resources not available on the market. Among these are: access to tacit knowledge, recommendations, business partners, and early customers (Baraldi et al., 2019). Startups in small towns rely on different sources of knowledge than those in metropolitan areas. Instead of formal networks or events dedicated to startups, they more often turn to informal mentors or local experts for help.

2.7. Quality of life and social stability

Small towns have an advantage over large cities in terms of quality of life, which is a key factor in the location decisions of technology companies and startups (Scott, 2012). In smaller cities, commuting times are shorter and safety is greater, which translates to lower stress levels. This is particularly important for startups, which are created by small teams (initially, most often two founders), so the well-being of each team member has a direct impact on the company's effectiveness (Aryadita et al., 2023). Housing conditions in small towns are more favorable not only because of prices, but also due to better housing availability and proximity

to nature. Knowledge workers more often need time to recharge in a peaceful environment (Boge et al., 2019).

Quality of life is also strongly linked to talent retention. Smaller cities offer social stability, which promotes a balance between work and private life. This characteristic is cited as one of the most important for the younger generation of entrepreneurs (Ciccarelli et al., 2025). In smaller communities, employees show greater loyalty to their employers and, as a result, are less likely to change jobs (Partridge, Rickman, 2008). This is beneficial for startups that require a high level of employee commitment. Fewer job openings in smaller cities and lower living costs result in less pressure for higher wages, which is significant for startups that are, by definition, low-budget (Cassar, 2004).

2.8. Local niches and regional specialization

Small towns are often associated with economic niches that constitute their competitive advantages. These reflect their unique resources and values, such as industrial history, local expertise, and socio-economic structure (Asheim et al., 2011). Thanks to specialized knowledge, skills, and a long-term learning process in a given location, small cities can establish a foundation for local competitiveness. This serves as the basis for further innovation processes, even if the local market is small.

In this context, smart specialization is crucial, as it posits that regions, regardless of scale, should identify and strengthen fields where they possess unique advantages, rather than competing in areas where they lack potential (McCann, Ortega-Argilés, 2015). Start-ups operating in such specialized environments benefit from the effect of local roots, which include access to specialized suppliers, local know-how, networks of industry partners, and specific market data not found in other regions (Bugge, Øiestad, 2015). Local roots and smart specialization can be a factor that attracts innovative companies, despite limited local demand (Isaksen et al., 2018).

In the context of Polish small towns, local specializations may emerge in sectors linked to existing regional resources, industrial traditions, or place-based competencies. For example, furniture manufacturing and wood-processing industries are strongly developed in smaller towns in the Wielkopolska region, while agri-food processing and dairy production remain important in towns located in eastern and north-eastern Poland. Spa and tourism-oriented towns such as Polanica-Zdrój or Krynica-Zdrój have developed entrepreneurial activity around wellness, hospitality, and tourism services. In turn, towns located near major transport corridors increasingly specialize in logistics and warehousing services. Some smaller towns also attract IT freelancers and creative micro-enterprises due to lower operating costs and improving digital infrastructure. Although these specializations are smaller in scale than metropolitan clusters, they may still support entrepreneurial ecosystems by creating local know-how, supplier networks, and niche market opportunities.

3. Methods

To assess the operating conditions for startups in small towns, a research tool was developed based on Spiegel's (2017) model of entrepreneurial ecosystems, expanded to include factors characteristic of small territorial units, identified through a review of the relevant literature. For analytical clarity, the study distinguishes between social capital (trust-based community relations), relational proximity (ease of direct interaction resulting from local embeddedness), and institutional support (formal support mechanisms provided by local organizations and authorities). Combining the classic attributes of an ecosystem with characteristics typical of small towns allows for a comprehensive understanding of the local conditions influencing the development of innovative enterprises (Table 1).

Table 1.
Spiegel's model adapted for small towns

Attribute (small-town version)	Diagnostic question	The attribute's role in the ecosystem	Relationship to Spiegel's model (2017)
1. Entrepreneurial culture	Does the town have a climate conducive to starting businesses?	It boosts motivation, lowers barriers to entry, and normalizes entrepreneurship.	Attribute retained
2. Local success stories	Are there well-known local examples of successful companies?	Provide role models and increase entrepreneurs' confidence in their own abilities.	Attribute retained
3. Networks and trust	Do entrepreneurs easily establish partnerships thanks to local connections?	It facilitates access to knowledge, customers, partners, and support.	Attribute retained (key)
4. Low operating costs	Do living and operating costs realistically support business growth?	Reduces business risk and facilitates the experimentation phase for startups.	Replaces "access to capital"
5. Quality of life and social stability	Does the quality of life help maintain a stable and loyal team?	Increases talent retention, reduces stress, and lowers employee turnover.	Replaces "access to talent"
6. Local economic niches and specialization	Does the city have an industry or niche specialization that supports startups?	It creates local demand, access to know-how, and a sense of rootedness.	Replaces "access to talent"

Source: author's own elaboration based on (Spiegel, 2017).

Of its ten attributes, those that are also present in small towns were retained: a culture of entrepreneurship, local success stories, networks of contacts, and basic support infrastructure. The remaining attributes, such as access to capital, talent, or knowledge institutions, have been replaced with elements specific to small towns. These include: low operating costs, high quality of life and social stability, and local economic niches based on smart specialization.

This adaptation resulted in a six-point diagnostic checklist that reflects the actual operating conditions for startups in small towns and allows for an assessment of whether a given urban center can create a micro-ecosystem conducive to innovative entrepreneurship. This list was then incorporated into the interview form. Before the study began, respondents were asked two screening questions designed to exclude those who did not meet the target population criteria.

These questions concerned the duration of business operation and the location of the business. The interview form was divided into three stages. The first stage involved asking respondents six questions regarding the conditions for start-up operations in cities on a dichotomous scale with possible “yes” or “no” answers. For each question, participants were asked to indicate whether the specified conditions conducive to start-up development were present in the city under analysis. Next, in the second stage, each participant was asked to evaluate the listed statements in the context of startup development using a five-point Likert scale, where 1 meant “definitely unimportant” and 5 meant “very important”. In the final part of the study, respondents were asked to identify the statement (factor) they considered most important for startup development, along with a justification for their choice.

The study group consisted of 32 respondents representing startups in small, medium, and large cities. The average duration of an interview was approximately 20 minutes. Interviews were conducted using an MS Forms questionnaire or via telephone. Table 2 presents a breakdown of survey respondents by the size of the city in which they operate. The largest group consisted of respondents operating in large cities (50% of respondents).

Table 2.

Summary of the number of survey respondents by the size of the city in which they conduct business

Category	Number of respondents	Percentage
Big cities	16	50%
Medium-sized cities	8	25%
Small towns	8	25%

Source: authors' elaboration.

Descriptive statistics were analyzed for the study sample (N = 32). The mean age of the startups was 2.76 years. The median age was 2 years, and the mode was also 2 years. Values ranged from 1 to 5 years. The first quartile (Q1) was 2 years, while the third quartile (Q3) was 4.5 years, corresponding to an interquartile range of 2.5 years. The results indicate moderate variation in the age of the companies and a slight right-skewed distribution, as the mean was slightly higher than the median.

4. Results

The first section of questions consisted of 6 statements to which respondents were asked to answer “yes” or “no” (Table 3).

Table 3.*Questions asked of respondents in the first section of the interview*

	Questions	Yes/No
1.	Is the city a good place to start a business?	
2.	Are there any well-known local examples of successful businesses in the city?	
3.	Do entrepreneurs find it easy to establish business partnerships thanks to local connections?	
4.	Do the costs of living and working in the city actually support the company's growth?	
5.	Does the quality of life in the city help foster a stable and loyal team?	
6.	Does the city have an industry or niche specialization that supports startups?	

Source: authors' elaboration.

The first question posed to business owners concerned the business-friendly environment for starting a company in the location where they operate. The highest percentage of affirmative responses was recorded in medium-sized and small cities (75% each). In large cities, however, this percentage was significantly lower (56.3%). This means that the entrepreneurial climate is rated relatively more favorably in smaller centers than in large metropolitan areas.

The second question concerned the presence in the city of well-known, local examples of companies that are successfully running a growing business. In this case, large cities stood out significantly, as many as 93.8% of respondents in this category confirmed the presence of such examples. In medium-sized and small cities, this percentage was lower, at 75%, indicating greater visibility of business successes in large urban centers.

In the third question, respondents were asked whether entrepreneurs in their city easily establish partnerships thanks to the existence of local relationships. Among respondents from large cities, only 37.5% answered “yes.” In medium-sized and small cities, the percentage of affirmative responses was higher, at 50% each, suggesting that local relationships function relatively better.

Next, respondents were asked whether the cost of living and doing business in the city actually supports the company's growth. This factor was rated most favorably in medium-sized cities (75% “yes” responses), followed by small cities (62.5%). In large cities, however, negative responses prevailed, as only 43.8% of respondents considered the costs to be conducive to business growth.

The fifth question addressed the impact of quality of life on maintaining a stable and loyal team. The highest percentage of affirmative responses was recorded in medium-sized cities (75%), followed by small cities (62.5%), while in large cities this rate was lower at 56.3%.

Regarding the final question in this section, concerning the existence of an industry or niche specialization supporting the development of startups, large cities showed a clear advantage, as 50% of respondents in this category confirmed the presence of such a specialization. In medium-sized and small cities, the percentage of affirmative responses was significantly lower, at 25% each, which may indicate a lower sectoral concentration outside major urban centers. The distribution of responses to the questions is presented in Figure 1.

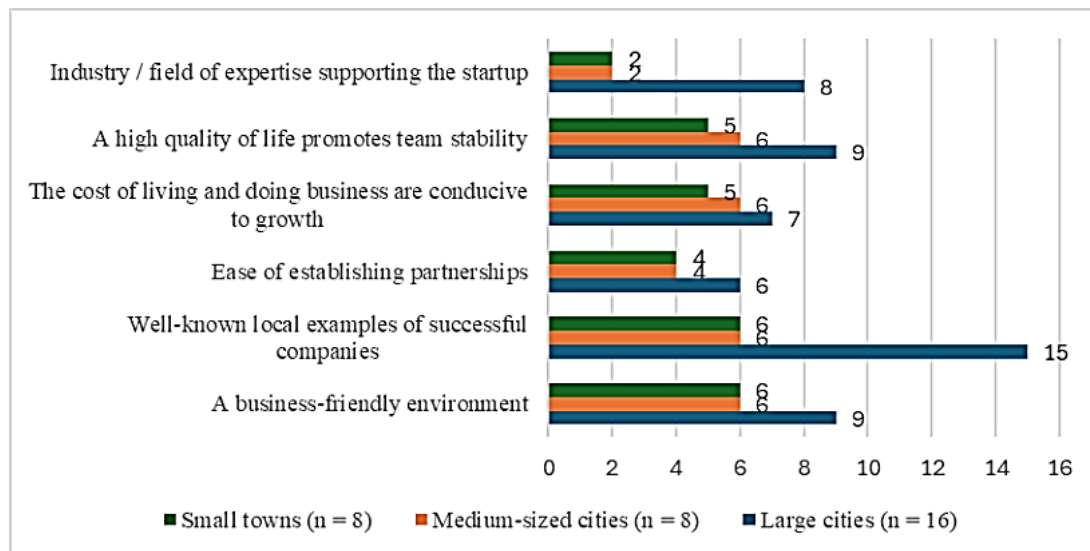


Figure 1. Assessment of operating conditions for startups-affirmative responses by city size.

Source: Authors’ elaboration.

Figure 1 presents a comparison of the number of “yes” responses for specific aspects of startup operations, broken down by city size. The visualization allows for the identification of areas where large, medium, and small cities differ in their assessments of conditions conducive to entrepreneurial development.

The second section of the study involved evaluating six factors on a scale from 1, where the factor was definitely unimportant, to 5, meaning the factor was very important in the respondents’ opinion. Table 4 presents the average ratings of startup development factors broken down by city size.

Table 4.

Average ratings of startup development factors (1–5) by city size

Factor	Large cities (N = 16)	Medium-sized cities (N = 8)	Small towns (N = 8)
A business-friendly environment	3,6	4,2	4,5
Local examples of successful companies	4,6	3,5	3
Local cooperation	3,2	4,1	4,4
Cost of living and running a business	2,9	4,5	4
A peaceful lifestyle	3	4,3	4,1
Industry specialization	4,5	3,2	2,8

Source: authors’ elaboration.

Assessments of factors conducive to the development of innovative enterprises reveal clear differences between cities of different sizes in terms of the operating conditions for startups. The climate conducive to starting a business was rated higher in small and medium-sized cities than in large ones. In contrast, local examples of successful enterprises and the presence of industry specialization were rated highest in large cities. In terms of the cost of living and doing business, medium-sized cities received the highest ratings, followed by small cities, while large cities were rated significantly lower. A similar pattern is evident in the assessment of quality of life and opportunities for collaboration, as medium-sized and small cities fare better in these

areas. The results indicate the existence of two distinct models of the entrepreneurial environment. Large cities are characterized by stronger industry specialization and a greater number of visible success stories, while medium-sized and small cities offer more favorable cost conditions, a higher quality of life, and better relational conditions. City size is a factor that differentiates the structure of advantages, though it does not unequivocally determine the overall level of favorable conditions for startup development.

The third and final stage of the study involved respondents identifying the most important factor favoring startup development and justifying their choice. The inclusion of a question asking respondents to select a single most important factor was intended to reduce the central tendency effect characteristic of Likert scales and to identify the factor with the highest decision-making significance. Table 5 highlights the most frequently selected responses in each city type using bold text.

Table 5.

The most important factor for startup development by city size

The most important factor	Large cities (N = 16)	Medium-sized cities (N = 8)	Small cities (N = 8)
Opportunity to establish a collaboration or partnership with local businesses	4 (25%)	4 (50%)	4 (50%)
A business-friendly environment	3 (19%)	2 (25%)	3 (38%)
Low cost of living and doing business in a given city	2 (13%)	2 (25%)	1 (12%)
The presence of an industry or niche specialization in a given city that supports the growth of a startup	4 (25%)	0	0
Local examples of thriving companies that serve as role models	3 (19%)	0	0

Source: authors' elaboration.

In large cities, respondents were relatively more likely to cite structural factors, such as the presence of an industry or niche specialization that supports startup growth, as well as local examples of thriving companies that serve as role models. This suggests the importance of sectoral concentration and visible business successes in large urban centers. In medium-sized cities, the most frequently cited factors were the opportunity to collaborate with local entrepreneurs and the low cost of living and doing business, which underscores the role of relational and economic factors in this category of cities. In small towns, the majority of respondents chose the opportunity for collaboration and a climate conducive to starting businesses, pointing to the importance of social capital and the overall institutional environment. Regardless of city size, the opportunity to collaborate with local entrepreneurs remained one of the most frequently cited factors. In contrast, industry specialization and success stories were clearly concentrated in large cities. These results indicate that city size shapes a distinct profile of perceived developmental advantages for startups and reflects diverse models of local entrepreneurial ecosystems. Table 6 presents sample responses from respondents that justify the selected factors for startup development in specific types of cities.

Table 6.*Justification for selecting the most important factor for startup development by city size*

The size of the city	The most important factor	Sample response from a respondent
Big city	The presence of an industry or niche specialization in a given city that supports the growth of a startup	“There are a lot of companies in our niche industry here, so it’s easier to find people and partners who understand what this business is all about. Unfortunately, a big city also means higher costs” (Respondent 4)
Big city	Local examples of thriving companies that serve as role models	“When you see that others have built a successful business here, you know this place offers real opportunities” (Respondent 9)
Medium-sized city	Low cost of living and doing business in a given city	“The costs are reasonable enough that you can grow your business without constant financial pressure. There’s less pressure on wages” (Respondent 15)
Medium-sized city	Opportunity to establish a partnership with local businesses	“It’s easy to get along with other business owners here, and the market isn’t oversaturated with competition. We feel closer to the authorities here” (Respondent 17)
Small town	A business-friendly environment	“People are more open and supportive, and it’s easier to start something from scratch, but it depends on the industry” (Respondent 21)
Small town	Opportunity to establish a partnership with local businesses	“In a smaller town, you can reach the right people more quickly, and relationships are more direct. I often work with my classmates” (Respondent 18)

Source: Authors’ elaboration.

The respondents’ comments shed further light on the previously identified differences between types of cities regarding the perceived factors influencing startup development. In large cities, structural factors are emphasized above all, such as the presence of a specific industry or niche specialization, as well as visible examples of other companies’ success. Respondents highlight access to specialized partners and expertise, while also noting the higher operating costs in large urban centers. In medium-sized cities, arguments related to reasonable cost levels and the relatively easier establishment of business relationships dominate. Comments point to lower wage pressure, less competition, and more direct contact with the local institutional and business environment. In small cities, on the other hand, respondents emphasize above all a climate conducive to entrepreneurship and the directness of social relationships. They highlight the openness of the community, easier access to key individuals, and stronger personal ties, which can support business development.

5. Conclusions

The study allowed for the development of answers to the research questions. The results show that approximately 75% of respondents from small towns report a climate conducive to starting a business. At the same time, the quality of life and opportunities for collaboration with local entrepreneurs were rated relatively high, indicating that small towns are perceived as entrepreneurship-friendly environments, particularly in relational and social dimensions.

Respondents' responses indicate that the following factors are particularly important in small towns: the ability to establish cooperation through local relationships (50% of affirmative responses), a business-friendly climate (75%), and relatively favorable living and operating costs (62.5%). This means that the entrepreneurial climate in small towns is primarily based on social capital, relationships, and cost factors rather than industry specialization.

The results of the study suggest that a predominance of relational factors and a focus on quality of life characterize small towns. At the same time, large cities are dominated by factors such as industry specialization and visible examples of success. This indicates that the entrepreneurial climate in small towns is more social and environmental, while in large cities it is based on sectoral concentration and economies of scale.

The findings are consistent with previous studies emphasizing the importance of social capital and local cooperation networks in smaller territorial units. Similar conclusions were presented by Huggins and Thompson (2015), who argued that trust-based local relationships significantly support entrepreneurial activity and knowledge exchange. The present study confirms that, in small towns, the opportunity to establish cooperation through local relationships is perceived as one of the most important factors supporting startup development.

The results also support the conclusions of Roundy (2017), who suggested that entrepreneurial ecosystems in small towns function differently from those in large metropolitan areas and rely more heavily on informal interactions and community embeddedness. Respondents from small towns emphasized relational proximity, direct access to local actors, and a supportive entrepreneurial climate rather than sectoral specialization or access to advanced institutions.

At the same time, the findings correspond with the literature indicating that lower operating costs and quality of life may compensate for the structural disadvantages of smaller cities (Stam, 2015; Scott, 2012). In the present study, entrepreneurs from small and medium-sized cities evaluated living and business costs significantly more positively than respondents from large cities, suggesting that cost advantages remain an important component of local entrepreneurial ecosystems outside metropolitan areas.

However, the study also reveals several findings that extend previous research. While earlier studies often emphasized the limited innovative potential of small towns due to weaker specialization and lower access to capital or talent (Lee, Xu, 2020), the obtained results suggest that startups may perceive relational and social factors as equally or even more important than traditional agglomeration advantages. This indicates that entrepreneurial ecosystems in small towns may follow a different developmental logic than ecosystems in large cities.

The study therefore contributes to the literature by proposing that small-town entrepreneurial ecosystems should not be evaluated solely through the lens of metropolitan growth models. Instead, their competitiveness may derive from social embeddedness, lower operational pressure, and stronger relational proximity. This perspective complements Spigel's

(2017) ecosystem framework by demonstrating that some ecosystem attributes operate differently in small territorial units and require contextual reinterpretation.

The findings suggest that not all relational mechanisms in small towns should be interpreted as social capital in the strict sense, as some advantages result primarily from relational proximity and easier interpersonal access rather than from deeply institutionalized trust networks.

Based on the study results, practical implications were formulated for three main stakeholder groups: entrepreneurs (start-ups), local authorities, and entities responsible for city territorial marketing. For entrepreneurs operating in small towns, leveraging social capital and local relationships is emphasized as a significant source of customers, business partners, and support in the enterprise development process. The specific nature of small towns, based on relational proximity, can be a significant factor in fostering business development.

Local authorities are recommended to pursue policies aimed at strengthening cooperation networks among entrepreneurs, including organizing industry meetings, networking initiatives, mentoring programs, and local business partnerships. Small towns may also support entrepreneurial ecosystems through the creation of local startup incubators, coworking spaces, and advisory centers tailored to early-stage firms. An important instrument may involve developing local financing mechanisms, such as microgrant programs, seed funding schemes, or preferential rental conditions for young enterprises operating in municipal properties. Investments in digital infrastructure, including high-speed internet access and smart-city solutions, may additionally increase the attractiveness of small towns for innovative and remote-based businesses. Local governments should also implement policies aimed at retaining young entrepreneurs and skilled workers, for example through housing support programs, cooperation with local universities and schools, internship initiatives, and measures improving the quality of life and cultural offer. Such instruments may help reduce the outflow of young talent to metropolitan areas and strengthen the long-term sustainability of local entrepreneurial ecosystems.

In turn, in the area of territorial marketing, it is indicated that small towns can enhance their attractiveness by communicating favorable business conditions, emphasizing the closeness of social relationships, and positioning themselves as a less expensive yet more entrepreneur-friendly alternative to large urban centers. The specific characteristics of small towns highlighted in the study can be a motivating factor for entrepreneurship, especially for start-ups, which, in the long run, can contribute to the development of the local economy and the expansion of urban offerings.

The study is subject to several limitations. First, the research was based on a relatively small sample of respondents ($N = 32$), which is characteristic of qualitative exploratory studies and limits the possibility of generalizing the findings to the broader population of startups in Poland. Second, the study relied on subjective assessments and self-reported perceptions of entrepreneurs, which may be influenced by individual experiences and local contextual

conditions. Third, the unequal distribution of respondents between large, medium-sized, and small cities may have affected the comparability of results between categories. Finally, the research focused exclusively on Polish cities, which limits the possibility of transferring the conclusions to other national and institutional contexts.

Regarding future research directions, given the qualitative approach, it seems justified to expand the scale of analyses and supplement them with quantitative research. This approach will enable more reliable results and provide a basis for generalizing them to a broader population. Furthermore, it is recommended to deepen the understanding of social capital in the context of start-up development. The results indicate that local relationships and a business-friendly climate are particularly important in small towns. Therefore, future research could focus on analyzing the importance of informal networks in the process of start-up creation, as well as their impact on the sustainability and dynamic development of young enterprises. This line of research would also allow for verification of whether and how social capital constitutes a real competitive advantage for small towns.

References

1. Aryadita, H. et al. (2023). Digital entrepreneurial ecosystems: A systematic literature review. *Journal of Business Research*, Vol. 154, pp. 113-125, doi: 10.1016/j.jbusres.2022.09.041
2. Asheim, B.T., Boschma, R., Cooke, P. (2011). Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases. *Regional Studies*, Vol. 45, Iss. 7, pp. 893-904, doi: 10.1080/00343404.2010.543126
3. Bacolod, M., Blum, B.S., Strange, W.C. (2009). Skills in the city. *Journal of Urban Economics*, Vol. 65, Iss. 2, pp. 136-153, doi: 10.1016/j.jue.2008.10.003
4. Baraldi, E., Havenvid, M.I., Linné, Å. (2019). Identifying and forming innovation networks: How firms engage in network orchestration. *Industrial Marketing Management*, Vol. 80, pp. 146-157, doi: 10.1016/j.indmarman.2018.04.002
5. Becker, S.D., Endenich, C. (2023). Entrepreneurial ecosystems as amplifiers of the Lean Startup philosophy: Management control practices in earliest-stage startups. *Contemporary Accounting Research*, Vol. 40, Iss. 1, pp. 624-667, doi: 10.1111/1911-3846.12806
6. Blank, S. (2013). Why the Lean Start-Up Changes Everything. *Harvard Business Review*, Vol. 91, No. 5, pp. 63-72.
7. Boge, K. et al. (2019). Knowledge workers deserve differentiated offices and workplace facilities. *Facilities*, Vol. 37, Iss. 1/2, pp. 38-60, doi: 10.1108/F-01-2018-0002

8. Bugge, M.M., Øiestad, S. (2015). The smart specialization framework: A critical assessment. *European Planning Studies*, Vol. 23, Iss. 5, pp. 962-979, doi: 10.1080/09654313.2014.928608
9. Cassar, G. (2004). The financing of business start-ups. *Journal of Business Venturing*, Vol. 19, Iss. 2, pp. 261-283, doi: 10.1016/S0883-9026(03)00029-6
10. Czarnecki, A. (2013). Atrakcyjność rynków pracy małych miast w Polsce (dla ludności miejscowej i dojeżdżających). *Studia Ekonomiczne*, Vol. 144, pp. 165-187.
11. Farelnek, E. (2022). Znaczenie koncepcji slow city w budowaniu zrównoważonego rozwoju małych miast w Polsce. *Studia BAS*, No. 3(71), pp. 99-120.
12. Florida, R., Mellander, C., Stolarick, K. (2008). Inside the black box of regional development—Human capital, the creative class and tolerance. *Journal of Economic Geography*, Vol. 8, Iss. 5, pp. 615-649, doi: 10.1093/jeg/lbn023
13. Getz, D. (2017). Developing a framework for sustainable event cities. *Event Management*, Vol. 21, Iss. 5, pp. 575-591, doi: 10.3727/152599517X15053272358901
14. Heffner, K. (2016). Obszary wiejskie i małe miasta: czy lokalne centra są potrzebne współczesnej wsi? *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*. *Studia Ekonomiczne*, Vol. 279, pp. 11-24.
15. Huggins, R., Thompson, P. (2015). Entrepreneurship, innovation and regional growth: a network theory. *Small Business Economics*, Vol. 45, Iss. 1, pp. 103-128, doi: 10.1007/s11187-015-9643-3
16. Isaksen, A., Tödtling, F., Trippel, M. (2018). Innovation policies for regional structural change: Combining actor-based and system-based strategies. *European Planning Studies*, Vol. 26, Iss. 3, pp. 428-449, doi: 10.1080/09654313.2017.1360471
17. Isenberg, D.J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review*, Vol. 88, Iss. 6, pp. 40-50.
18. Józefowicz, K. (2022). *Konkurencyjność małych miast w Polsce i jej uwarunkowania* (Doctoral dissertation). Poznań: Uniwersytet Ekonomiczny w Poznaniu.
19. Kesgin, M., Murthy, R.S., Pohland, L.W. (2019). Residents as destination advocates: The role of attraction familiarity on destination image. *Journal of Hospitality and Tourism Insights*, Vol. 2, Iss. 1, pp. 55-74, doi: 10.1108/JHTI-06-2018-0034
20. Kulawiak, A. (2022). Analiza atrakcyjności małych miast województwa łódzkiego pod względem rozwoju lokalnej przedsiębiorczości. *Przedsiębiorczość – Edukacja*, Vol. 18, Iss. 2, pp. 25-40.
21. Lebrun, K. et al. (2021). Towards a better understanding of urban accessibility: A review of accessibility measures and indicators. *Transport Reviews*, Vol. 41, Iss. 3, pp. 321-343, doi: 10.1080/01441647.2020.1807318
22. Lee, J., Xu, J. (2020). Why do businesses grow faster in urban areas than in rural areas? *Regional Science and Urban Economics*, Vol. 81, Article 103521, doi: 10.1016/j.regsciurbeco.2020.103521

23. Majewski, M. (2025). *Znaczenie innowacji dla sukcesu start-upów w Polsce*. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.
24. McCann, P., Ortega-Argilés, R. (2015). Smart specialization, regional growth and applications to European Union cohesion policy. *Regional Studies*, Vol. 49, Iss. 8, pp. 1291-1302, doi: 10.1080/00343404.2013.799769
25. McDermott, T. (2016). *Small, smart and connected: Boosting small cities*. TEDx Talks. Retrieved from: https://www.youtube.com/watch?v=Z1zd_Od4nBk, 11.02.2026.
26. McDonald, R., Bailly, A. (2017). *What investors want: A guide for cities – How should cities engage investors and developers? (Report)*. London: Centre for Cities.
27. Nowak, M., Lusarczyk, M. (2010). Przedsiębiorczość w najmniejszych miastach w Polsce. *Studia Prawno-Ekonomiczne*, Vol. 72, pp. 329-343.
28. OECD (2010). *High-Growth Enterprises: What Governments Can Do to Make a Difference*. Paris: OECD Publishing.
29. Okulicz-Kozaryn, A. (2017). Unhappy metropolis (when American city is too big). *Cities*, Vol. 61, pp. 144-155, doi: 10.1016/j.cities.2016.11.002
30. Partridge, M.D., Rickman, D.S. (2008). Distance from urban agglomeration economies and rural poverty. *Journal of Regional Science*, Vol. 48, Iss. 2, pp. 285-310, doi: 10.1111/j.1467-9787.2008.00557.x
31. Przesmycka, E. (2025). Współczesne teorie urbanistyczne a kierunki przekształceń małych miast w kontekście polityki Unii Europejskiej dotyczącej ich rewitalizacji. *State and Society*, No. 1, pp. 93-112.
32. Renn, A.M. (2013). *The tough realities facing smaller post-industrial cities*. Retrieved from: <https://www.urbanophile.com>, 30.04.2026.
33. Renn, A.M. (2013). *The tough realities facing smaller post-industrial cities*. Retrieved from: <https://www.urbanophile.com/2013/11/03/the-tough-realities-facing-smaller-post-industrial-cities/>, 14.01.2026.
34. Richards, G., Duif, L. (2019). *Small cities with big dreams: Creative placemaking and branding strategies*. New York: Routledge.
35. Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. New York: Crown Business.
36. Roundy, P.T. (2017). Small town entrepreneurial ecosystems: Implications for developed and emerging economies. *Journal of Entrepreneurship in Emerging Economies*, Vol. 9, Iss. 3, pp. 238-262, doi: 10.1108/JEEE-09-2016-0033
37. Schäfer, S., Brenning, A. (2024). Industry diversity in entrepreneurial ecosystems: a longitudinal study of industrial composition and firm locations in Tel Aviv, Israel. *Progress in Economic Geography*, Vol. 2, Iss. 2, Article ID 100016, pp. 1-9, doi: 10.1016/j.peg.2024.100016
38. Scott, A.J. (2012). *A World in Emergence: Cities and Regions in the 21st Century*. Cheltenham: Edward Elgar.

39. Skala, A. (2017). Spiralna definicja startupu. *Przegląd Organizacji*, No. 9, pp. 33-39.
40. Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice*, Vol. 41, Iss. 1, pp. 49-72, doi: 10.1111/etap.12167
41. Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies*, Vol. 23, Iss. 9, pp. 1759-1769, doi: 10.1080/09654313.2015.1061484
42. Stam, F.C., Schutjens, V.A.J.M. (2004). *The Performance of Team Start-Ups in the First Phases of the Life Course (ERIM Report Series Research in Management, ERS-2004-097-ORG)*. Rotterdam: Erasmus Research Institute of Management. Retrieved from: <http://hdl.handle.net/1765/1784>, 30.04.2026.
43. Stawasz, D. (2016). *Współczesne dylematy zarządzania rozwojem miast*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego
44. van der Wouden, F., Youn, H. (2023). The impact of geographical distance on learning through collaboration. *Research Policy*, Vol. 52, Iss. 2, doi: 10.1016/j.respol.2022.104698
45. Zadęcka, E. (2018). Cittàslow – koncepcja dobrego życia w małym mieście. *Studia Ekonomiczne*, Vol. 348, pp. 129-143.
46. Zdon-Korzeniowska, M. (2011). Marketing terytorialny jako forma działań przedsiębiorczych samorządów terytorialnych w Polsce. *Przedsiębiorczość – Edukacja*, Vol. 7, pp. 188-196.

THE FUTURE OF THE CORD MODEL: RECOMMENDATIONS FOR ITS DEVELOPMENT IN POLISH HIGHER EDUCATION INSTITUTIONS

Artur MATŁACH

Academy of Applied Sciences in Elbląg; a.matlach@ans-elblag.pl, ORCID: 0009-0008-4248-6463

Purpose: The paper addresses the future of the CORD model under the combined demographic, financial and technological pressures shaping contemporary higher education, including the rapid diffusion of generative artificial intelligence. Its dual aim is to reinterpret the CORD model (Contextualisation–Organisation–Researching–Developing/Delivery) in light of current Polish debates on the university transformation and to test its usefulness as a framework for explaining the educational decisions of candidates and the drop-out phenomenon.

Design/methodology/approach: The study combines a critical review of the literature on the CORD model with a quantitative, cross-sectional, exploratory survey (n = 247) conducted among first-year bachelor students in Poland. Items in the questionnaire were mapped onto the four CORD pillars in order to relate selected features of the educational offer and the organisation of studies to a self-reported intention to drop out.

Findings: Results show a clear dominance of pragmatic criteria — costs, flexibility of the schedule, employment prospects — over the symbolic prestige of the institution. The findings indicate that a mismatch between the organisation of studies and students' life profiles (combining studies with paid work) is associated with a higher declared propensity to drop out, regardless of the perceived prestige of the university.

Research limitations/implications: The sample was purposive rather than random and the design was cross-sectional, which precludes strong causal inferences. Findings should be tested on larger and longitudinal samples and linked with administrative data on study trajectories.

Practical implications: The study formulates recommendations for university management, including redesigning class schedules toward more flexible and condensed formats, expanding hybrid delivery, building early-warning systems based on LMS analytics and involving students in the co-design of programmes.

Social implications: By foregrounding the perspective of first-year students, the paper contributes to a more inclusive view of higher education quality and to a public debate on the social mission of universities under demographic decline and digital transformation.

Originality/value: The paper proposes an extension of the original CORD model toward CORD 2.0 / CORD+ — by explicitly integrating digital, resilience and sustainability dimensions — and tests it empirically on the Polish higher education context.

Keywords: CORD model, higher education management, drop-out, student experience, digital transformation.

Category of the paper: Research paper; conceptual paper.

1. Introduction

Polish higher education has entered a period in which several crises overlap: a demographic one, a financial one, a crisis of public trust and a technological one related to the rapid diffusion of generative artificial intelligence. A reorientation of public expenditure toward defence is currently visible, partly at the expense of the already modest spending on research, development and higher education. The literature stresses that the system has “entered a drift”, which means that, instead of coherent development strategies, the dominant pattern is one of reactive responses to financial and regulatory stimuli. At the same time, OPI PIB reports show persistently high drop-out rates and growing diversification of candidates’ motivations¹.

This diagnosis is not only a description of external pressures but also a starting point for identifying a theoretical and practical gap in the management of Polish higher education institutions. Existing studies usually analyse demographic decline, digital transformation, university stratification, student retention or higher education marketing as separate research areas. Much less attention has been paid to the question of how these pressures interact at the level of institutional strategy and how they are translated into the everyday student experience, especially in the first year of studies. This is particularly important because first-year students confront the promotional promises of universities with the actual organisation of teaching, timetable flexibility, support mechanisms and the perceived labour-market relevance of programmes.

Against this background, F. Maringe’s CORD model — which combines marketing, strategic planning and curriculum development — offers a promising framework for analysing the strategies of Polish universities. The paper has two objectives: first, to reinterpret the CORD model in light of Polish debates on the transformation of the university (Sulkowski, Kwiek, Antonowicz, Leja); second, to propose and preliminarily test the CORD approach as a tool for explaining the educational decisions of candidates and the drop-out phenomenon, drawing on the results of a survey conducted among first-year students².

In its original formulation, the CORD model was proposed as a tool for organising the marketing (and programme) strategies of universities around four interrelated areas: Contextualisation (analysis of demographic and social conditions), Organisation (structures, processes and organisational culture), Researching (systematic study of the needs and experiences of students and other stakeholders) and Developing (designing and improving the curriculum as the “core product” of the university). In its first applications the model focused mainly on responding to the marketing crisis in higher education and on the need to anchor communication in the actual educational offer — that is, on a shift from promotional activities toward a coherent, student-oriented strategy. Subsequent works gradually reinterpreted CORD as a broader instrument for managing change and building institutional resilience, opening space for further extensions with digital, analytical and sustainability-related components.

The present paper takes these original assumptions as its point of departure, while arguing that contemporary challenges justify the addition of further dimensions, in particular those referring to artificial intelligence, learning analytics, resilience and sustainability³.

The novelty of this paper lies in combining three perspectives that are usually discussed separately: the CORD model as a framework for university marketing and programme development, Polish debates on the strategic transformation of higher education, and empirical data on the motivations and drop-out intentions of first-year students. The article therefore does not treat CORD only as a descriptive model of university marketing, but as an analytical tool for diagnosing the mismatch between what universities communicate and what students actually need in order to continue their studies. In this sense, the study contributes to the literature by proposing a context-sensitive extension of CORD toward a more operational model of student retention, digital adaptation and organisational flexibility in Polish higher education institutions.

The rationale for taking up the topic rests on three research gaps still visible in the analysis of Polish higher education. First, there is a lack of coherent approaches linking the strategic decisions of universities with the micro-level of the student experience (timetable, forms of teaching, organisation of support, hybridity) in a way that allows for the formulation of testable hypotheses concerning the drop-out phenomenon⁴. Second, in many studies digitalisation and AI are treated as a technological or ethical-regulatory issue rather than as a factor permeating all dimensions of university management in the CORD logic (context, organisation, study of needs, design and delivery of the programme). Third, there is a shortage of empirical studies focused on the first year of studies — the period that is critical from the perspective of retention — which combine declared motivations for choosing studies with an assessment of the organisation of teaching and a self-reported propensity to drop out.

The present paper addresses these gaps by combining a theoretical reinterpretation of the CORD model with exploratory empirical evidence collected among first-year students. Its contribution is twofold: theoretically, it shows how CORD may be extended to include digitalisation, resilience, sustainability and retention-oriented management; empirically, it demonstrates which elements of the educational offer and study organisation are most strongly perceived by students as relevant to their educational decisions. The context outlined in this way sets the direction for the further parts of the paper — from the reconstruction of the CORD model and its embedding in the literature, through the analysis of empirical data, to proposals for its further development.

Consequently, the following research questions were formulated:

1. To what extent does the CORD model allow an adequate description of the contemporary conditions of higher education institutions in Poland, in particular under demographic, financial and technological pressure?

2. Which elements of CORD (context, organisation, study of needs, development/delivery of the programme) are most strongly linked to the factors that first-year students declare as driving their choice of studies?
3. Whether — and how — a discrepancy between students' declared priorities and the organisation and form of teaching may increase the propensity to drop out (the drop-out intention)?
4. Which modifications and extensions should be incorporated into the CORD model so that it better corresponds to the reality of Polish universities?

A set of working hypotheses was also adopted to structure the analysis and to indicate directions for further research (including panel research or studies using administrative data). In particular, it is assumed that:

- H1: A mismatch between the organisation of studies (schedule and class formats) and students' life profile (e.g. combining studies with paid work) increases the risk of dropping out.
- H2: The greater the alignment between students' declared priorities (costs, flexibility, employment prospects) and the actual offer and organisational practice of the university, the lower the declared propensity to drop out.
- H3: Universities with weaker research resources build their competitive advantage through investment in the Development/Delivery element (flexibility, support, personalisation), which may reduce drop-out in groups particularly sensitive to organisational factors.

Section 1 presents the CORD model and its interpretations against the background of debates on the strategy and transformation of Polish universities, indicates the perspectives of Polish researchers (Sułkowski, Kwiek, Antonowicz) and outlines the drop-out problem. Section 2 presents the methodology of the authors' own research (a survey of first-year students, $n = 247$). Section 3 discusses the results and interprets them within the four-pillar CORD framework, highlighting potential mechanisms generating the risk of drop-out. Section 4 organises the hypotheses and indicates possible causal relationships requiring further verification on longitudinal or administrative data. Section 5 presents the limitations of the research. The paper closes with Section 6, in which practical implications and directions for the development of the model are formulated (including its "digitalisation" and reinforcement with continuous evaluation mechanisms) as well as recommendations for university management practice in conditions of growing uncertainty.

2. The CORD model, Polish perspectives on university strategy and the drop-out phenomenon, literature review

2.1. Maringe: CORD — from marketing to strategy

The CORD model (Contextualisation–Organisation–Researching–Developing/Delivery) emerged as a response to the marketing crisis of higher education institutions, which consisted in the mechanical transfer of commercial tools into universities without reflection on their academic mission. Maringe argued that university marketing is “inappropriate, poorly coordinated and lacking formal operational guidelines”, and that fixing it requires anchoring marketing in study programmes and in a dialogue with stakeholders⁵. CORD proposes a distinction between four areas: the contextualisation of strategy, inclusive organisation and coordination, the systematic study of the student interface and the development of the curriculum as the “core product” of the university⁶. In the original version of CORD the key assumption was to reformulate the question from “how to promote the university effectively?” to “how to design and organise the offer so that it responds to real conditions and stakeholder needs?”. The response to the critique of traditional marketing was therefore to redirect attention from image-related messages to decisions about programme structures, forms of teaching, ways of researching student satisfaction and mechanisms of internal coordination. The model provided universities with a set of reflective questions on whether the offer is coherent with the demographic and labour-market context, whether the organisation supports retention, whether processes for studying needs are systematic, and whether programme development is linked with feedback from students⁷. In post-pandemic studies the model is read as a framework for building resilience and adaptive capacity, but requires complementing with a digital component and continuous evaluation mechanisms⁸.

Table 1.

*Operationalisation of the CORD model — key questions and research variables*⁹

CORD element	Key questions for the university	Relevant research areas / data	Sample variables in the survey / sources
Contextualisation (Context)	What are the real conditions in which the university operates (demography, labour market, generational expectations, technologies)?	Demographic analyses, labour market reports, system-level data on recruitment and drop-out, studies on candidates' motivations. ¹⁰	Importance of employment prospects after graduation in choosing a field; importance of location, costs, opportunities to work during studies; OPI data on the structure of drop-out by type of university, field and mode.
Organisation & Coordination (Organisation and coordination)	Do the organisational structure, culture and processes support a coherent, student-oriented strategy and retention?	Management structure, scope of responsibilities of dean's offices, quality units, careers offices; practices of timetable design; student support policies. ¹¹	Assessment of the timetable (ability to combine studies with work); perceived availability of support (tutor, year supervisor); differences between public and non-public universities in the organisation of studies; presence of anti-drop-out strategies / support procedures. ¹²

Cont. table 1.

Researching (Studying the student and market interface)	How does the university get to know the needs of candidates, students, employers and other stakeholders?	Satisfaction surveys, studies of choice motivations, graduate-tracking, analytics of e-learning systems, consultations with the socio-economic environment.	Survey on the factors of choice of studies; students' declarations on the importance of particular aspects of the offer; possible data on attendance.
Developing/ Delivery (Programme development and delivery)	Do the programmes and the form of teaching respond to the identified needs and life conditions of students?	Programme design (flexibility, modularity), involvement of practitioners, presence of online / hybrid components, teaching methods, AI-based tools supporting individual learning paths. ¹³	Importance of online and hybrid classes; assessment of the flexibility of the form of studies (ability to study and work); declared propensity to drop out; implementation of AI tools (chatbots, course recommendations) and their perception by students (in subsequent stages of research).

Source: own elaboration based on F. Maringe, P. Gibbs, *Marketing Higher Education: Theory and Practice*, Open University Press, 2008; OPI PIB reports (<https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelnich/>).

In the context of the present research, it becomes crucial to indicate how the individual components of CORD correspond to the real challenges faced by Polish universities. Table 1 maps these relationships, linking the theoretical pillars of the model with concrete research areas and variables that were used to construct the questionnaire and to interpret the results. This approach is consistent with tendencies visible in international research on the choice of university and study programme, in which students' decision models increasingly combine the analysis of contextual, organisational and experiential factors within a single, integrated analytical framework, rather than treating them as separate threads¹⁴.

2.2. Sułkowski: the “digital university” and CORD

The author shows that Polish universities are moving from the traditional model toward a “digital university” understood as a platform-based, data-driven organisation, with a growing role of remote and hybrid forms of teaching. This transformation has a technological dimension (LMS platforms, information systems), but above all a cultural one — it requires changes in the way the university is managed, in communication and in the role of the student. From the perspective of CORD this means the necessity of introducing a “T factor” (technological) into all four pillars: the context covers the digital environment and AI; the organisation encompasses structures responsible for digitalisation and analytics; researching includes learning analytics; and development covers programme design and delivery using digital and AI-based solutions¹⁵.

Sułkowski also underlines the tension between the “utopia of freedom” and the “dystopia of power” in managing the digital university — technologies can serve both personalisation and control. In the perspective of drop-out and individual development paths, CORD may become a tool for restoring balance: technological personalisation makes sense only when it is anchored in the mission and in dialogue, rather than in a pure efficiency logic¹⁶.

2.3. Kwiek: stratification and “the vanishing scientists”

Kwiek analyses Polish higher education in the perspective of a long-term transformation: the concentration of resources, the polarisation of universities and changes in the professional status of academic staff. The notion of “the vanishing scientists” shows that the base scenario is the shrinking of the academic population and the growing concentration of research in a narrow elite of universities. In CORD logic, this implies a dramatic differentiation of the Researching component: some universities are evolving into high-quality research-and-teaching centres, while others are confined to the role of providers of mass, low-cost education¹⁷.

Kwiek points out that university strategies are largely determined by funding algorithms and by the ranking-driven logic of the system. This reinforces the risk that marketing and programme decisions will be shaped more by indicators than by the recognised needs of students and the wider environment. From the perspective of drop-out research, the hypothesis arises that universities with weaker research resources will seek competitive advantage in the Delivery area (flexibility, personalisation, student orientation), while research-intensive universities may base their attractiveness mainly on prestige and resources¹⁸.

2.4. Antonowicz: the “drift” and the weakness of strategy

Antonowicz diagnoses Polish higher education as a system that has “entered a drift”, lacking a clearly defined vision and development policy, where decisions are often reactive and ad-hoc. From the perspective of CORD, this implies the underdevelopment of the Context and Research pillars: universities observe demographic and market changes but fail to translate them into a coherent reorientation of programmes and teaching models¹⁹.

Antonowicz also shows that the strategic documents of Polish universities are dominated by the language of modernisation, innovation and internationalisation, but lack solid mechanisms of implementation and monitoring. In our analysis this is a direct gap: CORD indicates that feedback loops between context, organisation and curriculum are crucial — Polish universities, however, often stop at the level of declarations²⁰.

2.5. Leja: university management and organisational culture

Leja emphasises the importance of organisational culture and the specificity of the university as a knowledge organisation, in which academic, bureaucratic and managerial logics coexist. Drawing attention to the limits of mechanical transfers of business solutions, he argues that effective university management requires the building of trust and participation, including the engagement of staff and students in decision-making processes²¹.

From the perspective of the research questions adopted in this paper, it is important to note that international literature converges on a similar set of themes: the growing significance of economic and organisational factors in students’ educational decisions, a shift from prestige

toward the “service experience”, and the need for the systematic study of the student–university interface using quantitative data. The CORD model can therefore be treated as a bridge between these strands, enabling both a synthesis of the international literature and the embedding of Polish discussions on system drift, university stratification and digitalisation within a broader comparative context. The literature review constructed in this way provides a direct basis for formulating research questions on the significance of the individual CORD pillars in the decisions of first-year students and for designing the empirical study presented in the next section.

3. Methods

Starting from the theoretical framework and research questions outlined above, an empirical study was designed, the key methodological assumptions of which are presented below. The literature review leads to the conclusion that Polish higher education is in a phase of “strategic drift” (Antonowicz, 2015), in which traditional ways of competing — based on prestige and image-oriented marketing — are losing their effectiveness. The analysis of F. Maringe’s work on the CORD model, set against the diagnoses of Polish researchers (Kwiek, Sułkowski, Leja), points to a fundamental shift of emphasis: from promotion (what the university says about itself) to delivery (how the university actually carries out the teaching process and provides support). The literature clearly suggests that, in the era of digital transformation and demographic pressure, the key strategic resource is not so much a static programme offer as organisational flexibility and the ability to personalise the student’s pathway.

Despite the rich literature on the macro-level conditions of the system (university stratification, funding), a significant research gap has been identified at the level of micro-analyses. There is a lack of studies that directly link the strategic pillars of the CORD model (Context, Organisation, Researching, Development) with the subjective assessment of first-year students — the group most exposed to the risk of drop-out. Existing research rarely verifies to what extent the “student-centric” strategies declared by universities correspond to the actual experience of the educational “customer” when confronted with the timetable, infrastructure or availability of teaching staff.

In light of the above, the main aim of the study is the empirical verification of the usefulness of the CORD model as a tool for explaining candidates’ educational decisions and the identification of organisational factors that increase the risk of dropping out.

The study seeks to answer the following research questions:

1. Which elements of the CORD model (in particular the Delivery and Organisation areas) are crucial for contemporary students when choosing a university, and do they dominate over traditional prestige?
2. Is there an observable convergence between the organisational “rigidity” of the university (e.g. lack of flexibility in the schedule, inadequate forms of teaching) and the intention to drop out declared by students?
3. To what extent does the “digital gap” and the way in which modern technologies are used in teaching differentiate the perceived attractiveness of the educational offer?

The methodology of the authors’ own research was designed so that the operationalisation of the variables of the CORD model (presented in Table 1) makes it possible to verify the hypotheses formulated earlier.

The study was quantitative, cross-sectional and exploratory in nature, embedded in the perspective of management and quality sciences, and used the CORD model as an interpretative framework. The sampling targeted the population of first-year bachelor students at Polish universities. The research sample consisted of 247 students, selected purposively (priority was given to social, economic and technical fields, where drop-out rates are relatively high)²².

The research technique used was a diagnostic survey in the form of an online questionnaire (electronic form) distributed via student self-government bodies and the universities’ communication platforms. The instrument was an original questionnaire consisting of four blocks: a record sheet, factors of choice of university and field of studies (Likert scale 1-5, from “1 — completely unimportant” to “5 — crucial”), assessment of the organisation and form of studies (including the flexibility of the schedule) and propensity to drop out.

Items concerning the factors of choice of studies and the assessment of the organisation of studies were designed by mapping them onto the elements of CORD: Context — e.g. employment prospects; Organisation — the timetable; Researching — the perception of dialogue and surveys; Developing/Delivery — the form of classes.

The study took into account dependent, independent and control variables. The dependent variable was the propensity to drop out of studies. The independent variables were the individual factors (and their significance) considered when choosing studies: costs, prestige, infrastructure, employment prospects, location, timetable, presence of online classes, student events, others’ opinions, family expectations; the assessment of the flexibility of the organisation of studies, including the ability to combine studies with work and the availability of hybrid and/or online classes. Control variables were also included: type of university (public/non-public), mode of studies (full-time/part-time), field of education and gender. Respondents answered questions concerning the factors of the choice of university and field, as well as the importance of various aspects of the offer and of the organisation of studies. The instrument included, among others, the assessment of the importance of: the prestige of the

university, costs, infrastructure, location, employment prospects, the timetable, the presence of online classes, student events, others' opinions and family expectations.

In order to move beyond purely descriptive distributions, future stages of the research should include regression-based modelling of drop-out intention. If the dependent variable is measured dichotomously, for example as the declared consideration of discontinuing studies, binary logistic regression would be the most appropriate approach. If the variable is measured on an ordinal Likert scale, ordinal logistic regression could be applied. Such an analysis would make it possible to identify which variables — timetable flexibility, the possibility of combining studies with paid work, perceived costs, employment prospects, satisfaction with the chosen programme or perceived institutional prestige — most strongly predict the declared intention to drop out. In the present exploratory stage, the results are interpreted as associations and directional hypotheses rather than as confirmed causal effects.

The paper assumes that the answers reflect the declared importance of the individual factors, and not necessarily their actual influence on future decisions to continue or drop out of studies; however, the comparison with OPI data makes it possible to formulate hypotheses on potential causal relationships²³.

4. Results — factors of the choice of studies

The selection of the analysed factors of the choice of studies was not random; it followed from a synthesis of the classical literature on the subject²⁴ and the specificity of the contemporary Polish market. International research traditionally distinguishes the so-called 7P model of educational marketing, including, among others, the programme (Product), the price and costs (Price) and accessibility (Place)²⁵. In the present study, this set was complemented by variables that are crucial for the generation of “digital pragmatists” identified in more recent Polish reports (including OPI PIB). Particular attention was paid to the gap between “soft” factors (prestige, atmosphere, opinions of friends) and “hard” ones (earnings prospects, flexibility of the timetable), which makes it possible to verify the hypothesis of the growing role of economic rationalisation in educational decisions²⁶.

The study was conducted among a group of $n = 247$ first-year bachelor students. The sample was purposive; this choice was dictated by the need to reach those at the stage of the “entry shock” into the academic environment — this group is the most exposed to the risk of drop-out and is constantly confronting its expectations about studies with the organisational reality of the university.

The analysis of the distribution of answers leads to the conclusions presented below.

Table 2.*Synthetic overview of survey results*

Factor / research variable	Element in the CORD model	Low importance (1-2)	Neutral / hard to say (3)	High importance (4-5)	Dominant tendency in the sample
Employment prospects after studies	Context	< 10%*	Low share	Dominant (> 60%)	Strong pragmatism
Ability to combine studies with work (timetable)	Organisation / Delivery	< 10%*	Low share	Dominant (> 60%)	Key priority
Location of the university	Context	Moderate share	Moderate share	High share	High importance
Costs of studying (tuition, fees)	Context	≈ 20%	≈ 35%	≈ 45%	Polarising factor
Range of fields offered	Developing	Low share	Low share	High share	High importance
Presence of online / hybrid classes	Delivery	Significant share	Differentiated	Significant share	Strong differentiation (polarisation)
Social factors (friends, events)	Context	Significant share	Differentiated	Moderate share	Moderate importance
Brand / prestige of the university	Context	Majority (> 40%)	Significant share	Approx. 20%	Low importance (devaluation of prestige)

Source: own elaboration based on the survey (n = 247).

The juxtaposition of results in Table 2 reveals a clear hierarchy of student motivations, supporting the hypothesis of the pragmatism of the new generation (Context). What stands out is the reversal of the traditional pyramid of prestige: the symbolic capital of the university's brand, important only to about every fifth respondent, loses to the "hard" parameters of the offer such as the flexibility of the timetable (Organisation/Delivery) and employment prospects.

Particularly important from the perspective of the CORD model is the result concerning costs and online classes. The distribution of answers indicates a strong polarisation of the sample — for a large group, about 35% in the case of costs, these are neutral factors, which may suggest the existence of specific student segments (e.g. those who work versus those supported by parents) to which the university should address different communication and support strategies. This points to the need to move from mass marketing to precise targeting of the offer (Researching)²⁷.

Already at this stage it is visible that for the studied group "hard" aspects of the offer (costs, infrastructure, timetable, employment prospects) are more important than symbolic prestige, which is consistent with OPI's observations on the growing role of economic and organisational factors in educational decisions²⁸.

4.1. Interpretation of the results in the CORD context

Context: a pragmatic generation and demographic decline

The results indicate a strongly pragmatic attitude among first-year students: what matters are costs, location, the ability to combine studies with work and employment prospects, rather than only prestige or “student life”. This picture fits well with labour market analyses showing the pressure to enter employment quickly and the uncertainty about the return on investment in a diploma. From the perspective of CORD, this means a change of context: students may perceive studies as an investment project that must be compatible with other spheres of life²⁹.

The demographic decline and the growing number of places in universities additionally shift the balance of power — it is the universities that compete for the student, not the other way around, as confirmed by both Kwiek and Antonowicz. At the same time, the presented results show that universities do not always accurately read the priorities of this new “clientele”: instead of building the prestige of the “brand”, they should work intensively on adjusting the organisation and the programme to pragmatic expectations³⁰.

Organisation: between declaration and practice

Strategic documents of Polish universities are dominated by the language of modernisation, digitalisation and student-centrism, yet the research of Antonowicz and Leja shows that the organisational mechanisms for implementing such strategies are weak, and that organisational culture often rests on inertia and conservatism. The results indirectly reveal this gap: students signal the high importance of a timetable that allows combining studies with other duties, but in many universities schedules are still designed according to the logic of the convenience of the staff rather than the rhythm of students’ lives³¹.

Researching: from a one-off survey to learning analytics

The very fact of conducting a survey among first-year students fits into the Researching component, but for CORD to work in full the research cannot be a one-off or purely declarative exercise. OPI shows that drop-out risk grows at specific moments and is associated, among other things, with attendance, timeliness and results in the first semesters. Combining survey data (on expectations and factors of choice) with administrative data (on the course of studies) could reveal non-obvious correlations, e.g.:³²

- students who declare a high importance of the flexibility of the timetable drop out more frequently when the schedule does not allow them to work,
- those who place strong importance on employment prospects may be more inclined to change university or field when they do not see a link between the programme and the labour market.

CORD can therefore be linked with the idea of the “data-driven university” described by Sułkowski — universities should not only ask students but also systematically analyse digital traces and respond to risk signals³³.

Developing/Delivery: the format of studies as the key “product”

The results clearly show that what matters to students is not only the content of the programme (employment prospects, range of fields), but above all the way it is delivered: the timetable, the form of classes (including online ones) and the ability to combine studies with other activities. This confirms Maringe’s central thesis that the “product” of the university is not the abstract “diploma” but the actual experience of learning — curriculum and delivery³⁴.

Set against OPI data, a functional hypothesis can be put forward: the flexibility of the form of teaching (including the presence of sensibly designed online components) and the possibility of more intensive, condensed timetables (3-4 days instead of 5 dispersed ones) act protectively against drop-out, especially among working students.

Czy jest dla Ciebie ważne mieć mniej dni z zajęciami w tygodniu (np. 3-4 intensywnie zamiast 5 luźniej)
247 odpowiedzi

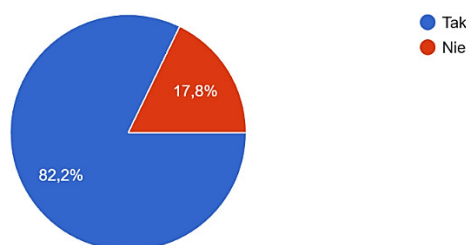


Figure 1. Importance of a flexible timetable for first-year students (distribution of answers to the question: “Is it important for you to have fewer days of classes per week — e.g. 3-4 intensive days instead of 5 dispersed ones?”, n = 247).

Source: own elaboration based on the survey (n = 247).

A non-obvious correlation emerging from the data is the relation between a low declared importance of prestige and a high importance of pragmatic aspects of the offer — this suggests that, in the competition for this group of students, advantage may be built more through “Delivery” than through the symbolic capital of the brand³⁵.

The declining importance of university prestige should not be interpreted as the disappearance of symbolic or reputational factors from the higher education choice process. Rather, the findings suggest a shift in the hierarchy of decision-making criteria among first-year students. In conditions of demographic decline, rising costs of living and increasing pressure to combine studies with paid work, prestige becomes only one of several competing signals. Students may increasingly evaluate higher education institutions through the lens of functional value: employability, timetable flexibility, affordability, location and compatibility with individual life circumstances. This interpretation is consistent with the literature on university choice, which shows that academic reputation remains important, but is assessed alongside costs, location, employment prospects, financial aid and programme structure.

5. Discussion — hypotheses and potential causal relations

Before the study, three preliminary hypotheses were adopted, which after the analysis of the results were developed and refined as propositions for further quantitative research. The following is a detailed mapping of the transition from the preliminary hypotheses to the final ones.

H1: A mismatch between the organisation of studies (schedule and class formats) and students' life profile (e.g. combining studies with paid work) increases the risk of dropping out.

The study showed that the alignment of the organisation of studies (schedule, class formats) with the student's profile (work, family duties) appears to be an important factor associated with declared drop-out intention. Prestige has only marginal significance for the studied group (around 20%), while organisation (timetable) is crucial. The final hypothesis has thus been strengthened — it shows that even a highly prestigious university will lose its student if it is poorly organised. This is an important conclusion: “prestige does not protect against drop-out”.

H2: The greater the alignment between students' declared priorities (costs, flexibility, employment prospects) and the actual offer and organisational practice of the university, the lower the declared propensity to drop out.

In the light of the study results, the hypothesis takes the form: the greater the fit between the student's declared priorities (costs, flexibility, employment prospects) and the university's offer, the lower the declared propensity to drop out.

This hypothesis is preliminarily supported by the descriptive results and should be tested further using regression-based and longitudinal designs. The results of the survey showed a convergence of priorities (costs, work) with the intention to continue studies. The hypothesis moved from the phase of “assumption” to the phase of a “conclusion from a pilot study”, ready to be tested on a large sample.

H3: Universities with weaker research resources build their competitive advantage through investment in the Development/Delivery element (flexibility, support, personalisation), which may reduce drop-out in groups particularly sensitive to organisational factors.

The study showed that universities with weaker research resources more often compensate for the lack of prestige with investments in Delivery (flexibility, support, personalisation), which may reduce drop-out in segments more sensitive to organisational factors³⁶.

The results of the survey (high importance of flexibility, low importance of the brand) provide strong grounds to claim that for non-public and regional universities this is the only effective strategy of survival.

Potential causal relationships may include changes in the timetable (e.g. moving to a 3-4 intensive day + 1-2 free day format), which can lead to a decrease in resignations among working students during the first two semesters and which requires further investigation. Other links worth verifying are the introduction of an early-warning system based on data from internal LMS platforms (attendance, activity, results) and intervention activities (tutor, advisor), which can reduce the rate of removals due to failed subjects³⁷. The aspect of involving students in the co-design of the programme (the Delivery/Organisation component) also requires verification, as this may increase their sense of agency and belonging and thereby indirectly lower their intention to drop out.

6. Summary —practical implications, research limitations and the future of the CORD model

The research has significant limitations that should be taken into account when interpreting the results. The sample was purposive and not random, which restricts the possibility of generalising the results to the entire population of first-year students in Poland. Moreover, the over-representation of certain fields or types of universities (e.g. urban universities) may distort the picture of the factors of choice and of the propensity to drop out. The study was cross-sectional in nature, which prevents the full capture of the dynamics of changes in attitudes and decisions over time. No strong causal conclusions can be drawn from it, only hypotheses. The study also lacks a link with actual data on the course of studies (passes, attendance), which makes it impossible to verify which respondents have actually dropped out in subsequent semesters.

Despite these limitations, the study provides a valuable, exploratory insight into how first-year students perceive the study offer, and into how these perceptions can be interpreted in the CORD logic, especially in the context of Polish debates on digitalisation, system drift and university stratification. Awareness of these limitations is crucial when formulating the practical implications and recommendations on the further development of the CORD model, which cannot be treated as universal, but rather as directional guidance.

On the basis of the analysis carried out, it is assumed that the original construction of CORD, although still useful, does not fully reflect the complexity of the contemporary challenges facing universities; hence, the author's proposal to extend the model and to formulate forecasts and recommendations concerning its further evolution. The title issue — “The future of the CORD model” — assumes a reflection both on how the model can evolve and on its usefulness for future challenges.

The most probable direction of development is to turn CORD into a more comprehensive model that takes into account new realities. This can be framed as a transition from CORD 1.0 to CORD 2.0, or CORD+.

An extended model could include the linking of CORD with the Digital element, that is the full integration of the digital component. Each of the CORD pillars should then be analysed in terms of the requirements of the digital era. Another recommendation is to link CORD with Resilience — the inclusion of explicit mechanisms increasing resilience in the model. These may include, for instance, procedures for the periodic review of risks and contingency plans, which connects to Context as the identification of concerns; the development of a culture of proactive adaptation as part of Organisation, encouraging staff initiatives for facilitation; early-warning and evaluation systems within Delivery — listening to warning signals from the environment and inside the institution — and the capacity for rapid refocus, that is the situation in which a change of environment can reorient the activity of the university, e.g. by launching new forms of teaching.³⁸

The final element is also the combination of CORD with Sustainability — the addition of a sustainable development perspective as a dimension permeating all the elements. Context expands to include concern for the social and environmental impact; Organisation, the building of shared responsibility for sustainable development goals (e.g. a green campus created by the entire community); Research, the design of curricula taking into account education for sustainable development; Delivery, the dialogue with stakeholders on the expectations related to the social mission of the university.

References

1. Al-Ali, M.S., Sellami, A., Ahmed, E.A. (2018). Determinants of College and University Choice for High-School Students in Qatar. *International Journal of Higher Education*, pp. 1–15.
2. Antonowicz, D. (n.d.). *Szkolnictwo wyższe w Polsce weszło w dryf [Higher education in Poland has entered a drift]*. Retrieved from: <https://wszystkoconajwazniejsze.pl/pepites/szkolnictwo-wyzsze-w-polsce-weszlo-w-dryf-prof-dominik-antonowicz/>, 29.12.2025.
3. Broadbent, J. et al. (2023). Post-pandemic higher education: systematic review of implications and transformations. *Social Sciences and Education Research Review*, pp. 316–322.
4. Domański, T. (n.d.). *Strategie internacjonalizacji uczelni [Strategies of university internationalisation]*. Retrieved from: https://repozytorium.uni.lodz.pl/bitstream/handle/11089/41693/Domanski_Strategie%20internacjonalizacji.pdf, 29.12.2025.

5. Edunews (n.d.). *Niedofinansowane szkolnictwo wyższe będzie dryfować [Underfunded higher education will drift]*. Retrieved from: <https://www.edunews.pl/badania-i-debaty/opinie/7262-niedofinansowane-szkolnictwo-wyzsze-bedzie-dryfowac>, 19.12.2025.
6. Google Scholar profile (n.d.). Retrieved from: <https://scholar.google.com/citations?user=Y3WfUzQAAAAJ&hl=en>, 30.12.2025.
7. IRSW (n.d.). *Raport OPI PIB: zjawisko drop-outu na polskich uczelniach [OPI PIB Report: drop-out at Polish universities]*. Retrieved from: <https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelniach/>, 21.12.2025.
8. Ivy, J. (2008). A new higher education marketing mix: The 7Ps for MBA marketing. *International Journal of Educational Management*, pp. 288-299.
9. Kwiek, M. (2024). Znikający naukowcy [The vanishing scientists]. *Nauka*. Retrieved from: http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_24425_nauka_2024_149837/c/articles-55996075.pdf, 29.12.2025.
10. Leja, K. (n.d.). *Publications*. Retrieved from: <https://mostwiedzy.pl/pl/krzysztof-leja,2958-1/publications>, 29.12.2025.
11. Maringe, F. (2005). Interrogating the crisis in higher education marketing: the CORD model. *International Journal of Educational Management, Vol. 19, Iss. 7*, pp. 564-578. Retrieved from: <https://www.emerald.com/ijem/article-abstract/19/7/564/117805/Interrogating-the-crisis-in-higher-education>, 21.12.2025.
12. Maringe, F. (2006). University and course choice: Implications for positioning, recruitment and marketing. *International Journal of Educational Management, Vol. 20, Iss. 6*, pp. 466-479. Retrieved from: <https://www.emerald.com/ijem/article-abstract/20/6/466/120037/University-and-course-choiceImplications-for>, 30.12.2025.
13. Maringe, F. (2009). The CORD model: Marketing strategy for higher education. In: F. Maringe, P. Gibbs (Eds.), *Marketing higher education: Theory and practice* (pp. 45-46). Maidenhead: Open University Press.
14. Maringe, F., Gibbs, P. (2008). *Marketing higher education: Theory and practice*. Open University Press. Retrieved from: [https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20\(2008\).pdf](https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20(2008).pdf), 21.12.2025.
15. Open ICM (n.d.). *Resource on academic policy*. Retrieved from: <https://open.icm.edu.pl/items/f3d3abde-e437-41cc-93ca-8f9ff5e4b362>, 31.12.2025.
16. OPI (n.d.). *Kto i dlaczego porzuca studia [Who drops out of studies and why]*. Retrieved from: <https://opi.org.pl/kto-i-dlaczego-porzuca-studia/>, 29.12.2025.
17. PMC (2022). Post-pandemic resilience in higher education. *PMC9605583*. Retrieved from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9605583/>, 21.12.2025.
18. Pomoc Materialna (n.d.). *Raport OPI PIB [OPI PIB Report]*. Retrieved from: <https://pomocmaterialna.pl/blog/raportopipib>, 30.12.2025.

19. RADON (n.d.). *Drop-out — analizy [Drop-out — analyses]*. Retrieved from: <https://radon.nauka.gov.pl/analizy/dropout>, 29.12.2025.
20. Repozytorium UR (n.d.). *Educational study resource*. Retrieved from: <https://repozytorium.ur.edu.pl/bitstreams/5259add7-d61c-4e7a-b264-fa2e1e1f4e45/download>, 30.12.2025.
21. Roga, R., Lapina, I., Müürsepp, P. (2015). Analysis of factors influencing foreign students' choice of higher education institution. *Procedia – Social and Behavioral Sciences*, Vol. 213, pp. 925-930.
22. Santoro, G., Vrontis, D. et al. (2018). A Framework Based on Sustainability, Open Innovation, and Value Co-creation Paradigms — A Case in an Italian Maritime Cluster. *Sustainability*, p. 729.
23. Sciendo (2023). Article on educational research. *Economics and Regional Studies*. Retrieved from: <https://sciendo.com/pdf/10.2478/ers-2023-0040>, 30.12.2025.
24. Sułkowski, Ł. (2022). *Zarządzanie uczelnią [University management]*. Retrieved from: https://www.biblos.pk.edu.pl/ST/2022/10/100000340978/100000340978_Sulkowski_ZarzadzanieUczelnia.pdf, 21.12.2025.
25. Zeszyty Naukowe GSW (n.d.). *Article on higher education*. Retrieved from: <https://ojs.gsw.gda.pl/index.php/ZNGSW/article/download/138/102/185>, 31.12.2025.

Footnotes

1. Edunews. *Niedofinansowane szkolnictwo wyższe będzie dryfować*. Retrieved from: <https://www.edunews.pl/badania-i-debaty/opinie/7262-niedofinansowane-szkolnictwo-wyzsze-bedzie-dryfowac>, 19.12.2025.
2. IRSW. *Raport OPI PIB: zjawisko drop-outu na polskich uczelniach*. Retrieved from: <https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelniach/>, 19.12.2025.
3. Santoro, G., Vrontis, D. et al. (2018). A Framework Based on Sustainability, Open Innovation, and Value Co-creation Paradigms — A Case in an Italian Maritime Cluster. *Sustainability*, p. 729.
4. Maringe, F. (2006). University and course choice: Implications for positioning, recruitment and marketing. *International Journal of Educational Management*, 20(6), pp. 466-479.
5. Maringe, F. (2009). *The CORD model: Marketing strategy for higher education. Theory and Practice*. In: F. Maringe, P. Gibbs (Eds.), Maidenhead: Open University Press, pp. 45-46.
6. Maringe, F. (2005). *Interrogating the crisis in higher education marketing: the CORD model*. Retrieved from: <https://www.emerald.com/ijem/article-abstract/19/7/564/117805/Interrogating-the-crisis-in-higher-education>, 21.12.2025.

7. Ibidem.
8. PMC (2022). Retrieved from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9605583/>, 21.12.2025.
9. Maringe, F., Gibbs, P. (2008). *Marketing Higher Education: Theory and Practice*. OPI PIB reports. Open University Press. Retrieved from: <https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelniaach/>, 21.12.2025.
10. IRSW. Retrieved from: <https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelniaach/>, 21.12.2025.
11. Sułkowski, Ł. (2022). *Zarządzanie uczelnia*. Retrieved from: https://www.biblos.pk.edu.pl/ST/2022/10/100000340978/100000340978_Sulkowski_ZarzadzanieUczelnia.pdf, 21.12.2025.
12. IRSW. Retrieved from: <https://irsw.pl/raport-opi-pib-zjawisko-drop-outu-na-polskich-uczelniaach/>, 21.12.2025.
13. Maringe, F., Gibbs, P. (2008). *Marketing Higher Education: Theory and Practice*. Retrieved from: [https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20\(2008\).pdf](https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20(2008).pdf), 21.12.2025.
14. Al-Ali, M.S., Sellami, A., Ahmed, E.A. (2018). Determinants of College and University Choice for High-School Students in Qatar. *International Journal of Higher Education*, pp. 1-15.
15. Sułkowski, Ł. (2022). *Zarządzanie uczelnia*. Retrieved from: https://www.biblos.pk.edu.pl/ST/2022/10/100000340978/100000340978_Sulkowski_ZarzadzanieUczelnia.pdf, 29.12.2025.
16. Ibidem.
17. Kwiek, M. (2024). *Znikający naukowcy*. Retrieved from: http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_24425_nauka_2024_149837/c/articles-55996075.pdf, 29.12.2025.
18. Ibidem.
19. Antonowicz, D. *Szkolnictwo wyższe w Polsce weszło w dryf*. Retrieved from: <https://wszystkoconajwazniejsze.pl/pepites/szkolnictwo-wyzsze-w-polsce-weszlo-w-dryf-prof-dominik-antonowicz/>, 29.12.2025.
20. Domański, T. *Strategie internacjonalizacji*. Retrieved from: https://repozytorium.uni.lodz.pl/bitstream/handle/11089/41693/Domanski_Strategie%20in ternacjonalizacji.pdf, 29.12.2025.
21. Leja, K. *Publications*. Retrieved from: <https://mostwiedzy.pl/pl/krzysztof-leja,2958-1/publications>, 29.12.2025.
22. RADON. *Drop-out — analizy*. Retrieved from: <https://radon.nauka.gov.pl/analizy/dropout>, 29.12.2025.

23. OPI. *Kto i dlaczego porzuca studia*. Retrieved from: <https://opi.org.pl/kto-i-dlaczego-porzuca-studia/>, 29.12.2025.
24. Maringe, F. (2006). University and course choice. Retrieved from: <https://www.emerald.com/ijem/article-abstract/20/6/466/120037/University-and-course-choiceImplications-for>, 30.12.2025.
25. Ivy, J. (2008). A new higher education marketing mix: The 7Ps for MBA marketing. *International Journal of Educational Management*, pp. 288-299.
26. Repozytorium UR. Retrieved from: <https://repozytorium.ur.edu.pl/bitstreams/5259add7-d61c-4e7a-b264-fa2e1e1f4e45/download>, 30.12.2025.
27. Roga, R., Lapina, I., Mürsepp, P. (2015). Analysis of factors influencing foreign students' choice of higher education institution. *Procedia – Social and Behavioral Sciences*, 213, pp. 925-930.
28. Pomoc Materialna. *Raport OPI PIB*. Retrieved from: <https://pomocmaterialna.pl/blog/raportopipib>, 30.12.2025.
29. Sciendo. Retrieved from: <https://sciendo.com/pdf/10.2478/ers-2023-0040>, 30.12.2025.
30. Google Scholar profile. Retrieved from: <https://scholar.google.com/citations?user=Y3WfUzQAAAAJ&hl=en>, 30.12.2025.
31. Open ICM resource. Retrieved from: <https://open.icm.edu.pl/items/f3d3abde-e437-41cc-93ca-8f9ff5e4b362>, 31.12.2025.
32. RADON. *Drop-out — analizy*. Retrieved from: <https://radon.nauka.gov.pl/analizy/dropout>, 31.12.2025.
33. PMC (2022). Retrieved from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9605583/>, 31.12.2025.
34. Maringe, F., Gibbs, P. (2008). *Marketing Higher Education: Theory and Practice*. Retrieved from: [https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20\(2008\).pdf](https://repo.darmajaya.ac.id/4213/1/Felix%20Maringe,%20Paul%20Gibbs%20-%20Marketing%20Higher%20Education_%20Theory%20and%20Practice%20(2008).pdf), 31.12.2025.
35. Zeszyty Naukowe GSW. Retrieved from: <https://ojs.gsw.gda.pl/index.php/ZNGSW/article/download/138/102/185>, 31.12.2025.
36. Kwiek, M. (2024). *Znikający naukowcy*. Retrieved from: http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_24425_nauka_2024_149837/c/articles-55996075.pdf, 03.01.2026.
37. Sułkowski, Ł. (2022). *Zarządzanie uczelnia*. Retrieved from: https://www.biblos.pk.edu.pl/ST/2022/10/100000340978/100000340978_Sulkowski_ZarzadzanieUczelnia.pdf, 03.01.2026.
38. Broadbent, J. et al. (2023). Post-pandemic higher education: systematic review of implications and transformations. *Social Sciences and Education Research Review*, pp. 316-322.

AN OVERVIEW AND COMPARISON OF SELECTED MBA PROGRAMS IN POLAND

Rafał MIŚKO

Wrocław University of Science and Technology, Faculty of Management; rafal.misko@pwr.edu.pl,
ORCID: 0000-0002-4154-419X

Purpose: Despite the growing number of MBA programs in Poland, comparative research examining the simultaneous integration of innovation, artificial intelligence, sustainability, and research competencies within MBA curricula remains limited. This article aims to assess the extent to which selected MBA programs in Poland incorporate these future-oriented areas and to evaluate their alignment with broader trends in the modernization of management education.

Design/methodology/approach: The study employs qualitative content analysis (QCA) based on publicly accessible information from official websites of MBA programs. Program descriptions were manually coded using a predefined set of keywords related to innovation, AI, sustainability, and research skills. The analysis compares public and private institutions in Poland and considers structural program characteristics such as duration, teaching load, and AMBA accreditation.

Findings: The research revealed significant differences in addressing innovation, sustainability, AI, and research skills. Innovation is included in 19 out of 26 programs, while sustainability and artificial intelligence appear in 12 and 11 programs, respectively. Research skills are notably underrepresented, being present in only two programs. Only seven programs simultaneously incorporated innovation, AI, and sustainability. Private universities more frequently included innovation, sustainability, and AI-related content than public institutions. The findings suggest that Polish MBA education is only partially aligned with global trends associated with digital transformation and sustainable leadership development.

Research limitations/implications: The study relies on publicly available data, which may not fully represent actual curricula. The keyword-based coding approach may also omit relevant content described using alternative terminology. Future research could include detailed syllabus analysis, interviews with program directors, and student perspectives.

Practical implications: The findings highlight the need for MBA program designers to strengthen the integration of emerging topics such as AI, sustainability, and research competencies.

Originality/value: The paper offers a comparative analysis of MBA programs in Poland that simultaneously considers innovation, artificial intelligence, sustainability, and research skills. It contributes to the discussion on the modernization of management education in Central and Eastern Europe and identifies important gaps in future-oriented managerial training.

Keywords: MBA programs, artificial intelligence, sustainability, innovation, management education.

Category of the paper: Research paper.

1. Introduction

Education distinguishes individuals because it determines career paths and develops the knowledge and skills needed to enter the labour market in our chosen fields (Bočková et al., 2021). Therefore, it can be considered a crucial element in today's world. Lifelong learning (LLL) is one of the key concepts in contemporary educational theory and policy. This concept is based on the premise that the learning process should not be confined to formal educational institutions or the early stages of life but should continue throughout an individual's lifetime (Laal et al., 2014).

Recognizing lifelong learning as a continuous process allows us to better understand how professionals, especially those in managerial positions, must keep developing their competencies throughout their careers. Managers learn and develop through structured programs outside the workplace and through informal on-the-job training (Jarošová et al., 2017). Studying for an MBA or participating in short-term lifelong learning programs are examples of formal programs.

The Master of Business Administration (MBA) is one of the most globally recognized postgraduate qualifications. It is a professional program designed to equip individuals with the skills needed for high-level roles in business, typically in management. Although the MBA has been around since the early 1900s, its popularity and relevance continue to grow (Aithal, 2015). In Poland, a particularly significant role in assessing the quality of MBA programs is played by the MBA Ranking published by the "Perspektywy" Educational Foundation. This ranking takes into account a variety of criteria, such as the program's reputation in academic and business circles, the competencies of the teaching staff, internationalization, the quality of participants, as well as feedback from alumni and employers. The business environment is changing very fast with technological advancements, growing emphasis on sustainability, and the increasing role of data-driven decision-making. To keep up, MBA programs need to cover essential modern topics. Innovation, artificial intelligence, sustainable development, and research skills are key areas that help managers succeed in today's environment.

This article aims to assess whether MBA programs in Poland incorporate courses on innovation, artificial intelligence, sustainable development, and research skills. It examines programs based on the total number of class hours and the duration in semesters. Additionally, it evaluates whether a university holds AMBA accreditation. In order to examine these issues, the study focuses on three interrelated questions concerning: (1) the extent to which MBA programs incorporate innovation, AI, sustainability, and research skills, (2) differences between public and private institutions, and (3) variation in program structure and teaching intensity.

2. Literature review

Research on MBA programs shows a diverse set of thematic areas reflecting the evolving objectives, challenges, and societal expectations surrounding business education. One research stream examines leadership curricula. Western management schools often focus on leadership principles rooted in Western traditions and ways of thinking. However, the research argues that these schools should broaden their approach and incorporate leadership perspectives from non-Western cultures as well (Mellahi, 2000).

The academic literature is increasingly emphasizing the importance of internationalization and global competencies. Research shows that institutions can improve teaching by using innovative and interactive methods, such as group research projects, role-playing games, international guest lectures, and cross-border virtual classes, instead of traditional lecture-based teaching. However, curriculum reform requires a thoughtful balance between global standards and local needs, including the use of original, market-relevant materials with an emphasis on intercultural communication. Strengthening the international faculty is also essential, which involves sending lecturers for training abroad and inviting experienced foreign instructors to participate in on-site or online teaching. These efforts are essential for developing professionals ready to lead in a globally connected world (Zhang, 2015).

Other studies investigate student motivations, revealing how personal interests, perceived career opportunities, and peer influence guide MBA paths (Din et al., 2014). Entrepreneurial intentions fostered by business education (Hmedat et al., 2017) and need for innovation (Aithal, Aithal, 2023) are also evident. (Hmedat et al., 2017) show that most MBA students in Oman are inclined to start their own businesses as a way to establish their careers. The study (Aithal, Aithal, 2023) examines and assesses a novel experiential learning approach known as "incubationship", designed to foster entrepreneurship at the higher education level. It utilizes advanced research skills such as design, analysis, comparison, evaluation, interpretation, and the generation of innovative ideas. It is worth mentioning that there are also studies on the development of MBA students' research skills, which show that engaging in qualitative research not only improves their research skills but also provides additional benefits that enhance managerial effectiveness (Cassell, 2018). Finally, studies also highlight institutional challenges, such as program scalability, supervision quality, and alignment with industry needs, especially in developing contexts (Pandiyan, 2011).

Sustainability is increasingly recognized as a key aspect of modern business. It is unsurprising that MBA programs are incorporating green business management into their curricula. Programs that focus on environmental responsibility can provide a competitive advantage. By introducing future managers to the principles of green management, these programs equip graduates with the necessary skills to function in a corporate environment that values sustainable practices (Page, Collins, 2010). There is also the concept of the Super

Innovative MBA, whose authors advocate for a far-reaching transformation of management education programs, including, among other things, a deep focus on research, the implementation of specialized analytical tools, and a strong grounding in the realities of the digital economy and sustainable development (Aithal, Karanth, 2024).

Given the above, academic attention is focused on topics such as innovation, sustainability, artificial intelligence, and research competencies. These are increasingly seen as key to shaping MBA programs for the future. Not only as indicators of modernizing educational content, but also as elements of developing leadership competencies in a dynamically changing global economy. In the face of technological innovations and the complex challenges of sustainable development, MBA programs are expected to become multidisciplinary, providing students with cross-cutting skills beyond the traditional managerial knowledge.

Three leading accrediting organizations for business schools - AACSB, AMBA, and EQUIS - are collectively known as the "triple crown accreditation". AMBA, AACSB International, and EQUIS require school activities to be based on policies and processes that will lead to continuous improvement (Avolio, Benzaquen, 2020). AMBA accreditation applies directly to MBA programs and has been awarded by the British Association of MBAs since 1967 (Jacqmin et al., 2021). It focuses on areas such as program impact, graduate employability, and learning outcomes. Rigorous criteria are applied regarding teaching quality, career development, and collaboration with the business sector. The accreditation is international and regularly updated to reflect changing standards and market needs. AMBA also promotes innovation, encouraging business schools to adapt their programs to new trends and maintain a high level of excellence (AMBA, 2025).

Existing studies on MBA education focus primarily on leadership development, internationalization, entrepreneurship, or sustainability as separate dimensions of management education. Previous research has also examined innovation-oriented MBA models and the growing importance of AI-related competencies. However, the existing literature rarely investigates the simultaneous integration of innovation, artificial intelligence, sustainability, and research competencies within MBA curricula.

Moreover, comparative studies focusing on MBA programs in Poland remain very limited, despite the rapid expansion of postgraduate management education in the country. To the best of the author's knowledge, no previous study has systematically compared Polish MBA programs with regard to the combined presence of these future-oriented curricular components.

Therefore, this study addresses an important research gap by providing a comparative analysis of selected MBA programs in Poland in the context of innovation, AI, sustainability, and research competencies.

3. Methods

As part of the adopted research procedure, qualitative content analysis (QCA) was conducted. It is one of the most commonly used analytical tools (Zhang, Wildemuth, 2017). QCA has a strong foundation in various fields of social sciences, including management (Komor, Grzyb, 2023). The focus was on publicly available information presented on the official websites of selected MBA programs offered by Polish universities. Each program was manually coded based on the presence or absence of the identified thematic areas. Course descriptions were analyzed using keyword matching and contextual interpretation to ensure accurate classification. The website analysis was conducted in October 2025. Although this approach is limited to declarative data published by the universities themselves, it nevertheless allows for a comparative assessment. The analysis included both public and private universities from different regions of the country.

This article aims to compare MBA programs according to several key criteria. First, it analyzes the presence of content related to innovation, artificial intelligence, sustainable development, and research skills, as well as the number of hours devoted to these topics. Then, it compares the programs in terms of total course hours and the number of semesters. Finally, it analyzes whether a given university is AMBA accredited.

A list of keywords was created to assign courses to specific thematic areas. This list includes, among others, innovation, sustainability, ESG, artificial intelligence, and research skills. Various combinations of these keywords with other terms were also considered in the search. For the purposes of this analysis, a dataset based on the latest "Perspektywy MBA 2025" ranking was used. This ranking is one of the most comprehensive sources of quality assessment for Master of Business Administration programs in Poland, taking into account both academic criteria and factors related to the qualifications of teaching staff and graduate career support. The study covers institutions and programs listed in the ranking, including the Warsaw School of Economics, Kozminski University, Warsaw University of Technology, Poznań University of Economics and Business, and Wrocław University of Economics and Business, as well as several regional and private institutions, such as the WSB University, Lazarski University, and Merito WSB University, as shown in Table 1.

Table 1.
List of schools offering analyzed MBA programs

Adam Mickiewicz University in Poznań
Cracow University of Technology
Gdańsk University of Technology
Kozminski University
Krakow University of Economics
Medical University of Warsaw
Nicolaus Copernicus University in Toruń
Poznań University of Economics and Business

Cont. table 1.

SGH Warsaw School of Economics
Silesian University of Technology
University of Gdańsk
University of Lodz
University of Warsaw
Warsaw University of Life Sciences
Warsaw University of Technology
West Pomeranian Business School
Wroclaw Business University of Applied Sciences
Wroclaw University of Economics and Business
Wroclaw University of Science and Technology
WSB Merito University in Gdańsk
WSB Merito University in Poznań
WSB University
WSHIU University

Source: own work.

Some schools appear in the ranking more than once because they offer multiple MBA programs. The University of Lodz website did not provide curriculum information, so it was excluded from the analysis. Warsaw University of Life Sciences was also excluded, as no information about an MBA program was available on its website. Additionally, one of the two Kozminski University programs was also removed. In total, 26 programs from 21 schools were examined.

4. Results

An analysis of MBA program content in Poland, based on data from universities included in the "Perspektywy MBA 2025" ranking, revealed significant variation in the integration of selected thematic areas: innovation, artificial intelligence, sustainability, and research skills. Among the 26 MBA programs examined, components related to innovation were present in 19 cases, AI-related topics appeared in 11 programs, and sustainability issues were included in 12 programs. Research skills were present in just 2 programs.

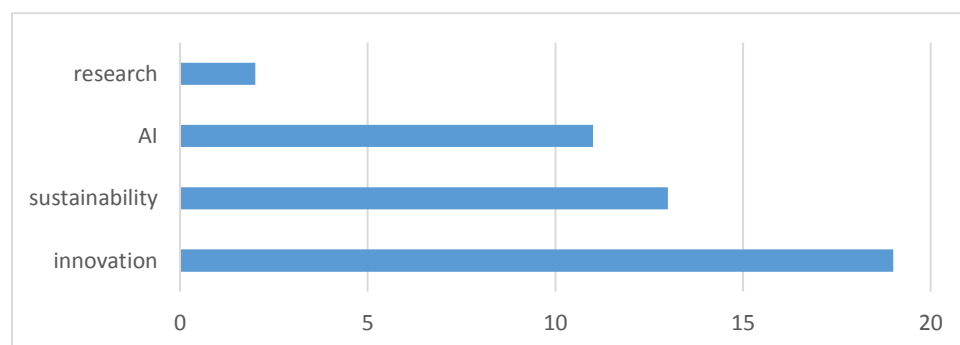


Figure 1. Number of MBA programs including selected thematic areas.

Source: own work.

The particularly low representation of AI may suggest a delay in the adoption of technological trends in Polish MBA-level management education. It is also worth noting that none of the four analyzed components are present in all programs, confirming the lack of a standardized teaching framework in this regard. The identified gaps serve as an important signal for MBA curriculum designers, highlighting the need for deeper integration of these subjects into the educational structure to better address the challenges of the contemporary business environment. Some topics are combined within a single course, for example UMK innovation and AI. This case is noteworthy because sustainability is addressed in three separate courses. The program includes courses such as: Sustainability and ESG, ESG Strategies, and ESG Regulations.

A comparative analysis demonstrated significant variation in the presence of key program components depending on the nature of the institution and the level of technological advancement in the educational offerings. MBA programs run by private universities more frequently include topics related to innovation than public universities (72% vs. 66%), sustainability (54% vs. 40%), and AI (54% vs. 33%). The results suggest that private universities can respond more quickly to changing market needs and employer expectations, which is reflected in the structure of their MBA programs. Public universities also incorporate modern content, but to a lesser extent, which may be due to more complex program procedures and greater structural stability. Overall, the observed differences indicate distinct program strategies between the two types of institutions. Another pattern can be observed in the relationship between the inclusion of AI-related modules and innovation components - among the 19 programs incorporating innovation, 11 also featured AI-related elements. This suggests a tendency to cluster technological themes within select, modernly designed programs. Additionally, only seven MBA programs in the entire set integrate three strategic components: innovation, AI, and sustainability. These programs can be regarded as leaders in incorporating content that addresses contemporary digital and environmental transformation challenges, offering a more holistic model of management education. Table 2 presents a graphical representation. A green field shows that the thematic course is included in the program, while a red field signifies its absence. An asterisk denotes that the institution is not a public university, and "N/A" means no data is available.

Table 2.*Presence of key thematic courses in selected MBA programs*

	Innovation	AI	Sustainability/ ESG	Research skills	Hours	Semesters
List of schools						
SGH Warsaw School of Economics					672	N/A
Kozminski University*					578	4
Warsaw University of Technology					550	4
Poznań University of Economics and Business					660	4
University of Warsaw					N/A	4
SGH Warsaw School of Economics					640	N/A
Krakow University of Economics					530	4
Wroclaw University of Economics and Business					680	4
Medical University of Warsaw and SGH Warsaw School of Economics					658	4
Gdańsk University of Technology					N/A	N/A
WSB Academy*					521	3
Nicolaus Copernicus University in Toruń					540	4
WSB Merito University in Gdańsk*					450	4
Wroclaw University of Science and Technology					N/A	2
WSB Academy*					N/A	3
Silesian University of Technology					670	4
Cracow University of Technology					350	N/A
WSB Merito University in Gdańsk*					501	4
Wroclaw Business University of Applied Sciences*					437	3
University of Gdansk					570	4
WSB Merito University in Poznań*					437	4
Wroclaw Business University of Applied Sciences*					437	3
West Pomeranian Business School*					446	3
Adam Mickiewicz University in Poznań and Poznań University of Economics and Business					540	4
Lazarski University*					460	N/A
WSHIU University*					N/A	2

Source: own work.

The highest annual teaching workload is observed at the Wroclaw University of Economics and Business, where there are 680 hours of teaching within four semesters, averaging 170 hours per semester. Comparable intensity comes from institutions such as the Silesian University of Technology (670 hours over 4 semesters, 167.5 hours/semester), Kozminski University (578 hours over 4 semesters, 144.5 hours/semester), and WSB Academy (521 hours over 3 semesters, approximately 173 hours/semester). Very heavy teaching loads are also reported at the following institutions: Krakow University of Economics: 530 hours over 4 semesters (132.5 hours/semester), Poznań University of Economics and Business: 660 hours over 4 semesters (165 hours/semester), SGH Warsaw School of Economics: 640 hours (no number of semesters specified; but, if small, intensity would be large). Alternatively, lower semester average workloads are indicated by some institutions such as Nicolaus Copernicus University in Toruń (540 hours in 4 semesters, 135 hours/semester) and Kozminski University (578 hours in 4 semesters, 144.5 hours/semester).

A few institutions did not provide complete course information regarding the number of semesters or total instructional hours, which limited the potential for a comprehensive analysis. Yet, the reported statistics reflect characteristic trends. The differences in the length of programs and the total number of hours suggest the existence of different didactic models. These range from time-concentrated and intensive programs to those stretched over time but less burdensome per semester. This suggests the need for further research on the relationship between the organizational form of studies, their educational effectiveness, and the perception of students and graduates in terms of the quality of education.

The analysis of hours dedicated to specific subjects shows a significant variety in the number of hours dedicated to individual courses within the MBA programs offered by Polish universities. Only a few institutions provide specific modules with a clearly defined number of hours. For example, Nicolaus Copernicus University offers 20 hours for innovation and 30 and 20 hours in two different blocks for sustainability. The joint program of the Medical University of Warsaw and the Warsaw School of Economics offers the most hours – 42 hours devoted to innovation. A few universities, such as the West Pomeranian Business School or the Warsaw University of Life Sciences, allocate only 5-10 hours to a given course. However, the vast majority of the analyzed institutions do not provide specific hourly values on their websites, which prevents a broader analysis.

Seven universities in Poland hold AMBA accreditation. All are listed in Table 3 and were included in the study, with accreditation details confirmed on their official websites. It is significant that out of all AMBA-accredited institutions, four schools have programs covering AI, innovation, and sustainable development: Poznań University of Economics, Gdańsk University of Technology, Kozminski University, and Nicolaus Copernicus University.

5. Discussion and Conclusions

The findings provide clear answers to the research questions. First, MBA programs in Poland show uneven integration of key contemporary topics, with innovation being the most frequently represented and research skills the least. Second, observable differences between public and private institutions confirm the role of institutional context. Third, structural variation across programs reflects diverse educational models rather than a standardized approach.

The diversity of MBA program content indicates a lack of a unified approach to management education in the area of strategic challenges of the present day, such as innovation, artificial intelligence, sustainable development, and research skills. Despite the growing importance of these areas in international MBA education standards, their relatively low presence in Polish programs suggests a certain delay in relation to global trends. The low level

of integration of AI-related content is particularly worrying, which may indicate that programs are not adapted to the challenges of digital transformation. The identified gaps serve as an important signal for MBA curriculum designers, highlighting the need for deeper integration of these subjects into the educational structure to better address the challenges of the contemporary business environment.

The observed tendency to "cluster" technological topics (e.g., simultaneous occurrence of innovation and AI in selected programs) may suggest selective implementation of modern didactic components within more advanced, flexible and probably better-funded programs. This phenomenon may be related to institutional differences - as indicated in the results, private universities more often integrate elements of innovation, AI and sustainable development. Their organizational structure and decision-making processes may allow them to respond more rapidly to evolving market needs and employer expectations. The analysis of didactic intensity (number of hours vs. number of semesters) reveals differences in the organizational models of MBAs, from intensive two-semester executive courses to more time-stretched but less demanding four-semester models. This differentiation may be a response to different needs of target groups: professionals may prefer shorter, focused courses, while people entering the labor market may choose more extensive programs. These results suggest that future actions of institutions offering MBA programs should aim to better harmonize the structure of programs with the challenges of the global economy - both in terms of content (e.g., AI, ESG) and the organization of the educational process.

There are also dedicated ESG-focused MBA programs available. For example, Lazarski University offers one such program, consisting of 450 hours and structured into eight modules: Organizational Transformation and Responsible Business Management, Policies and Regulations for Operating Responsible Enterprises, Environmental Responsibility in Management, Social Responsibility in Management, Corporate Governance and Leadership, Business Strategies, Reporting, Compliance, and ESG Auditing, Sustainable Leadership - Developing Competencies for Responsible Leaders, and Diploma Seminar. However, this program was not included in the ranking that was the basis for this article.

A similar trend can be observed in the case of MBA programs dedicated to artificial intelligence. Several Polish universities have introduced specialized management education tracks that focus on the application of AI and digital tools in organizational leadership. One notable example is the MBA Artificial Intelligence and Digital Transformation offered by the Warsaw University of Technology, which integrates knowledge of modern technologies, process automation, and digital transformation with traditional managerial competencies.

Diversity in content and teaching intensity reflects not only a range of didactic models but also an evolving interpretation of what constitutes innovative management education. As such, Polish MBA programs demonstrate potential for transformative impact. However, these programs still require deeper alignment with global educational trends to fully realize the vision of future-oriented leadership development.

There are some methodological limitations that should be acknowledged when interpreting the results. Not all MBA programs were examined, and those that were indicated in the ranking "Perspektywy MBA 2025". The analysis was based on publicly available information published on the official websites of higher education institutions offering MBA programs. Institutions may present only selected elements of their curricula or use generalized descriptions, potentially leading to inconsistencies in course categorization. The identification of relevant subject areas - such as innovation, artificial intelligence, sustainability, and research skills - was conducted through keyword analysis. While this approach allows for a structured and replicable examination, it is inherently limited by the vocabulary used on institutional websites. Important content may have been overlooked if different terminology was employed. Third, the study focuses on the presence and declared number of instructional hours, without evaluating learning outcomes. While instructional time can serve as a basic indicator of curricular intensity, it does not provide insight into the depth of knowledge acquired, the development of key competencies, or the alignment of teaching practices with intended learning objectives.

Future research could benefit from incorporating qualitative interviews with program directors, detailed syllabus analysis, and student surveys to provide a more holistic understanding of how MBA programs address contemporary managerial challenges. Qualitative interviews with program directors would offer valuable insights into institutional intentions behind curriculum choices. Detailed syllabus analysis could help uncover the extent to which key themes such as innovation, sustainability, artificial intelligence, and global competencies are operationalized within course structures. Additionally, student surveys would provide critical feedback on the perceived relevance, effectiveness, and applicability of course content in preparing graduates for modern managerial roles. It is also worth conducting further research on the effectiveness of individual teaching models from the point of view of their impact on the development of managerial competences and compliance with the needs of employers.

References

1. Association of MBAs (2025). *MBA accreditation criteria*. Retrieved from: <https://www.associationofmbas.com>, 01.12.2025.
2. Aithal, P.S. (2015). Comparative study on MBA programmes in private & public universities—A case study of MBA programme plan of Srinivas University. *International Journal of Management Sciences and Business Research*, 4(12), pp. 106-122.
3. Aithal, P.S., Aithal, S. (2023). Super innovation in higher education by nurturing business leaders through incubationship. *Journal of Applied Engineering and Management Letters (JJAEML)*, 7(3), pp. 142-167. <http://doi.org/10.2139/ssrn.4673874>

4. Aithal, P.S., Karanth, B. (2024). A new model of super innovative MBA programme to achieve its objective of creating super executives. *Poornaprajna International Journal of Teaching & Research Case Studies (PIJTRCS)* 1(1), pp. 1-27. <https://doi.org/10.5281/zenodo.12669893>
5. Avolio, B., Benzaquen, J. (2020). Strategic drivers to approach business school's accreditations. *Journal of Education for Business*, 95(8), pp. 519-526. <https://doi.org/10.1080/08832323.2019.1707751>
6. Bočková, K., Šimek, V., Hanák, M. (2021). Does MBA studies increase the value of human capital in the labour market? *TEM Journal*, 10(4), pp. 1857-1868. <https://doi.org/10.18421/TEM104-49>
7. Cassell, C. (2018). "Pushed beyond my comfort zone:" MBA student experiences of conducting qualitative research. *Academy of Management Learning & Education*, 17(2), pp. 119-136. <https://doi.org/10.5465/amle.2015.0016>
8. Din, M.S., Anjum, Z.A., Ullah, R., Latif, A. (2014). Students' perception regarding selection of specialization in MBA. *City University Research Journal*, 4(2), pp. 177-188.
9. Hmedat, W., Ali, M., Muthuraman, B. (2017). A study on entrepreneurial initiatives among MBA students in Sultanate of Oman. *International Journal of Management, Innovation & Entrepreneurial Research*, 3(2), pp. 78-91. <https://doi.org/10.18510/ijmier.2017.324>
10. Jacqmin, J., Lefebvre, M., Lhuillery, S., Menger, P.-M., Manceau, D., Gergaud, O., Dulaquais, B., Lambin, X., Le Saout, R., Zolitz, U. (2021). *The effect of international accreditations on students' decisions: Evidence from French business schools*. Bureau d'Economie Théorique et Appliquée
11. Jarošová, E., Lorencová, H., Půbalová, K., Šedivý, L. (2017). Teaching methods in MBA and lifelong learning programmes for managers. *Journal on Efficiency and Responsibility in Education and Science*, 10(3), pp. 86-92. <https://doi.org/10.7160/eriesj.2017.100304>
12. Komor, M., Grzyb, K. (2023). Qualitative content analysis – A research method in social science. *Przegląd Badań Edukacyjnych*, 43(2), pp. 143-163. <https://doi.org/10.12775/PBE.2023.032>
13. Laal, M., Laal, A., Aliramaei, A. (2014). Continuing Education; Lifelong Learning. *Procedia - Social and Behavioral Sciences*, 116, pp. 4052-4056. <https://doi.org/10.1016/j.sbspro.2014.01.889>
14. Mellahi, K. (2000). The teaching of leadership on UK MBA programmes: A critical analysis from an international perspective. *Journal of Management Development*, 19(4), pp. 297-308.
15. Page, R.A., Collins, K.A. (2010). The green MBA: A competing values matrix. *Competitiveness Review*, 20(1), pp. 62-71. <https://doi.org/10.1108/10595421011019984>
16. Pandiyan, A.V.R. (2011). Employers' perspective of MBA curriculum in meeting the requirements of the industry. *Management and Labour Studies*, 36(2), pp. 143-154.

17. Zhang, C. (2015). *The Overview of Studies on the International Ability of MBA*. International Conference on Social Science and Higher Education, Atlantis Press.
18. Zhang, Y., Wildemuth, B.M. (2017). Qualitative analysis of content. In: B.M. Wildemuth (Ed.), *Applications of Social Research Methods to Questions in Information and Library Science* (pp. 318-329). Santa Barbara: Libraries Unlimited.

WORK LIFE BALANCE – THE IMPORTANCE OF BALANCE IN THE ACADEMIC LIVE OF STUDENTS

Katarzyna OLEJNICZAK-SZUSTER

The Management Faculty, Czestochowa University of Technology; k.olejniczak-szuster@pcz.pl,
ORCID: 0000-0002-7820-4746

Purpose: The aim of this study is to examine the relationship between the negative impact of paid work on academic performance, the balance between studies and personal life, and the level of academic stress among students. Additionally, the study seeks to determine whether these relationships vary according to selected sociodemographic and educational variables, such as gender, age, level of study, and mode of study.

Design/methodology/approach: The study was conducted using a diagnostic survey administered to 156 students majoring in Management as well as Finance and Accounting. Based on the survey items, three composite indicators were constructed to represent the key variables under investigation: the negative impact of paid work on academic performance, the balance between studies and personal life, and academic stress. The reliability of the scales was assessed using Cronbach's alpha. Data analysis included descriptive statistics, correlation analysis, and nonparametric tests (the Mann-Whitney U test and the Kruskal-Wallis test) to examine differences between groups.

Findings: The results indicate that a greater negative impact of paid work on studies is associated with higher levels of academic stress and lower levels of work-life balance. A significant relationship was also found between work-life balance and academic stress. Furthermore, the findings show that the levels of the variables under study vary according to selected respondent characteristics, particularly age, gender, level of study, and mode of study.

Originality/value: This study contributes to the literature on the experiences of students engaged in paid work during their studies by adopting an integrated approach to the issue. Unlike many previous studies that have focused on individual aspects of students' employment, this research simultaneously examines the relationships between paid work, the balance between studies and personal life, and academic stress. The findings may serve as a basis for developing initiatives aimed at supporting students who combine academic responsibilities with professional work.

Keywords: students, work-life balance (WLB), academic environment, academic stress.

Category of the paper: Research paper.

1. Introduction

Starting college is a significant milestone in many students' lives, often accompanied by numerous challenges, including managing time, responsibilities, and financial demands. Rising living costs and education-related expenses lead a substantial proportion of students to undertake paid work during their studies (Robotham, Julian, 2006; Noor-ul-Huda et al., 2025). This situation may affect students' ability to meet academic and professional obligations, as well as their overall well-being. Given that students have limited time, which must be allocated among studying, paid work, and personal life, achieving balance between these competing domains represents a considerable individual challenge, requiring effective time and resource management (Beatson et al., 2021; Kanu et al., 2025).

In this context, maintaining a balance between studies, paid work, and personal life becomes particularly important; however, achieving such balance remains difficult within the academic environment (Ramachandaran et al., 2024; Kocsis, 2024). This study contributes to addressing a gap in the literature on combining paid work with academic study. Previous research has produced mixed findings, indicating both positive and negative effects of paid work on students' academic performance and well-being (Dundes, Marx, 2006; Triventi, 2014; Sánchez-Gelabert et al., 2017; Kutyló et al., 2019; Kocsis, 2021a, 2021b; Orbilla, Paglinawan, 2025). At the same time, the relationships between the negative impact of paid work on studying, the balance between studies and personal life, and academic stress—as well as the role of factors such as gender, age, field of study, and mode of study—remain relatively underexplored (Kroupová, 2024; Blindheim et al., 2025).

Against this background, the present study adopts an integrated approach, linking these dimensions to both students' academic functioning and mental well-being. Accordingly, the aim of this study is to analyze the relationships between undertaking paid work during studies, the balance between studies and personal life, and students' academic functioning, with particular emphasis on the level of academic stress. This objective is addressed using data from a survey conducted among full-time and part-time students enrolled in Management and in Finance and Accounting in Business.

2. Theoretical Background and Hypotheses

Work-life balance is commonly defined as the ability to harmoniously reconcile paid work with other areas of life, particularly personal and family life (Lantsoght, 2025; Anastasopoulou, Vraimaki, Trivellas, 2023). The concept refers to the relationship between two fundamental spheres of human functioning that are often in tension: the professional sphere, associated with

paid work, and the private sphere, encompassing rest, social relationships, and the pursuit of personal interests (Heijstra, Rafnsdottir, 2010). Due to the interpenetration of these domains, maintaining balance between them is considered a key condition for preserving psychophysical well-being, the quality of interpersonal relationships, life satisfaction, and professional effectiveness. In this sense, work–life balance may also be understood as a form of managing an individual’s time and resources to achieve equilibrium between professional development and private life, including health, family, leisure, and personal growth (Elifneh et al., 2025; Lantsoght, 2025). It is important to emphasize that the concept encompasses three core dimensions: time balance (the allocation of time between work and private life), involvement balance (the distribution of energy and emotional engagement across these domains), and satisfaction balance (the attainment of a comparable level of satisfaction in both spheres) (Greenhaus, Collins, Shaw, 2003). From this perspective, work–life balance can be viewed as a continuum reflecting the multidimensional interactions between different areas of an individual’s functioning (Sirgy, Lee, 2018). At the same time, contemporary society characterized by increasing professional and personal demands makes maintaining this balance progressively more difficult (Akanji et al., 2020). This raises important questions about how students manage to combine academic responsibilities with paid employment (Kanu et al., 2025). Research indicates that the impact of paid work on academic outcomes is not uniform. Negative effects on academic performance are primarily observed in cases of high-intensity employment, whereas part-time work especially when related to the field of study does not necessarily reduce academic achievement and may even support the development of competencies (Callender, 2008; Triventi, 2014). Furthermore, employment during studies may positively influence graduates’ later position in the labor market, particularly through the development of human capital and general competencies, although its effect on the acquisition of specialized skills remains inconclusive (Ormiston, 2016). At the same time, the literature highlights the importance of contextual factors and the potential psychological costs arising from role conflict between being a student and an employee (Beerkens et al., 2011; Tur-Sinai et al., 2017).

In light of the above, the following hypotheses are proposed:

- H1: A higher level of the negative impact of paid work on studying is associated with a higher level of academic stress.*
- H2: A higher level of work-life balance is associated with a lower level of academic stress.*
- H3: A higher level of the negative impact of paid work on studying is associated with a lower level of work-life balance.*

3. Methodology of the Study and Presentation of Results

To achieve the main objective of the study, a survey was conducted among 156 respondents from the Faculty of Management at the Częstochowa University of Technology. An analysis of the sample structure (Table 1) indicates that the majority of participants were women ($n = 96$; 61.5%), while men accounted for 38.5% of the sample ($n = 60$). With regard to age, the largest group consisted of respondents aged 24–26 ($n = 86$; 55.1%). Participants aged 21–23 represented 27.6% of the sample ($n = 43$), whereas those over 26 years of age constituted 17.3% ($n = 27$). In terms of educational level, master's degree students slightly outnumbered undergraduate students ($n = 83$; 53.2% vs. $n = 73$; 46.8%). Regarding mode of study, full-time students comprised 55.8% of the sample ($n = 87$), while part-time students accounted for 44.2% ($n = 69$).

Table 1.
Characteristics of respondents

Variable	Category	n	%
Gender	Female	96	61.5
	Male	60	38.5
Age	21–23	43	27.6
	24–26	86	55.1
	>26	27	17.3
Level of study	Bachelor	73	46.8
	Master	83	53.2
Mode of study	Full-time	87	55.8
	Part-time	69	44.2

Source: own research.

Before proceeding with the main analyses, the reliability of the scales was assessed (Avadhani Menon, 2022). Cronbach's alpha coefficients were high for all three indicators: for the scale of the negative impact of work on studying, $\alpha = 0.915$; for the study–private life balance scale, $\alpha = 0.913$; and for the academic stress scale, $\alpha = 0.886$. The results indicate very good measurement quality and allow the scales used to be considered reliable indicators of the constructs under study. The data analysis utilized descriptive statistics, correlation analysis, and nonparametric tests (the Mann-Whitney U test and the Kruskal-Wallis test) for intergroup comparisons. To verify the hypotheses, three composite indices corresponding to the analyzed constructs were created. The first referred to the subjectively perceived negative impact of paid work on studying and included aspects such as limited time for class preparation, difficulties with systematic learning, decreased concentration during classes, and fatigue resulting from work responsibilities (Ostoj, 2019; Neyt et al., 2019; Nidogon Višnjić et al., 2024). The second indicator concerned the balance between studies and private life and included the ability to manage time, opportunities for rest, maintaining harmony between different areas of life, and engagement in extracurricular activities (Bartlett et al., 2021; Abdilah et al., 2025). The third construct referred to academic stress and included feelings of psychological tension,

being overwhelmed by responsibilities, pressure to achieve, and a lack of time for recovery (Robotham, Julian, 2006; Drăghici, Cazan, 2022; Olson et al., 2025).

The results (Table 2) showed a positive correlation between the negative impact of paid work on studying and academic stress ($r = 0.330$; $p < 0.001$). This indicates that individuals who more strongly perceived the negative consequences of paid work on their studies also tended to report higher levels of psychological tension, overload, and stress related to academic responsibilities (Neyt et al., 2019; Drăghici, Cazan, 2022). This finding allows Hypothesis H1 to be considered confirmed. A significant relationship was also found between the balance between studies and private life and academic stress ($r = 0.292$; $p < 0.001$). However, the interpretation of the direction of this relationship requires methodological caution and consideration of how responses were coded in the questionnaire. Nevertheless, the existence of a significant relationship indicates that life balance is closely associated with students' psychological functioning (Sprung, Rogers, 2021). Therefore, Hypothesis H2 can be considered partially confirmed. The third hypothesis, stating that a higher level of the negative impact of paid work on studying is associated with a lower level of work-life balance, was also confirmed. The correlation coefficient was $r = -0.261$ ($p = 0.001$), indicating that an increase in the perceived disruption of the study process by paid work was associated with a decrease in the subjective sense of balance between academic responsibilities and private life (Grzywacz, Carlson, 2007).

Table 2.

Relationships between the variables under study

Variables	Pearson's r	p-value	Hypothesis test result
Negative impact of paid work on studying	0.330	< 0.001	H1 confirmed
Work-life balance	0.292	< 0.001	H2 partially confirmed
Academic stress	-0.261	0.001	H3 confirmed

Source: own research.

The findings also align with the broader context of contemporary research on academic stress. Recent studies indicate that academic stress is not merely a short-term reaction to educational demands but may function as a central mechanism leading to mental exhaustion, reduced cognitive performance, and difficulties in adapting to the university environment (Olson et al., 2025; Benítez-Agudelo et al., 2025; Zhang et al., 2024).

In the subsequent part of the analysis, we examined whether the levels of the constructs under study differed according to selected sociodemographic and educational variables. With regard to gender (Table 3), significant differences were found in both the negative impact of paid work on studying ($p = 0.003$) and the level of academic stress ($p = 0.026$).

Table 3.
Gender differences

Variable	Women M (SD)	Men M (SD)	Mann-Whitney U test	p-value
Negative impact of paid work on studying	3.12 (1.28)	3.89 (0.53)	2064.0	0.003
Work-life balance	3.12 (1.13)	3.06 (0.86)	2817.0	0.818
Academic stress	2.82 (1.02)	2.58 (1.05)	3482.5	0.026

Source: own research.

However, no significant differences were observed in the balance between studies and private life ($p = 0.818$). These results suggest that women and men differ in terms of the perceived burden associated with combining work and studies, as well as in their levels of academic stress, while no significant gender differences were identified in the reported level of life balance (Andrade et al., 2024).

The results regarding age were particularly noteworthy (Table 4), as age significantly influenced all three areas analyzed: the negative impact of paid work on academic performance ($p < 0.001$), the balance between studies and personal life ($p < 0.001$), and academic stress ($p = 0.038$).

Table 4.
Differences by age

Variable	Age 21-23 M (SD)	Age 24-26 M (SD)	Above 26 M (SD)	Mann-Whitney U test	p-value
Negative impact of paid work on studying	2.80 (0.89)	3.38 (1.13)	4.51 (0.34)	54.52	<0.001
Work-life balance	4.16 (0.63)	2.77 (0.93)	2.48 (0.51)	63.16	0.362
Academic stress	2.78 (0.72)	2.55 (1.24)	3.23 (0.42)	6.55	0.001

Source: own research.

This suggests that age should be considered one of the most important factors influencing students' functioning. This finding can be interpreted in light of research indicating that older students are more likely to navigate a more complex set of social roles, as working adults who are often burdened with additional family and financial responsibilities (Kulik, 2025).

Significant differences were also observed with regard to the level of studies (Table 5). It was shown that students at different educational levels differed significantly in terms of the negative impact of paid work on their studies ($p < 0.001$) and the level of academic stress ($p = 0.001$). However, no significant differences were found in the balance between studies and private life ($p = 0.362$). It can be concluded that master's students more frequently experience a stronger conflict between work and education, which is also associated with higher levels of stress compared to undergraduate students (bachelor's and engineering programs). This is consistent with the findings of Fentahun et al. (2025), which indicate that individuals at more advanced stages of education are more likely to take on more demanding forms of employment, combining their studies with more stable or intensive professional activity.

Table 5.*Differences by type of degree program*

Variable	Undergraduate studies M (SD)	Master's studies M (SD)	Mann-Whitney U test	p-value
Negative impact of paid work on studying	2.93 (1.37)	3.85 (0.58)	1946.5	<0.001
Work-life balance	3.16 (1.30)	3.05 (0.72)	3284.5	0.362
Academic stress	2.44 (0.87)	2.99 (1.10)	2064.5	0.001

Source: own research.

With regard to study mode, the results showed (Table 6) that it significantly affects the level of work-life balance ($p < 0.001$) and academic stress ($p < 0.001$), but does not significantly affect the negative impact of paid work on studies ($p = 0.217$).

Table 6.*Differences by type of program*

Variable	Part-time students M (SD)	Full-time students M (SD)	Mann-Whitney U test	p-value
H1	3.46 (1.31)	3.39 (0.96)	3346.5	0.217
H2	2.57 (0.78)	3.52 (1.02)	1307.5	<0.001
H3	3.04 (1.12)	2.48 (0.89)	4187.0	<0.001

Source: own research.

This finding appears particularly significant from the perspective of academic practice. Although the impact of work on studies may be experienced similarly by students in different modes of study, their overall mental well-being and sense of life balance differ significantly. This may stem from the fact that part-time students more often navigate a more complex web of professional, educational, and family responsibilities, whereas full-time students may experience different forms of pressure, primarily related to the intensity and organization of the teaching process (Di Paolo, 2022).

Summary

In summary, the results indicate that combining paid work with studies poses a significant risk to students' mental well-being. The study confirmed that the more strongly respondents perceive the negative impact of work on their academic performance, the higher their stress levels and the lower their sense of balance between studies and personal life. At the same time, it has been shown that this experience is not uniform but varies significantly depending on factors such as gender, age, type of study program, and mode of study. The obtained results align well with current findings in the literature, according to which academic stress, role conflict, and task overload are among the most important factors influencing students' well-being and their educational functioning. From a practical perspective, these results point to the need for universities to develop solutions supporting working students, such as flexible class

schedules, psychological support, psychoeducation on time and stress management, and initiatives aimed at enhancing recovery and life balance. In the reality of contemporary higher education, where students taking on paid work is becoming increasingly common, these measures seem not so much an add-on as an essential element for supporting the effective and healthy functioning of young adults.

References

1. Abdilah, M.F., Shari, N.I., Ibrahim, F.A. (2025). The influence of work-life balance on perceived stress among part-time students. *Sains Humanika*, 17(3), 73-78. <https://doi.org/10.11113/sh.v17n3.2254>
2. Akanji, B., Mordi, C., Simpson, R., Adisa, T.A., Oruh, E.S. (2020). Time biases: Exploring the work-life balance of single Nigerian managers and professionals. *Journal of Managerial Psychology*, 35(2), 57-70. <https://doi.org/10.1108/JMP-12-2018-0537>
3. Andrade, C., Fernandes, J.L., Almeida, L.S. (2024). Mature working student parents navigating multiple roles: A qualitative analysis. *Education Sciences*, 14(7). Article 786. <https://doi.org/10.3390/educsci14070786>
4. Avadhani, V.D., Menon, R.B. (2022). Development and standardization of the work-life balance scale for the insurance sector employees. *Cogent Business & Management*, 9(1). <https://doi.org/10.1080/23311975.2022.2154994>
5. Bartlett, M.J., Arslan, F.N., Bankston, A., Sarabipour, S. (2021). Ten simple rules to improve academic work-life balance. *PLOS Computational Biology*, 17(7), e1009124. <https://doi.org/10.1371/journal.pcbi.1009124>
6. Beatson, N.J., de Lange, P., Oosthuizen, H. (2021). A question of balance: Study-work-life perspectives from accounting students. *Pacific Accounting Review*, 33(3), 257-273. <https://doi.org/10.1108/PAR-09-2020-0137>
7. Beerkens, M., Mägi, E., Lill, L. (2011). University studies as a side job: Causes and consequences of massive student employment in Estonia. *Higher Education*, 61(6), 679-692.
8. Blindheim, S., Eriksen, H.R., Langjordet Johnsen, T. (2025). Balancing expectancies: Academic stress and coping in teacher education. *Journal of Further and Higher Education*, 49(8), 1148-1162. <https://doi.org/10.1080/0309877X.2025.2539881>
9. Butler, A.B. (2007). Job characteristics and college performance and attitudes: A model of work-school conflict and facilitation. *Journal of Applied Psychology*, 92(2), 500-510. <https://doi.org/10.1037/0021-9010.92.2.500>
10. Callender, C. (2008). The impact of term-time employment on higher education students' academic attainment and achievement. *Journal of Education Policy*, 23(4), 359-377.

11. Drăghici, G.-L., Cazan, A.-M. (2022). Burnout and maladjustment among employed students. *Frontiers in Psychology*, 13, Article 825588. <https://doi.org/10.3389/fpsyg.2022.825588>
12. Dundes, L., Marx, J. (2006). Balancing work and academics in college: Why do students working 10 to 19 hours per week excel? *Journal of College Student Retention: Research. Theory & Practice*, 8(1), 107-120.
13. Elifneh, Y.W., Wonda, T.A., Abbay. Y.A. (2025). Work-life balance among university academic leaders in a developing country context: Empirical evidence from Ethiopia. *SAGE Open*, 15(3).
14. Fentahun, S., Rtbey, G., Nakie, G. et al. (2025). Burden of perceived stress among university students in Africa: a systematic review and meta-analysis. *BMC Public Health*, 25, 2248, <https://doi.org/10.1186/s12889-025-23533-2>
15. Greenhaus, J.H., Collins, K.M., Shaw, J.D. (2003). The relation between work-family balance and quality of life. *Journal of Vocational Behavior*, 63, 510-531.
16. Grzywacz, J.G., Carlson, D.S. (2007). Conceptualizing work-family balance: Implications for practice and research. *Advances in Developing Human Resources*, 9(4), 455-471. <https://doi.org/10.1177/1523422307305487>
17. Heijstra, T.M., Rafnsdottir, G.L. (2010). The Internet and academics' workload and work-family balance. *The Internet and Higher Education*, 13, 158-163.
18. Kanu, W.N., Emenalo, F.C., Alisigwe, H.C. (2025). Work-study-life balance: Challenges and impact on academic performance of students in higher institutions in Imo State. Nigeria. *IOSR Journal of Humanities and Social Science*, 30(12), 58-70.
19. Kocsis, Z. (2021a). Eredményesebbek-e a dolgozó hallgatók? [Are working students more successful?]. In: G. Pusztai, F. Szigeti (Eds.), *Lemorzsolódási kockázat és erőforrások a felsőoktatásban* (pp. 264-288). CHERD.
20. Kocsis, Z. (2021b). Features of student employment in the Hungarian-Romanian cross border area. *Acta Didactica Napocensia*, 14, 188-202.
21. Kocsis, Z. (2024). Learning/earning: Characteristics of student work and its impact on learning outcomes. *Education Sciences*, 14(9), Article 981. <https://doi.org/10.3390/educsci14090981>
22. Kulik, L. (2025). Role conflict, enrichment, sense of balance. and well-being among working students who are parents. *Journal of Family Social Work*, 28(2), 86-107. <https://doi.org/10.1080/10522158.2025.2468264>
23. Kutyło, Ł., Łaska-Formejster, A.B., Ober-Domagańska, B. (2019). Zmęczenie wśród pracujących i niepracujących studentów: Socjologiczna analiza czynników środowiskowych determinujących jego poziom. *Medycyna Pracy*, 70(5), 597-609. <https://doi.org/10.13075/mp.5893.00851>
24. Lantsoght, E.O.L. (2025). Improving work-life balance in academia after COVID-19 using inclusive practices. *Societies*, 15(8), Article 220. <https://doi.org/10.3390/soc15080220>

25. Neyt, B., Omey, E., Verhaest, D., Baert, S. (2019). Does student work really affect educational outcomes? A review of the literature. *Journal of Economic Surveys*, 33(3), 896-921. <https://doi.org/10.1111/joes.12301>
26. Nidogon Višnjić, S., Pažur Aničić, K., Divjak, B. (2024). A systematic review of the literature on student work and academic performance. *Industry and Higher Education*, 38(5), 473-484. <https://doi.org/10.1177/09504222241241974>
27. Noor-Ul-Huda Alam, N., Khan, M.L. (2025). Economic hardship, academic performance and psychological well-being among university students. *Indus Journal of Social Sciences*, 3(2), 851-867. <https://doi.org/10.59075/IJSS.V3I2.1591>
28. Olson, N., Oberhoffer-Fritz, R., Reiner, B., Schulz, T. (2025). Stress, student burnout and study engagement – a cross-sectional comparison of university students of different academic subjects. *BMC Psychology*, 13, Article 293. <https://doi.org/10.1186/s40359-025-02602-6>
29. Orbilla, E.C. Jr, Paglinawan, J.L. (2025). Balancing between work and study: Trials and triumphs of working student at an early age. *International Journal of Research and Innovation in Applied Science*, 10(5), <https://doi.org/10.51584/IJRIAS.2025.100500015>
30. Ostoj, I. (2019). Skutki łączenia studiów stacjonarnych z pracą. *Polityka Społeczna*, 46(4), 1-7.
31. Ostoj, I. (2019). The consequences of combining full-time studying with gainful employment: A theoretical review and survey results. *Polityka Społeczna*, 46(11), 1-7.
32. Park, Y., Sprung, J.M. (2013). Work-school conflict and health outcomes: Beneficial resources for working college students. *Journal of Occupational Health Psychology*, 18(4), 384-394.
33. Ramachandaran, S.D., Nuraini, R., Doraisingam, P. (2024). Understanding work-life balance challenges among academic professionals in higher education: A phenomenological study. *International Journal of Learning, Teaching and Educational Research*, 23(12), 130-147. <https://doi.org/10.26803/ijlter.23.12.8>
34. Richardson, M., Evans, C., Gbadamosi, G. (2014). The work–study nexus: The challenges of balancing full-time business degree study with a part-time job. *Research in Post-Compulsory Education*, 19(3), 302-309. <https://doi.org/10.1080/13596748.2014.920582>
35. Robotham, D., Julian, C. (2006). Stress and the higher education student: A critical review of the literature. *Journal of Further and Higher Education*, 30(2), 107-117. <https://doi.org/10.1080/03098770600617513>
36. Sánchez-Gelabert, A., Figueroa, M., Elias, M. (2017). Working whilst studying in higher education: The impact of the economic crisis on academic and labour market success. *European Journal of Education*, 52(2), 232-245. <https://doi.org/10.1111/ejed.12212>
37. Sirgy, M.J., Lee, D.-J. (2018). Work-life balance: An integrative review. *Applied Research in Quality of Life*, 13(1), 229-254. <https://doi.org/10.1007/s11482-017-9509-8>

38. Sprung, J.M., Rogers, A. (2021). Work-life balance as a predictor of college student anxiety and depression. *Journal of American College Health*, 69(7), 775-782. <https://doi.org/10.1080/07448481.2019.1706540>
39. Triventi, M. (2014). Does working during higher education affect students' academic progression? *Economics of Education Review*, 41, 1-13.
40. Tur-Sinai, A., Romanov, D., Zussman, N. (2017). The true effect of students' employment on the duration of studies. *Applied Economics*, 49(33), 3328-3340.

CONCEPTUAL APPROACH TO INFORMATION WASTE IN LEAN MANAGEMENT

Pamela OMIOTEK

University of Gdansk; pamela.omiotek@ug.edu.pl, ORCID: 0000-0003-0128-4503

Purpose: This paper presents and extends the classical concept of waste (muda) in Lean Management by introducing an informational perspective. It proposes a conceptual framework that systematises and explains inefficiencies in information flows.

Design/methodology/approach: The article draws on a critical review of the literature in Lean Management, information theory, knowledge management, and organisational communication. The analysis identifies underlying mechanisms responsible for the emergence of informational inefficiencies. It also develops theoretical analogies between material waste in production systems and information waste.

Findings: The paper formulates a novel definition of information waste, understood as any process or action that causes information to lose its function of reducing uncertainty. It proposes a typology of sixteen categories of informational waste. The model integrates reinterpretations of classical muda with newly conceptualised categories specific to information processes.

Research limitations/implications: The typology provides a conceptual and theoretical foundation for future empirical research. Future studies should quantify the costs of information waste. They should also examine its impact across different organisational contexts and sectors.

Originality/value: The paper contributes to Lean Management theory by offering an integrated perspective on informational waste. It integrates fragmented views on informational inefficiency into a coherent framework. By introducing clearly defined categories, it adapts Lean principles to digital work environments and intellectual labour.

Keywords: Lean Management, information waste, muda, knowledge management, information flow.

Category of the paper: Conceptual paper.

Introduction

The concept of Lean Management emerged at Toyota in the 1950s and 1960s (Walentynowicz, 2013). Many related practices had already appeared in the United States. Most scientists regard Lean as one of the most effective approaches to improving processes and eliminating waste (Walentynowicz, 2013; Al-Aomar, 2012). Interest in Lean production in

Japan led to the publication of *The Machine That Changed the World*. The book by Womack, Jones, and Roos gave the concept global visibility (Womack et al., 2007).

Practitioners first focused on Lean Manufacturing. Later, the concept expanded into services, healthcare, and construction. Lean Management now covers the whole enterprise, not only production (Walentynowicz, 2013). Nogalski and Walentynowicz describe Lean as a way of thinking and acting rooted in Toyota practice. The approach seeks the best results with the smallest possible resources under given conditions. Lean relies on eliminating waste (*muda*). It also aims to reduce unevenness (*mura*) and overburden (*muri*). Another definition is presented by E. Pawłowski, K. Pawłowski and Trzcieliński. Authors define Lean Management as “a management methodology that fosters a work culture within an organization in which all members are committed to continuously reducing costs, improving quality, and shortening delivery cycles. All of this is done to maximize customer satisfaction [...]” (Pawłowski, Pawłowski, Trzcieliński, 2010). The authors of the book “*The Lean Strategy: Using Lean to Create Competitive Advantage, Unleash Innovation, and Deliver Sustainable Growth*” offer yet another definition. For them Lean is a learning system that any leader can develop within their organization. All they need to do is find a way to use the Toyota Production System framework to identify their own North Star—that is, the ideal balance of customer satisfaction and profitability (Balle, Jones, Chiaze, Fiume, 2019).

Most studies still analyse waste in material, production, or logistics processes. Classical views of *muda* emerged from physical flows of work and products. Modern organisations now depend mostly on information processes. Data, knowledge, and messages shape daily work. Researchers still define information waste in narrow and fragmented ways. Existing studies usually focus on single problems, such as information overload or communication errors. To date, no coherent and integrative theoretical model has systematically adapted the concept of waste to information flows. To date, no study has explicitly linked Lean process logic with the concept of information entropy.

These gaps indicate a significant theoretical and conceptual limitation in existing research, justifying the need for a new perspective on waste. The present article aims to develop an integrative conceptual framework for analysing information waste in organisations. It adapts classical *muda* categories. It also extends them to phenomena specific to information processes.

The study adopts a conceptual–theoretical research design grounded in interdisciplinary literature synthesis. It does not test hypotheses. It builds an integrative analytical model based on the synthesis of multiple theoretical perspectives. The presented typology connects material and informational waste within a single analytical framework. It also supports future operationalisation and empirical research. The proposed framework organises dispersed theoretical insights. It also points to practical applications in knowledge-intensive and digitally mediated organisations.

The method consists of four sequential steps:

1. formulation of a definition of information waste,
2. identification of classical muda categories,
3. development of corresponding categories of information waste,
4. analytical discussion of information waste in organisations.

This approach was chosen to ensure systematic conceptualisation and theoretical consistency across the analysed domains.

The first step introduced the author's definition of information waste. The definition draws on Lean Management, waste theory, and information theory. The second step adopted the Lean Management canonical set of waste categories. This set includes the seven forms of waste identified by Taiichi Ohno and the later extension concerning the underutilisation of human potential. These categories formed the analytical baseline for the study.

The third step translated the logic of classical waste into the context of information-based work. The analysis focused on mechanisms rather than surface examples. It examined how disruptions to flow, unnecessary resource use, and loss of value appear in information processes. For each classical category, the study identified an equivalent mechanism in the information domain.

The fourth step presented an analytical discussion of information waste in organisations. This discussion linked the proposed categories with existing research and practical examples. It also examined their implications for organisational efficiency and decision-making.

Informational waste

In the classical understanding of Lean Management, waste (muda) refers to all activities that consume organisational resources without creating added value (Ohno, 1988; Womack, Jones, 2001; Liker, 2021). Taiichi Ohno stressed that waste includes not only unnecessary activities but also those performed in excess, because both delay or destabilise the flow of work. The literature consistently identifies muda as the main enemy of organisational efficiency. It increases costs, slows processes, and places additional burdens on employees (Nogalski, Walentynowicz, 2009; Walentynowicz, 2013). The logic of waste, therefore, has a universal character. It expresses the mismatch between action and the value created in a process.

Although Taiichi Ohno developed the seven types of waste for production systems, their logic applies to all flow-based systems. This includes systems based on materials, energy, and labour. Contemporary organisations now operate in conditions far more complex than those for which the Toyota Production System was designed. Digitalisation, project-based work, multichannel communication, advanced information systems, and the growth of knowledge work have transformed information into a key operational resource.

To analyse information waste, one must first clarify what “information” means. In Shannon’s theory (1948), information reduces uncertainty in a system. Davenport and Prusak (1998) describe information as data that people organise and contextualise to make it meaningful. Ackoff (1989) adds that relevance, timeliness, completeness, accessibility, and clarity directly shape decision quality. From this perspective, information resembles a stream. It moves between people, systems, and processes. It undergoes interpretation and supports action. At every stage, information may become distorted, delayed, overloaded, fragmented, or devalued.

Waste, therefore, no longer concerns only material resources, product defects, or excessive transport. Its modern sources increasingly include data overproduction, information overload, communication errors, redundant processing, decision delays caused by data deficits or excess, and dispersed organisational knowledge. Information flows exhibit structural and dynamic properties analogous to material flows. They may become constrained, unstable, excessively expanded, incomplete, or degraded in quality.

If customer value arises through appropriate information processing, then information - like material can carry both value and loss. Applying classical muda categories to information processes, therefore, extends Lean Management into the domains of knowledge and communication. This perspective allows scholars and practitioners to treat information as part of the value stream that may be disrupted, overloaded, or disorganised.

This reasoning raises a fundamental question: which forms of waste occur in information processes, and how do they correspond to Ohno’s seven classical losses. To answer this question, one must define information waste with precision, drawing on Lean theory and information theory.

Information waste can be defined as all processes, actions, or omissions that cause information to lose its function of reducing uncertainty and supporting decisions. This occurs when individuals or organisations produce, process, transmit, or store information in excessive, delayed, erroneous, inadequate, or unclear ways. This definition includes data excess, information overload, access delays, quality errors, knowledge dispersion, timeliness problems, and the need to search for or reinterpret information. Information waste, therefore, includes all practices that prevent information from supporting decisions.

From a Lean perspective, information functions like material in the value stream. Its flow may experience bottlenecks, instability, quality loss, and overproduction. Information waste therefore increases organisational entropy, understood as the level of disorder and uncertainty within organisational systems, weakening decision quality, prolonging lead times, and intensifying cognitive burden. Although entropy is not formally operationalised in this study, it is treated as a conceptual lens that helps explain the emergence of disorder and inefficiencies in information processes. Its identification and elimination remain as critical for knowledge-based processes as the elimination of muda remains for classical production systems.

Types of informational waste

Taichi Ohno created the Toyota Production System and defined seven types of waste that disrupt workflow, raise costs, and increase process complexity (Liker, 2021). Although Ohno developed these categories for production systems, their logic also applies to information processes, which now shape most work in contemporary organisations.

The classical types of waste include (Walentynowicz, 2013; Liker, 2021; Marchwiński, Shook, Schroeder, 2018):

- Overproduction – producing without demand or “for stock”, including the delivery of excessive information, which generates overvalue and stimulates other losses.
- Defects and production errors – outputs that require repair or scrapping due to failures to follow standards, material defects, insufficient training, late quality control, or equipment failures.
- Unnecessary inventory – excess physical or informational stock that occupies space, generates costs, and freezes financial resources, including outdated documents and unused solutions.
- Waiting – downtime caused by failures, poor organisation, missing tools or information, transport delays, or bottlenecks in the process.
- Unnecessary processing – repeated activities, unsuitable tools, procedures, and excessive information processing, as well as quality levels beyond customer expectations.
- Excessive transport – unnecessary movement of parts, products, documents, or work-in-progress between processes and locations.
- Unnecessary motion – avoidable employee movements, such as searching for information or tools, bending, or handling materials, caused by poor workplace organisation.
- Underutilisation of human potential – low engagement, lack of improvement initiatives, and limited development opportunities for employees.

Contemporary literature emphasises that the list of waste types is not closed and evolves with changes in the business environment. In digital contexts, particular importance attaches to information-related waste, such as losses caused by data dispersion, wishful thinking, excessive complexity of information processes, or low information quality (Lisiecka, Burka, 2015; Al-Aomar, 2012). Waste therefore no longer concerns only physical resources but increasingly affects information resources that underpin modern organisations.

Lean literature and practice also indicate additional forms of muda (Omiotek, 2026; Lisiecka, Burka, 2015; Nogalski, Walentynowicz, 2011):

- Lost time – time that could create value but is lost due to waiting, searching for information, repeating activities, or lacking standardisation.
- Unnecessary processes – activities that do not create customer value, including excessive formalisation, duplicated procedures, or overly detailed documentation.
- High costs – costs resulting from errors, surplus storage, low-quality products or information, and repeated corrections.
- Designing products that do not meet customer needs (overvalue) – products and services with unnecessary or unwanted elements due to incorrect or misinterpreted information.
- Wishful thinking – decisions based on unrealistic or unverified assumptions that generate strategic and operational errors.
- Dispersed information – knowledge that remains inaccessible, unstructured, hidden, or scattered across systems and teams.
- Environmental waste – uneconomical use of energy, water, raw materials, or packaging, reflecting Lean's extension toward sustainability.

In literature not specifically devoted to lean management, one can find many aspects related to information waste. Eppler and Mengis (2004) show that information excess may cause disorientation, cognitive overload, and declining decision quality. Alavi and Leidner (2001) similarly argue that knowledge management fails not only due to poor information quality but also due to excess, which hinders interpretation and use. Connelly et al. (2012) demonstrate that knowledge hiding leads to duplication, delays, and weakened collaboration. Jackson (2007) shows that information overload increases errors and task completion time. Hislop (2013) further links poorly designed information flows with knowledge loss and reduced work effectiveness.

Knowledge-based work continues to expand, and organisations intensify digital and multichannel communication. Classical interpretations of muda no longer capture contemporary inefficiencies. Waste increasingly takes intangible forms linked to information quality, flow, availability, and interpretation. These developments justify a typology that captures waste specific to information processes. As presented in Table 1, the proposed typology organises the main categories of informational waste and their underlying mechanisms. Unlike existing approaches, which typically address isolated dimensions such as information overload (Eppler, Mengis, 2004) or knowledge management processes (Alavi, Leidner, 2001), the proposed typology provides a more integrative and process-oriented classification of informational waste. The following table presents an original, conceptually grounded classification developed through the synthesis of Lean theory and information process analysis. The typology builds upon classical Lean categories and extends them based on insights from information theory and knowledge management literature.

Table 1.*Type of informational waste*

Type of information waste	Characteristics	
	Mechanism of emergence	Examples in the organization
Information overproduction	Lack of relevance criteria; “just in case” reporting; culture of excessive documentation.	Unread reports, copying entire departments in emails, overly verbose messages.
Defective information	Time pressure, lack of responsibility for data, weak information standards.	Two different versions of the same table, outdated procedures, incorrect figures, misleading messages.
Information inventories	Lack of archiving policy; defensive behaviors; chaotic repositories.	Duplicate files, overloaded drives, unused project folders.
Waiting for information	Unclear communication roles; overloaded managers.	Waiting for emails, lack of decisions blocking projects, delays in document approvals.
Overprocessing of information	Perfectionism; lack of standards; multiple revisions; unclear expectations.	Ten versions of a presentation, a forty-page analysis for a simple problem, unnecessary data “polishing.”
Unnecessary information transport	Duplicated channels; lack of a single source of truth; too many intermediaries.	Endless forwards, copying files between systems, the same messages in several tools.
Cognitive motion	Dispersed repositories; lack of metadata; poor searchability.	Twenty open windows, searching for a file in multiple folders, manual data merging.
Lack of feedback / underutilization of knowledge	Organizational silence; lack of feedback culture; hierarchical barriers.	No information about work quality, knowledge hidden in silos, lack of mentoring.
Narrative waste (complaining, destructive communication)	Entrenched complaining norms; lack of communication moderation; low trust.	Gossip, blame without facts, emotional escalations, negative emails.
Lost informational time	Lack of standardization; insufficient automation; lack of information source mapping.	Repeating the same analysis, searching for data, repeated requests for the same information.
Unnecessary informational processes	Excessive formalization; bureaucracy; overregulation.	Forms for the sake of forms, redundant approval steps, documents nobody reads.
Excessive informational costs	Informational chaos; repeated mistakes; lack of data policies.	Financial losses due to incorrect data, storage costs of duplicate files.
Informational over-quality	Perfectionism; poor understanding of the audience; lack of quality criteria.	Presentations overloaded with irrelevant details, analyses with unnecessary precision.
Wishful thinking	Cognitive bias; lack of analytics; avoidance of uncomfortable facts.	“Gut feeling” declarations, unrealistic schedules, planning without reliable data.
Dispersed information	Organizational silos; lack of shared repository; missing naming standards	Critical knowledge held by one employee, files on private drives, information scattered across tools.
Environmental informational waste	Lack of optimization; absence of environmental policies; low IT energy awareness.	Servers storing unused data, unnecessary printing of documents.

Source: own study.

The presented typology demonstrates that information waste constitutes a complex and multidimensional organisational phenomenon whose complexity goes beyond classical interpretations of muda. Losses no longer concern only physical processes but materialize primarily in the quality of information, its flow, accessibility, usability, and interpretation. Information, as a dynamic, stream-based resource, is subject to the same disturbances as

material in production systems: it may be excessively generated, distorted, stored without purpose, delayed, incorrectly processed, or unavailable at the moment of decision-making.

The typology extends the analytical scope of Lean Management by allowing for the identification of previously underexplored forms of waste that have so far remained outside the direct focus of the Lean literature, such as destructive communication patterns, wishful thinking, a lack of feedback, or the underutilization of tacit knowledge. These phenomena have a crucial impact on decision quality, organisational communication efficiency, and the organisation's capacity for learning. Their inclusion extends the classical understanding of muda by adding cognitive, emotional, and cultural dimensions, making the approach more adequate to the realities of contemporary knowledge-intensive organizations.

The proposed original typology may serve as a starting point for further research on the nature of information losses, including their measurement, sources, consequences, and methods of reduction. From a managerial practice perspective, it serves as a diagnostic tool for identifying key areas of informational inefficiency and for designing interventions to improve information flows, communication quality, and decision-making processes. Incorporating information-related categories into waste analysis thus opens the way toward a more holistic and contemporary Lean approach, encompassing both operational processes and the cognitive-communicative aspects of organizational work.

Conclusion

The study contributes to theory by extending the Lean Management framework to the domain of information processes and by introducing a structured conceptualisation of information waste. It reflects the conditions of contemporary organisations, where information has become the primary resource. Information flow, processing, and use now form key organisational processes. A review of the literature and organisational practice shows that traditional waste concepts derived from the Toyota Production System no longer capture many phenomena typical of knowledge-intensive environments. These limitations are most evident in communication and information systems.

The article presents an original and extended typology of information waste. The model integrates classical muda categories with contemporary Lean extensions and newly identified phenomena. These include destructive communication patterns, wishful thinking, lack of feedback, cognitive motion, and the underutilisation of tacit knowledge. The typology allows a more precise identification of inefficiencies in information and communication processes. It also supports the systematic diagnosis of these problems and the design of targeted interventions.

The analysis demonstrates that information waste is inherently complex and multidimensional. It includes technical imperfections such as data errors, outdated information, and dispersed repositories. It also includes socio-cultural factors such as organisational silence, lack of feedback, and destructive narratives. These findings suggest that organisations should address information waste through an explicitly interdisciplinary approach. Effective solutions should combine Lean Management, information theory, knowledge management, organisational communication, and work psychology.

The conceptual nature of the study constitutes its main limitation, as the proposed framework has not yet been empirically validated. The typology has a strong conceptual character and provides a structured foundation for future empirical research. Future studies should focus on several key areas. Researchers should identify dominant forms of information waste across different organisational contexts. They should measure the intensity and costs of information waste. They should also examine links between information quality, organisational culture, and process effectiveness. Further work should develop diagnostic tools to detect and classify information losses. Researchers should also design Lean methods and tools to reduce information waste. These tools may include information standards, visualisation systems, feedback rules, information flow mapping, and methods to reduce cognitive load.

The proposed approach can support the development of practical training, auditing, and implementation tools. These tools may help organisations manage information as a strategic resource, reduce losses, and increase the value of decision-making processes. In the long term, such solutions may contribute to the emergence of a distinct research stream focused on Lean Information Management. In this perspective, eliminating information waste is as important as eliminating waste in material flows.

References

1. Ackoff, R.L. (1989). From data to wisdom. *Journal of Applied Systems Analysis*, Vol. 16, pp. 3-9.
2. Al-Aomar, R. (2012). Analysis of Lean Construction practices at Abu Dhabi construction industry. *Lean Construction Journal*, Iss. 1, pp. 105-121.
3. Alavi, M., Leidner, D.E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, Vol. 25, Iss. 1, pp. 107-136.
4. Balle, M., Jones, D., Chaize, J., Fiume, O. (2019). *Strategia Lean. Kultura uczenia się kluczem do budowania przewagi konkurencyjnej*. Warszawa: MT Biznes.
5. Davenport, T.H., Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Boston: Harvard Business School Press.

6. Eppler, M.J., Mengis, J. (2004). The concept of information overload: A review of literature from organization science, accounting, marketing, MIS, and related disciplines. *Journal of Knowledge Management*, Vol. 8, Iss. 5, pp. 325-344.
7. Hislop, D. (2013). *Knowledge management in organizations: A critical introduction*. Oxford: Oxford University Press.
8. Jackson, T.W. (2007). Email overload: Exploring the moderating role of personality. *Journal of Knowledge Management*, Vol. 11, Iss. 1, pp. 81-97.
9. Liker, J.K. (2021). *The Toyota Way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill Education.
10. Lisiecka, K., Burka, I. (2015). Źródła powstawania marnotrawstwa w organizacjach na przykładzie usługowych przedsiębiorstw ciepłowniczych. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, Vol. 233, pp. 65-78.
11. Marchwiński, C., Shook, J., Schroeder, A. (2018). *Leksykon Lean. Ilustrowany słownik pojęć z zakresu Lean Management*. Wrocław: Lean Enterprise Institute Polska.
12. Nogalski, B., Walentynowicz, P. (2009). Lean Management – koncepcja zarządzania przedsiębiorstwem. *Przegląd Organizacji*, Vol. 10, pp. 3-8.
13. Ohno, T. (1988). *Toyota Production System: Beyond large-scale production*. New York: Productivity Press.
14. Omiotek, P. (2026). *Model procesu kreowania kultury Lean w przedsiębiorstwach produkcyjnych w Polsce*. Warszawa: Difin.
15. Pawłowski, E., Pawłowski, K., Trzcieliński, S. (2010). *Metody i narzędzia Lean Manufacturing*. Poznań: Wydawnictwo Politechniki Poznańskiej.
16. Shannon, C.E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, Vol. 27, pp. 379-423, 623-656.
17. Walentynowicz, P. (2013). *Uwarunkowania skuteczności wdrażania Lean Management w przedsiębiorstwach produkcyjnych w Polsce*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego.
18. Womack, J.P., Jones, D.T. (2001). *Lean Thinking: Banish waste and create wealth in your corporation*. New York: Simon & Schuster.
19. Womack, J.P., Jones, D.T., Roos, D. (2007). *The Machine That Changed the World: The Story of Lean Production*. New York: Simon & Schuster.

ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON ECONOMIC TRANSFORMATION IN INDIA

Zbigniew ORBIK^{1*}, Bogdan PLISZKA²

¹ Silesian University of Technology, Faculty of Organization and Management;
zbigniew.orbik@polsl.pl, ORCID:0000-0001-7092-1567

² Silesian University of Technology, Faculty of Organization and Management; bogdan.pliszka@polsl.pl,
ORCID: 0000-0002-3021-905X

* Correspondence author

Purpose: The aim of this article is to analyze the impact of artificial intelligence on economic transformation in India. Drawing on various sources, the authors attempt to outline the impact of AI-based systems on various sectors of the Indian economy, such as agriculture, industry, healthcare, finance, and services. The choice of research area is due to the growing importance of India as the most populous country in the world and its influence on both the global and European economies.

Design/methodology/approach: This article is conceptual in nature and is based on selected literature on the application of AI in management across various economic sectors, as well as Indian policy.

Findings: Analyses of the impact of AI on various areas of the Indian economy indicate that AI could significantly contribute to GDP growth through integration with various economic sectors, such as manufacturing, agriculture, healthcare, finance, and services. The implementation of AI-based systems in the Indian economy, however, is a complex interaction, and the ongoing changes, while promising, require a critical examination of the country's structural changes, both economically and socially.

Research limitations/implications: The article refers to a limited number of studies. The size of the Indian economy and the dynamics of its ongoing changes require further monitoring of the multifaceted impact of AI on all sectors of Indian economic, social, and cultural life. Therefore, the analyses presented in this article should be considered a description of the current state of this impact and must be continually updated.

Originality/value: This article reports on the current state of research on the impact of AI on the dynamically developing Indian economy. It provides an overview of the trends dominating the transformation taking place in the economy of the world's most populous country.

Keywords: India, Indian economy, Economic transformation, AI in the economy.

Category of the paper: Conceptual paper.

1. Introduction

Artificial Intelligence (AI) is rapidly emerging as a pivotal driver of economic transformation worldwide, with its influence extending across various sectors to reshape productivity, employment dynamics, and overall economic growth (Varalakshmi, Yoganandham, 2024). In India, the integration of AI is particularly critical, given its potential to significantly enhance GDP growth and catalyze advancements across diverse industries, including agriculture, manufacturing, and services. This integration is projected to contribute substantially to the global economy, with AI potentially adding \$15.7 trillion by 2030, largely through enhanced productivity and consumption (Shingare, 2020).

This profound economic impact underscores the imperative for comprehensive research into AI's specific implications for the Indian economy, where the technology is anticipated to create 133 million jobs globally in the manufacturing sector by 2022 (Sharma et al., 2021). However, this rapid technological adoption also presents challenges, such as the need to address potential job displacement in certain sectors and the imperative for upskilling the workforce to meet the demands of an AI-driven economy (Panigrahi et al., 2024).

Such transformation necessitates a strategic approach to policy formulation, infrastructure development, and educational reform to harness AI's full potential while mitigating associated risks (Srivastava, 2018). Therefore, analyzing the current "Tech-tonic Shifts" and their effects on India's socioeconomic environment is crucial for understanding how AI can drive economic growth, promote inclusivity, and address societal challenges (Faishal et al., 2023).

This paper will delve into the multifaceted ways AI is catalyzing economic transformation in India, focusing on its role in driving industrial efficiencies, fostering innovation, and shaping the future of labor markets within the framework of Industry 4.0 (Dhanabalan, Sathish, 2018). While AI offers considerable promise for economic growth, it simultaneously poses challenges such as potential labor displacement and increased wealth disparity, particularly in the initial stages of technological adoption within emerging economies.

Specifically, emerging economies like India and China could see a 26% impact on existing jobs due to AI technologies, particularly within the manufacturing sector, which also suggests a greater scope for technological advancement. This indicates that while AI adoption presents transformative opportunities for economic growth and industrial innovation, it also requires a critical examination of its societal implications and the strategic development of policies to ensure equitable benefits and minimize adverse effects (Banerjee et al., 2023). The nuanced interaction between AI and India's economic landscape, therefore, demands a meticulous investigation into how this technology can be leveraged to not only enhance productivity and competitiveness but also to address socio-economic disparities and foster inclusive growth (Folorunso et al., 2024).

2. Methods

This research employs a mixed-methods approach to comprehensively analyze the multifaceted impact of AI on India's economic transformation, integrating both quantitative economic modeling and qualitative policy analysis. This methodology allows for a robust examination of the causal relationships between AI integration and various economic indicators, alongside a nuanced understanding of the policy frameworks and competitive dynamics shaping India's AI landscape (Malik et al., 2025).

Specifically, econometric models will be utilized to quantify the macroeconomic effects of AI adoption, including its influence on GDP growth, employment patterns, and sectoral productivity (Frigg, Nguyen, 2017). This will be complemented by qualitative policy analysis, drawing upon government reports, to explore the strategic initiatives and ethical considerations guiding AI deployment within India's unique developmental context (D'Souza, 2017). The quantitative dimension of this study will incorporate analyses of key indicators such as GDP growth rates, employment statistics, income distribution data, and technological adoption rates in critical sectors (Prabhakar, 2024). The qualitative insights will be derived from a comprehensive review of policy documents, and academic literature, to contextualize the quantitative findings and identify emerging trends and challenges in AI governance and implementation (Abanga, Dotse, 2024).

The qualitative approach further synthesizes existing literature and analyzes relevant policies to comprehensively understand the current scenario (Bharati, 2025). This mixed-methods design, incorporating both quantitative and qualitative techniques, is consistent with established research practices for analyzing complex socio-economic phenomena (Swargiary, 2023). This will provide a holistic perspective on the implications of AI on the Indian economy, reflecting the need for continued focus on building digital capabilities to fully utilize the power of AI (Kathuria et al., 2020).

Such an approach is deemed optimal for interpreting complex social phenomena, as it enables extensive interpretations of the emergent contours of AI governance and its associated capabilities (Larsen, 2022). The study employs an exploratory descriptive research method to investigate policy frameworks related to AI governance in nations like India, drawing on secondary data from scholarly journals, e-books, and reports (Sharma, Sharma, 2025). The quantitative analysis will utilize existing datasets from governmental and financial institutions to assess macroeconomic indicators such as GDP growth, inflation, investment rates, and sectoral contributions from 2010 to 2022, thereby identifying causal relationships and emerging patterns within the Indian economic landscape (Baranidharan, 2023).

This comprehensive approach, employing both statistical methods like regression analysis and thematic analysis of qualitative data, ensures a rigorous and accurate examination of AI's multifaceted impact on business efficiency and overall economic performance (Edilia, Larasati,

2023). The qualitative dimension will involve thematic analysis of policy documents, white papers, and expert interviews to delineate the strategic initiatives, ethical frameworks, and societal considerations underpinning India's AI development (Du, 2025). Such dual analytical framework will facilitate a nuanced understanding of both the demonstrable economic shifts attributable to AI integration and the strategic policy responses formulated to manage these transformations within a rapidly evolving technological and socio-economic environment (Cannavale et al., 2025).

The research integrates literature reviews on AI's transformative potential and algorithmic accountability, particularly within the Indian context, complementing the quantitative and qualitative data (P.R. & Gayathri, 2024). This conceptual and exploratory design allows for an analysis of not only policy outcomes but also the underlying assumptions, political dynamics, and institutional capacities that shape AI strategies, particularly within resource-constrained environments (Frimpong, 2025). The research methodology therefore integrates both explanatory and descriptive approaches, leveraging quantitative data for interrelationships among variables and qualitative data for comprehensive understanding of the contextual factors shaping AI adoption and governance (Sharma, 2023).

To conduct the literature review, the Google Scholar and Science Direct databases were utilized. The search strategy involved specific keywords, including "India", "Indian economy", "Economic transformation", and "AI in the economy". A concise overview of the various methodologies and classifications of literature reviews is provided in Table 1.

Table 1.
Types of Literature Review

Type	Systematic	Semi-systematic	Integrative
Typical purpose	Integrate and contrast empirical findings from diverse studies	Map the landscape of a specific research field and analyze its chronological progression	Evaluate the validity and quality of findings while amalgamating them into a unified theoretical framework
Search strategy	Systematic	May or may not be systematic	Usually not systematic
Research questions	Specific	Broad	Narrow or broad
Analysis and evaluation	Quantitative	Qualitative/quantitative	Qualitative
Sample characteristics	Quantitative articles	Research articles	Research articles, books, and other published texts
Examples of contribution	Validated findings of research outcomes	A synthesis of the current body of literature and the established evidence base	Taxonomy or classification. Theoretical model or framework

Source: own elaboration.

Another method employed in this article is logical analysis. This approach utilizes logical instruments to differentiate sound arguments—namely, those conforming to the principles of logic—from those that contravene logical rules. The principles of logic govern the validity of reasoning across all scientific fields (Waldt, 2020). Moreover, logic and its techniques facilitate

the identification of the most fundamental structural dimensions of human cognition and behavior (Bless, 2022). Thought experiments constitute one variant of logical analysis. Applying the instruments of logical analysis to propositions formulated in natural language is warranted, as the conventions of such language are themselves governed by logical principles (Frigg, Nguyen, 2017). One of the key elements of scientific methodology is reasoning. Logic can be defined as the science of correct patterns of reasoning. An overview of the different types of logical reasoning used in scientific cognition is presented in Table 2.

Table 2.
General Characteristics of Reasonings

Form of reasoning	Name	Characteristics
Non-defeasible	Deduction	Deductive reasoning starts from a general premise to reach a specific conclusion. It is the type of reasoning used in logical arguments, where the conclusions are necessarily true if the premises are true
Defeasible	Quasi-deductive	Quasi-deductive reasoning is an informal approach that mimics the structure of formal logic to suggest certainty, though it actually depends on linguistic simplifications and assumed premises rather than strict formal criteria
Defeasible	Counterfactual reasoning	Counterfactual reasoning involves the cognitive analysis of hypothetical scenarios—events that never materialized but were possible under alternative conditions (Hájek, 2006). This form of reasoning is fundamental to rational deliberation and strategic choice within disciplines like decision theory and game theory
Defeasible	Plausible reasoning	Plausible reasoning is a non-deductive method that draws likely conclusions from partial or inexact observations. Unlike classical logic, which requires complete truth sets for absolute certainty, this approach produces "best-effort" answers based on current knowledge, allowing for future revision or retraction as new evidence emerges
Defeasible	Abduction	It is a form of logical inference that seeks the simplest and most likely conclusion from a set of observations
Defeasible	Induction	Inductive reasoning starts from specific observations to reach a general conclusion. It is used in generalization processes, where concrete examples are used to reach a broader conclusion

Source: own elaboration.

To achieve the research goal of identifying the impact of AI on various sectors of the Indian economy, the following research questions were formulated:

- Q1: How do technological, organizational, and cultural prerequisites influence AI adoption in the Indian economy?
- Q2: How does the use of AI impact specific sectors of the Indian economy?
- Q3: What are the risks of implementing AI for India's social life?
- Q4: What are the opportunities AI offers for addressing socioeconomic inequalities?

This article mainly analyzes the title issue from a theoretical point of view. The aim of this research is to examine the relationship between AI development and economic growth in various sectors of the Indian economy, as well as its various economic, ethical, and social consequences.

3. General Characteristics of AI's Impact on the Indian Economy

This section critically evaluates extant scholarly work concerning AI's influence on India's economic and managerial frameworks, drawing insights from studies that analyze its effects on GDP, employment, and productivity (Jaleel, Kurbonnazarovich, 2024). This review further examines the socio-economic implications of AI-driven automation on employment patterns, highlighting findings that indicate a correlation between increased AI adoption and job displacement, particularly in low- and middle-skilled occupations, while simultaneously fostering the emergence of high-skilled roles (Ritika, Manju, 2025). Conversely, other research emphasizes that AI contributes to economic growth in India by enhancing productivity and fostering innovation (Yadav, 2025). This dual impact necessitates a nuanced understanding of how AI reallocates labor demand across occupations, as routine-intensive tasks decline while non-routine cognitive tasks experience increased demand (Prasad, 2025).

Furthermore, the integration of AI within the Indian manufacturing sector, despite its slow initial implementation, holds significant promise for elevating worker productivity and achieving the nation's ambitious economic targets (Sharma et al., 2021). This phenomenon underscores a departure from conventional skill-biased technological change patterns, as AI's capabilities may complement certain middle-skill occupations while automating some high-skill cognitive tasks (Ganuthula, Balaraman, 2025). This requires a reassessment of educational paradigms and workforce development strategies to ensure that the Indian labor force can adapt to evolving skill requirements and leverage AI-driven tools effectively.

The Indian government acknowledges AI's transformative potential to enhance service delivery, governance efficiency, and drive economic growth by fostering innovation and creating new job opportunities (Bansal, Jain, 2023). However, the effective realization of these benefits hinges on addressing foundational issues such as basic literacy, computer literacy, and widespread internet connectivity, as posited by proponents of Keynesian economics who advocate for government intervention to stabilize and advance the economy (Mukherjee, 2022). Indeed, a successful implementation of AI across various industries requires a concerted effort from industries, academia, and the government to ensure a holistic approach to technological integration and societal preparedness (Folorunso et al., 2024). This integrated strategy becomes particularly vital given that AI adoption in India is projected to significantly influence the employment landscape by automating routine tasks and fostering new skill requirements.

An analysis using ordinary least squares regression revealed that a 1% increase in AI adoption correlated with a 0.18% rise in job displacement, predominantly affecting low- and middle-skilled occupations (Ritika & Manju, 2025). However, other studies suggest that AI primarily leads to labor reallocation rather than widespread job displacement, with occupations requiring non-routine cognitive tasks experiencing increased demand (Prasad, 2025). This dichotomy highlights the critical need for robust upskilling and reskilling initiatives

to prepare the workforce for these evolving demands and to mitigate the adverse effects of automation (Mukherjee, 2022). Such initiatives are crucial for India, where over 50% of the current workforce is estimated to require reskilling to maintain employability in an AI-driven economy (Kumar, 2025).

Moreover, the development of robust educational and training infrastructures is imperative to equip the workforce with the adaptability and continuous learning capabilities necessary to thrive amidst rapid technological advancements (Jadhav, Banubakode, 2024). Such situation necessitates a strategic emphasis on hybrid approaches that blend AI with human expertise, alongside proactive policies for retraining and redeploying employees impacted by automation (Herden et al., 2021). These proactive measures are essential to ensuring that AI's integration into the Indian economy translates into inclusive growth rather than exacerbating existing socio-economic disparities (Carter, Hermansen, 2026). A comprehensive national strategy for AI, therefore, must encompass not only technological innovation but also significant investment in human capital development, with a focus on building AI-complementary skills rather than merely traditional technical capabilities (Ganuthula, Balaraman, 2025).

The government's national strategy for AI highlights the importance of developing a skilled workforce, promoting research and innovation, and ensuring responsible AI adoption across various sectors like healthcare, agriculture, and education (Bansal, Jain, 2023). This strategic framework aims to address critical concerns such as the ethical implications of AI, data privacy, and algorithmic bias, which are paramount for fostering public trust and ensuring equitable societal outcomes (Jadhav, Banubakode, 2024). The emphasis on responsible AI aligns with the broader global discourse on balancing technological advancement with ethical research and societal well-being (Bhalla et al., 2023). India's approach to AI, therefore, seeks to harness its transformative potential for economic and social value creation, aiming to add significantly to its GDP while fostering inclusive development (Hammer, Karmakar, 2021). In fact, the Indian government has explicitly aimed to integrate AI into its 'Make In India' initiative, positioning the nation as a hub for AI development and application, thereby supporting domestic manufacturing and technological self-reliance (Bhalla et al., 2023). This strategic vision, articulated by NITI Aayog's comprehensive AI strategy, seeks to balance financial impact with broader societal good by embracing AI for its incremental value across diverse sectors (Marda, 2018).

This strategic approach, which emphasizes public consent in data usage and ethical AI development, reflects India's unique socio-political values and economic goals (Adigwe et al., 2024). Unlike the risk-averse model adopted by the European Union, India's governance style prioritizes innovation and employment, channeling AI applications into critical public sectors such as healthcare and education (Ijiga et al., 2024; Shetty et al., 2025). Such proactive stance is further reinforced by the NITI Aayog's objective to leverage AI for economic growth, social development, and inclusive growth, often framing AI as a tool for "social good" to address societal challenges and accelerate socioeconomic development (Kathuria et al., 2020;

Radhakrishnan, 2021). This human-centric approach to AI, emphasizing ethical considerations and human values, aligns with global discussions on ensuring AI systems are developed, deployed, and monitored responsibly (Radavoi, 2025).

However, India's unique economic and cultural context necessitates targeted regulations that specifically address potential negative consequences of AI, differentiating its approach from models adopted by other nations (Walter, 2024). For example, while the EU AI Act takes a centralized, risk-based approach that prohibits certain AI applications, India's regulatory landscape is still developing, with fragmented guidelines like the Medical Device Rules, 2017, and the Indian Council of Medical Research's ethical guidelines addressing AI in specific sectors like healthcare (Naik, Reddy, 2025). This nascent regulatory framework, characterized by sector-specific directives, suggests an incremental rather than an overarching strategy towards AI governance, reflecting a pragmatic balance between fostering innovation and addressing emergent ethical concerns (Joshi, 2024). Such incremental approach contrasts with more centralized models seen in other nations, highlighting the necessity for periodic reviews and holistic impact assessments to ensure comprehensive oversight of AI technologies (Naik, Reddy, 2025).

4. Results

Initial findings indicate a positive correlation between increased AI adoption rates and GDP growth, projected to potentially add 1.9 trillion USD to India's GDP by 2035, with 87% of Indian enterprises actively utilizing AI solutions (Carter, Hermansen, 2026). Concurrently, qualitative data gleaned from stakeholder interviews and policy document analysis reveal that while there is strong governmental impetus to position India as a global AI leader, significant challenges persist regarding data governance, privacy, and the equitable distribution of AI's economic benefits (Chatterjee, 2020; Gupta et al., 2025). Moreover, a notable disparity exists in AI adoption and benefits across different sectors and regions within India, reflecting the extant digital divide (Dangar, 2025). This digital divide is exacerbated by the fact that nearly half of the Indian population lacks internet access, with women, rural communities, and Adivasis disproportionately affected (Sun, Chen, 2025).

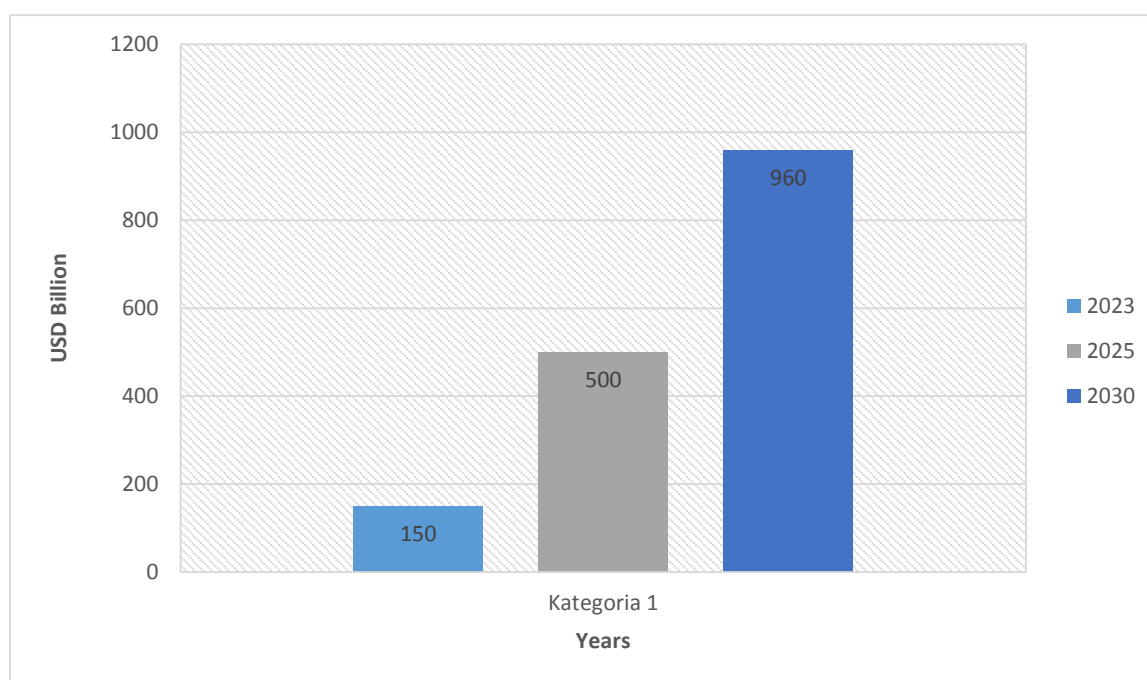


Figure 1. Projected AI contribution to Indian GDP growth over time.

Source: PwC (2018).

This highlights the urgent need for inclusive digital infrastructure development and targeted interventions to bridge these access gaps, ensuring that the transformative potential of AI benefits all segments of society, not just privileged demographics. Such efforts are critical for India's digital economy, which has emerged as a significant driver of economic expansion and employment generation over the past decade (Madhu, Pujari, 2025; Edilia, Larasati, 2023). The growth is further characterized by the digital economy's projected contribution of nearly 20% to national income and its role in employing 14.67 million workers with substantially higher productivity levels compared to other sectors (Madhu, Pujari, 2025). This rapid expansion underscores the critical need for comprehensive policies that address both the opportunities and challenges presented by advanced technologies like AI within India's evolving digital landscape.

Despite the digital divide, India has demonstrated significant progress in leveraging AI for public service delivery and has developed various initiatives to embed AI across governmental and societal levels (Bhalla et al., 2023). For instance, the strategic integration of AI in agriculture through initiatives such as IoT and precision farming has demonstrably boosted regional GDP and is projected to create substantial employment opportunities by 2024, particularly attracting younger demographics into the sector. However, realizing the full potential of AI for inclusive growth in India necessitates addressing persistent disparities in digital literacy and infrastructure, especially in rural areas, to prevent the exacerbation of existing socio-economic inequalities (Hazari, Mohan, 2024; Lazanyuk et al., 2025; Saxena, Kumar, 2025). This includes targeted investments in digital infrastructure, enhancing digital literacy programs, and fostering equitable access to AI technologies to ensure that all segments

of the population, particularly those in disadvantaged regions, can participate in and benefit from the AI-driven economic transformation (Gupta, Kaul, 2024; Nations, 2024).

The ongoing expansion of India's digital economy, fueled by increasing internet penetration and affordable data, further underscores the imperative for such inclusive policies to ensure widespread access to AI-driven solutions. This includes promoting digital literacy and providing accessible digital infrastructure, particularly in rural areas, to bridge the pervasive digital divide (Sindakis, Showkat, 2024). These foundational steps are crucial for mitigating issues such as algorithmic bias and data privacy, which are paramount for fostering trust and ethical deployment of AI in sensitive sectors like banking (Shakyawar, Shakya, 2024). The integration of AI in critical sectors like banking, while offering transformative potential for efficiency and financial inclusion, also necessitates a robust regulatory framework to address inherent complexities such as data security, algorithmic transparency, and consumer protection (Shakyawar, Shakya, 2024).

These regulatory considerations extend beyond finance to encompass all domains where AI intersects with public welfare, necessitating a coherent national strategy that balances innovation with safeguards for accountability and trust (Prakash et al., 2023). Such a framework is essential for navigating the complex ethical and societal implications of AI, particularly given India's stated objective to cover AI-related areas with legal regulations to ensure legal certainty (Cyman et al., 2021). This regulatory clarity is crucial for mitigating potential threats to emerging economies, like India, which face the dual challenge of job creation for a young population and ensuring equitable benefits from AI advancements (Vipra, 2020).

The proactive promotion of technology application for implementing regulations and creating policy frameworks, particularly within the banking sector, under the leadership of figures like Dr. Raghuram Rajan and Urjit Patel, highlights a governmental commitment to AI integration (Agarwal et al., 2019; Shaikh et al., 2024). However, the conceptualization of a strategy significantly precedes its effective implementation, particularly in a nation with India's demographic scale and rural-urban dichotomy (Tiwari, 2021). To effectively bridge this implementation gap, comprehensive policy frameworks must move beyond conceptualization to robust execution, incorporating scalable pilot programs and iterative feedback mechanisms tailored to India's diverse socio-economic landscape.

5. Discussion

This section delves into the multifaceted implications of AI for India's economic transformation, synthesizing findings from policy analysis and empirical observations. It examines how AI can drive economic growth, enhance productivity, and create new opportunities while also scrutinizing potential challenges such as job displacement, ethical

dilemmas, and the imperative for comprehensive regulatory frameworks to ensure equitable and sustainable development. This discussion specifically addresses the technological, legal, and ethical challenges inherent in regulating AI within India, recognizing the unique context of its rapidly evolving digital economy (Rathore et al., 2025).

India's rapid AI adoption across sectors like healthcare, finance, and education, while promising significant innovation and growth, concurrently introduces complex legal and ethical challenges, including data privacy breaches, algorithmic bias, and accountability deficits for AI-driven decisions. These concerns necessitate a comprehensive regulatory approach that addresses the intricacies of AI's rapid growth and complexity, ensuring data protection and mitigating algorithmic bias (Rathore et al., 2025). The ongoing efforts by various ministries and agencies to articulate AI policy stances highlight the fragmented nature of current governance, requiring a more unified and coherent national strategy (Vipra, 2025).

To address this fragmentation, a centralized regulatory framework is essential to streamline policy implementation, promote interoperability across various AI applications, and establish clear guidelines for ethical AI development and deployment, particularly within critical financial sectors (Adeyelu et al., 2024). The proliferation of AI in digital financial services, especially in underserved regions, further underscores the urgent need for such a unified strategy to ensure equitable access and prevent the widening of digital divides (Chatterjee, 2020). This centralized framework must balance the imperative for innovation with robust safeguards for public interest and ethical standards, ensuring transparency, accountability, and fairness in AI system development and deployment (Walter, 2024).

Such a framework would align with global best practices, wherein countries like India are positioning themselves as global AI hubs by contributing significantly to AI research and fostering a thriving start-up ecosystem (Joshi, 2024). This aspirational goal, however, confronts the practical challenges of establishing robust intellectual property rights and cross-border data flow regulations within India's current legal infrastructure (Rathore et al., 2025). These challenges are compounded by the absence of a comprehensive AI-specific legal framework, leading to a regulatory vacuum that struggles to keep pace with rapid technological advancements. The existing legal concepts of causation and responsibility, for instance, are often ill-equipped to address situations involving AI, necessitating significant adaptation of legal norms to accommodate these technological developments (Hasibuan et al., 2024).

The lack of specific regulatory standards for AI innovations in fintech, alongside the reliance of AI systems on sensitive personal data, intensifies these issues, raising concerns about data protection, unauthorized access, and compliance with new laws like the Digital Personal Data Protection Act, 2023. This legal lacuna is further exacerbated by the fragmented nature of existing governance landscapes, characterized by a mix of principles-based national strategies and sector-specific ethical guidelines (Joshi et al., 2026). This disaggregated approach often results in inconsistencies and gaps, failing to provide a cohesive regulatory environment

necessary for fostering public trust and mitigating the systemic risks associated with AI adoption (Arowona, Ganiyu, 2026; Glavina, 2024).

To effectively manage these complexities, a harmonized, comprehensive regulatory approach is crucial, integrating sector-specific considerations with broader ethical guidelines to ensure AI development aligns with global public goods and human rights. Such an integrated framework would draw upon international best practices, such as the EU AI Act's risk-based approach, while simultaneously tailoring regulations to India's unique socio-economic context (Bhalla et al., 2024; Joshi et al., 2026). Specifically, the absence of AI-specific legislation creates substantial challenges concerning liability, data protection, and algorithmic accountability, necessitating a dedicated legal framework beyond existing acts like the Information Technology Act and the Digital Personal Data Protection Act (Gupta, George, 2024). While the Digital Personal Data Protection Act, 2023, represents a step towards greater data privacy, it, alongside the Information Technology Act, 2000, remains insufficient in addressing the multifaceted complexities introduced by AI technologies (Biju, Gayathri, 2025; Yadav, Sharma, 2025).

For instance, the Information Technology Act from 2000, despite being India's central digital law, predates modern AI systems, leading to ambiguities regarding the application of its provisions to AI-generated contracts and the formation of valid consent by AI agents (Satarkar, 2026). Moreover, the rapid evolution of AI technology, particularly in areas like deep learning and generative AI, often outpaces the legislative cycle, creating a persistent regulatory gap that current legal instruments struggle to bridge. The Digital Personal Data Protection Act, while an advancement in data privacy, still exhibits limitations compared to international benchmarks like the EU GDPR, particularly concerning robust enforcement mechanisms and explicit limitations on state surveillance, which are critical in an era of pervasive AI and automated decision-making (Alibeigi, 2025). This includes the absence of explicit provisions for the right to explanation for automated decisions, the right to contest algorithmic profiling, or the right to be forgotten from AI training datasets, which are increasingly recognized as essential user rights in AI governance (Satarkar, 2026).

Consequently, India's AI policy landscape, despite recent advancements such as the 2024 India AI Mission, still struggles with meaningfully integrating fundamental rights, fairness, and inclusion into its ethical considerations, often influenced predominantly by private sector interests (Daly et al., 2019). The absence of explicit statutory frameworks tailored to AI's unique characteristics—such as its capacity for autonomous learning and decision-making further complicates the application of existing legal principles, making it challenging to delineate accountability for AI-driven outcomes (Vipra, 2025). This necessitates a dedicated regulatory body and specialized tribunals to adjudicate AI-related disputes and interpret evolving legal principles within the context of artificial intelligence (Joshi, 2024). Such a body could address issues like algorithmic bias and unpredictable system behavior, which current regulations,

including the Telecommunications Act, 2023, and the CERT-In Rules, primarily designed for cybersecurity and data breaches, do not adequately cover (Avinash, 2025).

Moreover, the lack of a horizontal AI law in India exacerbates these issues, leaving a significant regulatory gap for AI-specific operational incidents like performance degradation and algorithmic bias (Avinash, 2025). This regulatory deficit is particularly evident when considering the need for legal frameworks to attribute responsibility for errors or biases generated by autonomous AI systems (Hasibuan et al., 2024). Furthermore, the lack of a standardized legal definition for AI, coupled with the rapid iteration of AI technologies, creates difficulties in establishing clear lines of accountability, particularly in scenarios involving complex algorithmic interactions and emergent properties (Deo, Singh, 2022). This calls for a dynamic and adaptive regulatory paradigm, such as active matrix theory or hybrid regulation, that can evolve alongside AI advancements rather than being perpetually reactive to them (Sharma, 2023). To mitigate this, India could draw upon international frameworks that emphasize a human-centric approach to AI, ensuring that ethical considerations like explainability and accountability are embedded in the AI lifecycle, aligning with its constitutional mandates (Mukherjee, 2025; Radavoi, 2025).

Such proactive approach would require the establishment of regulatory sandboxes and interdisciplinary expert panels to continuously evaluate and adapt governance mechanisms to the rapid technological advancements in AI (Naik, Reddy, 2025). This includes developing robust frameworks for algorithmic auditing and impact assessments to ensure AI systems are deployed responsibly and ethically, particularly in high-stakes domains such as healthcare and finance (Stetler, 2025).

Given the significant ethical considerations, it is crucial to establish clear guidelines for identifying and mitigating bias in AI systems, especially when they are employed in critical judicial processes, as evidenced by debates surrounding their use in predicting recidivism (Srivastava, 2023). Moreover, the establishment of independent fairness assessment laboratories and standardized AI incident reporting mechanisms is critical for objectively evaluating and continuously monitoring AI systems for ethical compliance and performance robustness (Agarwal, Nene, 2025).

These measures would provide necessary safeguards against potential adverse impacts, ensuring that AI development in India aligns with principles of fairness, transparency, and accountability, thereby fostering public trust in these transformative technologies (Cheong et al., 2024). India's "AI for All" strategy and "Responsible AI Principles" demonstrate an initial commitment to ethical AI development, yet comprehensive legislation is still required to address the nuances of accountability, privacy, and systemic bias in high-impact AI applications (Sankaran, 2025).

6. Conclusion

The present discussion underscores the critical importance of a nuanced regulatory approach that balances the imperatives of fostering AI-driven innovation with the establishment of stringent safeguards for data privacy, algorithmic transparency, and equitable access to technology.

This approach is essential to address potential information asymmetries, adverse selection, and moral hazards that can arise with the widespread adoption of AI in critical sectors like finance (Addula et al., 2024). Furthermore, such a regulatory framework must be adaptable and forward-looking, anticipating the rapid evolution of AI technologies and their multifaceted impact on economic and social structures (Adeyelu et al., 2024). This necessitates the development of AI-specific financial regulations, enhanced transparency mandates, and robust risk management frameworks, drawing lessons from global best practices (Rai, Shekhar, 2025).

A comprehensive regulatory framework must also address concerns surrounding algorithmic discrimination, accountability for AI-driven decisions, and the protection of digital personal data, especially within the fintech sector. This includes navigating the complexities of multilingual data, mitigating biases, and ensuring adherence to ethical guidelines to foster responsible and inclusive AI adoption in India's financial markets (Raju, 2025). Such strategic imperative is further highlighted by the rapid growth of India's Reg Tech market, projected to reach USD 5.31 billion by 2032, underscoring the urgent need for a cohesive and adaptable regulatory environment that can support this expansion while mitigating emergent risks (Goswami, 2026).

The growth trajectory needs a proactive regulatory stance that considers cross-sectoral applications of AI, moving beyond fragmented approaches to establish a unified policy framework (Vipra, 2020). Such a framework should prioritize the development of tailored regulations that promote innovation while simultaneously safeguarding market integrity and consumer protection, especially given the rapid adoption of AI in banking and fintech industries. One effective strategy involves the creation of regulatory sandboxes, allowing fintech companies to test novel AI-powered products and services in controlled environments under regulatory oversight, thereby enabling the identification of potential risks and the development of appropriate responses without stifling innovation. Such a proactive engagement allows regulators to influence the creation of innovation-friendly regulations, fostering a balanced financial ecosystem (Jede, Teuteberg, 2025).

Furthermore, continuous collaboration between regulatory bodies, financial institutions, technology companies, and civil society is crucial for developing robust standards and guidelines addressing ethical considerations, data privacy, security, and algorithmic bias in AI applications. This collaborative approach could facilitate the formulation of dynamic regulatory frameworks that accommodate technological advancements while upholding

principles of fairness, transparency, and accountability in AI deployment across various economic sectors.

This adaptive regulatory posture would enable India to capitalize on the transformative potential of AI in its financial sector, balancing innovation with the imperative of maintaining financial stability and consumer trust (Gupta et al., 2024). Such an approach could learn from international examples where regulatory bodies have implemented frameworks to manage the risks associated with AI-driven financial markets, such as mandatory reporting of AI-driven trading activities and strict data privacy standards (Ekundayo, 2024).

Moreover, incorporating explainable AI principles into regulatory frameworks can enhance transparency in AI-driven decision-making, particularly in critical areas like credit scoring, allowing stakeholders to understand the rationale behind algorithmic outputs and identify potential biases. This also involves establishing clear accountability mechanisms for AI systems, particularly when errors or adverse outcomes occur, to ensure that liability can be appropriately assigned and redress provided.

References

1. Addula, S.R., Meduri, K., Nadella, G.S., Gonaygunta, H. (2024). AI and Blockchain in Finance: Opportunities and Challenges for the Banking Sector. *IJARCCCE*, 13(2).
2. Alibeigi, A. (2025). Bridging the Gap: Assessing India's Digital Personal Data Protection Act in Light of the EU GDPR. *SN Computer Science*, 6(7).
3. Baranidharan, S. (2023). *Decoding the Indian Economic Slowdown: An Insight into the Factors behind the Stumble*. Research Square (Research Square). <https://doi.org/10.21203/rs.3.rs-2552685/v1>, 2.05.2026.
4. Bhalla, N., Brooks, L., Leach, T. (2024). Ensuring a 'Responsible' AI future in India: RRI as an approach for identifying the ethical challenges from an Indian perspective: Driving Responsible AI in the world's largest society: RRI as a tool for identifying the ethical challenges of AI in India. *AI and Ethics*, 4(4), 1409-1422.
5. Bharati, R. (2025). AI-Driven Diagnostics: Data Protection and Patient Empowerment in Indian Healthcare. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.5352177>
6. Bharati, D.R.K. (2024). AI-Driven Diagnostics: Data Protection and Patient Empowerment in Indian Healthcare. *Frontiers in Health Informatics*, 13(8), 6797-6815.
7. Bless, B.D. (2022). Deriving a theoretical framework for interpreting management research results in South Africa. *Proceedings of the European Conference on Research Methods in Business and Management Studies*, 191-198.

8. Chatterjee, S. (2020). AI strategy of India: policy framework, adoption challenges and actions for government. *Transforming Government People Process and Policy*, 14(5), 757-775.
9. Dangar, N.R. (2025). Ethics in the Digital Age: Challenges and Opportunities for Corporate Social Responsibility. *Journal of Research and Innovation*, 4(2), 335-343.
10. Dhanabalan, T., Sathish, A. (2018). Transforming Indian industries through artificial intelligence and robotics in industry 4.0. *International Journal of Mechanical Engineering and Technology*, 9(10), 835-845.
11. D'Souza, E. (2017). *Reserve Bank of India: The Way Forward. Rethinking Public Institutions in India*. New Delhi, India: Oxford University Press.
12. Du, J. (2025). Toward Responsible and Beneficial AI: Comparing Regulatory and Guidance-Based Approaches-A Comprehensive Comparative Analysis of Artificial Intelligence Governance Frameworks across the European Union. United States, China: IEEE. *arXiv preprint arXiv:2508.00868*
13. Edilia, S., Larasati, N.D. (2023). Innovative approaches in business development strategies through artificial intelligence technology. *IAIC Transactions on Sustainable Digital Innovation (ITS DI)*, 5(1), 84-90.
14. Ekundayo, F. (2024). Economic implications of AI-driven financial markets: Challenges and opportunities in big data integration. *International Journal of Science and Research Archive*, 13(2), 1500-1515.
15. Faishal, M., Mathew, S., Neikha, K., Pusa, K., Zhimomi, T. (2023). The future of work: AI, automation, and the changing dynamics of developed economies. *World Journal of Advanced Research and Reviews*, 18(3), 620-629.
16. Folorunso, A., Olanipekun, K., Adewumi, T., Samuel, B. (2024). A policy framework on AI usage in developing countries and its impact. *Global Journal of Engineering and Technology Advances*, 21(01), 154-166.
17. Frigg, R., Nguyen, J. (2017). Models and representation. In *Springer handbook of model-based science* (pp. 49-102). Cham: Springer International Publishing.
18. Frimpong, V. (2025). Artificial intelligence investment in resource-constrained African economies: Financial, strategic, and ethical trade-offs with broader implications. *World*, 6(2), 70.
19. Glavina, S. (2024). AI in financial industry: ethic issues. *Journal of Trends and Challenges in Artificial Intelligence*, 1(1), 15-20.
20. Gupta, N., George, A. (2024). Digital Personal Data Protection Act, 2023: Charting the Future of India's Data Regulation. In: *Data Governance and the Digital Economy in Asia* (pp. 34-53). Routledge.
21. Hammer, A., Karmakar, S. (2021). Automation, AI and the future of work in India. *Employee Relations: The International Journal*, 43(6), 1327-1341.

22. Ijiga, A.C., Abutu, E.P., Idoko, P.I., Agbo, D.O., Harry, K.D., Ezebuka, C.I., Umama, E.E. (2024). Ethical considerations in implementing generative AI for healthcare supply chain optimization: A cross-country analysis across India, the United Kingdom, and the United States of America. *International Journal of Biological and Pharmaceutical Sciences Archive*, 7(1), 048-063.
23. Joshi, N. (2024). Emerging Challenges in Privacy Protection with Advancements in Artificial Intelligence. *International Journal of Law and Policy*, 2(4), 55-77.
24. Kathuria, R., Kedia, M., Kapilavai, S. (2020). Implications of AI on the Indian Economy. *RePEc, Research Papers in Economics*.
25. Malik, P., Jain, N., Kanwar, S., Das, B., Dhadwal, S. (2025). *AI Markets and Competition in India* (No. 25-r-01). New Delhi, India: Indian Council for Research on International Economic Relations (ICRIER).
26. Marda, V. (2018). Artificial intelligence policy in India: a framework for engaging the limits of data-driven decision-making. *Philosophical Transactions of the Royal Society A Mathematical Physical and Engineering Sciences*, 376(2133), 1-19.
27. Mukherjee, A.N. (2022). Application of artificial intelligence: benefits and limitations for human potential and labor-intensive economy – an empirical investigation into pandemic ridden Indian industry. *Management Matters*, 19(2), 149-166.
28. Mukherjee, S.R. (2025). Algorithmic Bias and Discrimination: Legal Accountability of AI Systems. *International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences*, 13(4).
29. Panigrahi, A.K., Ahirrao, S.C., Patel, A. (2024). Impact of artificial intelligence on Indian economy. *Journal of Management Research and Analysis*, 11(1), 33-40.
30. Prabhakar, A.C. (2024). India's Industrial Revolution: Navigating Job-Oriented Growth Amidst Global Geopolitical Realities. *Mediterranean Journal of Social Sciences*, 15(6), 33.
31. Prasad, Dr.R. (2025). *AI Adoption and Labor Demand Reallocation in India*. Zenodo (CERN European Organization for Nuclear Research).
32. PwC (2018). *The Economic Impact of Artificial Intelligence on the Indian Economy*, 4.
33. Radavoi, C.N. (2025). Preserving human relevance, as a new social responsibility of business in the AI age. *Social Responsibility Journal*, 22(1), 244-257.
34. Radhakrishnan, R. (2021). Experiments with Social Good: Feminist Critiques of Artificial Intelligence in Healthcare in India. *Catalyst Feminism Theory Technoscience*, 7(2).
35. Raju, R. (2025). From Models to Markets: Generative AI and Its Emerging Role in Indian Financial Services. *SSRN Electronic Journal*, 1-64.
36. Sankaran, S. (2025, August). Enhancing trust through standards: a comparative risk-impact framework for aligning ISO AI standards with global ethical and regulatory contexts. *International Conference on Artificial Intelligence, Computer, Data Sciences and Applications (ACDSA)*. IEEE, pp. 1-9.

37. Satarkar, G.S. (2026). Regulating Artificial Intelligence in India: Legal Frameworks, Governance Challenges, and the Path toward a Dedicated AI Law. *Zenodo (CERN European Organization for Nuclear Research)*, 1(2), 22-61.
38. Shaikh, A.A., Kumar, A., Mishra, A., Elahi, Y.A. (2024). A study of customer satisfaction in using banking services through Artificial Intelligence (AI) in India. *Public Administration and Policy*, 27(2), 167-181.
39. Shakyawar, M., Shakya, K. (2024). Using artificial intelligence to improve banking services in India: A review and prospects for the future. *International Journal for Research in Applied Science and Engineering Technology*, 12(4), 728.-738.
40. Sharma, A.K., Sharma, R. (2025). Governance in the age of artificial intelligence: A comparative analysis of policy framework in BRICS nations. *AI Magazine*, 46(2).
41. Sharma, M.K. (2023a). India's Courts and Artificial Intelligence: A Future Outlook. *Lexonomica*, 15(1).
42. Sharma, M.K. (2023b). A Study: How AI is Incorporated in the Middle East Banking. *Journal for Research in Applied Sciences and Biotechnology*, 2(3), 202.
43. Sharma, M., Luthra, S., Joshi, S.K., Kumar, A. (2021). Implementing challenges of artificial intelligence: Evidence from public manufacturing sector of an emerging economy. *Government Information Quarterly*, 39(4).
44. Shingare, A.D., Kanoi, T. (2020). India 2030: the decade ahead. *International Journal for Research in Applied Science and Engineering Technology*, 8(7), 1503-1514.
45. Srivastava, S.K. (2018). Artificial Intelligence: way forward for India. *Journal of Information Systems and Technology Management*, 15, 1-23.
46. Srivastava, S.K. (2023). AI in Justice Delivery in India: Current Status, Identification of Potential Applications and Way Forward. *Informatica*, 47(5). <https://doi.org/10.31449/inf.v47i5.4361>
47. Stetler, N. (2025). *Reinsuring AI: Energy, Agriculture, Finance & Medicine as Precedents for Scalable Governance of Frontier Artificial Intelligence*. arXiv (Cornell University). <https://doi.org/10.48550/arxiv.2504.02127>
48. Swargiary, K. (2023). *Examining the Impact of Digital Transformation on Economic Growth in India: A Study of the Post-Pandemic Era*. Research Square. <https://doi.org/10.21203/rs.3.rs-3464759/v1>
49. Tiwari, S., Bharadwaj, S., Joshi, S. (2021). A study of impact of cloud computing and artificial intelligence on banking services, profitability and operational benefits. *Turkish Journal of Computer and Mathematics Education*, 12(6), 1617-1627.
50. Varalakshmi, M.D., Yoganandham, G. (2024). Balancing Growth And Equity: Evaluating The Impact Of Union Finance Commission Recommendations On State Development In India. *Science, Technology And Development*, ISSN 0950-0707, 17-28.
51. Vipra, J. (2020). Regulating AI in the Finance Sector in India. *Artificial Intelligence in India*, Vol. 7.

52. Vipra, J. (2025). Towards AI sovereignty: The good, the bad, and the ugly of AI policy in India. *The African Journal of Information and Communication*, 35, 1-11.
53. Walter, Y. (2024). Managing the race to the moon: Global policy and governance in Artificial Intelligence regulation—A contemporary overview and an analysis of socioeconomic consequences. *Discover Artificial Intelligence*, 4(1), 14.
54. World Economic Forum (2020). *The Future of Jobs Report*.
55. Yadav, M.M., Sharma, A. (2025). Indian Privacy Laws and the Need for Reform in light of Artificial Intelligence. *International Journal of Social Science Research (IJSSR)*, 2(3), 42-55.

CONSUMER PERCEPTION OF SUSTAINABILITY COMMUNICATION ON FERMENTED PROBIOTIC MILK PACKAGING: A FOCUS GROUP STUDY

Agnieszka PIEKARA^{1*}, Małgorzata KRZYWONOS², Stanisław POPEK³,
Magdalena ANKIEL⁴, Michał KUCIA⁵, Paulina ŻMIJOWSKA⁶, Michał HALAGARDA⁷,
Bogdan PACHOLEK⁸, Bartłomiej JEFMAŃSKI⁹, Sylwia SADY¹⁰

¹ Department of Process Management, Faculty of Management, Wrocław University of Economics and Business;
agnieszka.piekara@ue.wroc.pl, ORCID: 0000-0002-7623-1679

² Department of Process Management, Faculty of Management, Wrocław University of Economics and Business;
malgorzata.krzywonos@ue.wroc.pl, ORCID: 0000-0002-2947-0503

³ Department of Food Product Quality, Institute of Quality Sciences and Product Management, Krakow
University of Economics; popeks@uek.krakow.pl, ORCID: 0000 0002 36811679

⁴ Department of Product Marketing, Institute of Marketing, Poznań University of Economics and Business;
magdalena.ankiel@ue.poznan.pl, ORCID: 0000-0003-2594-1600

⁵ Department of International Management, Faculty of Management, Katowice University of Economics;
michal.kucia@uekat.pl, ORCID: 0000-0001-9112-7805

⁶ Department of International Management, Faculty of Management, Katowice University of Economics;
paulina.zmijowska@ue.katowice.pl; ORCID: 0000-0002-6589-5146

⁷ Department of Food Product Quality, Institute of Quality Sciences and Product Management, Krakow
University of Economics; michal.halagarda@uek.krakow.pl, ORCID: 0000-0001-5716-0353

⁸ Department of Natural Science and Quality Assurance, Institute of Quality Science, Poznań University of
Economics and Business; bogdan.pacholek@ue.poznan.pl, ORCID: 0000-0003-0576-1426

⁹ Department of Econometrics and Computer Science, Faculty of Economics and Finance, Wrocław University
of Economics and Business; bartlomiej.jefmanski@ue.wroc.pl, ORCID: 0000-0002-0335-0036

¹⁰ Department of Natural Science and Quality Assurance, Institute of Quality Science, Poznań University of
Economics and Business; sylwia.sady@ue.poznan.pl, ORCID: 0000-0002-4744-9361

* Correspondence author

Purpose: This paper examines how consumers perceive and interpret sustainability-related communication on fermented probiotic milk (FPM) packaging, addressing a recognised gap in qualitative evidence specific to fermented dairy products.

Design/methodology/approach: Two focus group interviews (FGI) were conducted with FPM consumers in Poland (N = 16), diversified by age, lifestyle, and environmental engagement. Products were selected through purposive sampling to capture a range of packaging materials and communicative attributes. Data were analysed using structuring qualitative content analysis (Kuckartz, 2018) with ATLAS.ti 25, following the Gioia methodology.

Findings: Five overarching interpretive dimensions were identified: (1) health-framed sustainability, whereby "sustainable" is equated with "natural" and "minimally processed" rather than with systemic environmental performance; (2) symbolic sustainability indicators, marked by scepticism towards general eco-claims and greater trust in externally verified certifications; (3) a packaging material hierarchy in which glass serves as a dominant but conditional ecological heuristic; (4) informational transparency as a prerequisite for considering

a purchase; and (5) conditional consumer engagement, where pro-environmental choices depend on price, availability, and minimal effort. A conceptual framework integrating these dimensions is proposed.

Research limitations/implications: The study is exploratory, based on a small sample within a single country and product category. Future research should test the proposed framework through quantitative or experimental designs across broader contexts.

Practical implications: Sustainability communication on FPM packaging should align with the consumer health frame, prioritise legibility as a precondition for environmental message reception, and rely on institutionally grounded certifications rather than multiplying general eco-claims.

Social implications: The findings highlight a persistent attitude-behaviour gap and underscore the need for systemic solutions - producer-led recycling infrastructure and clearer labelling regulation - that reduce the organisational burden on individual consumers.

Originality/value: The paper offers the first qualitative exploration of sustainability packaging communication in the FPM segment, identifying health-frame dominance as a novel theoretical contribution and providing a five-dimension interpretive framework for both academic investigation and packaging design practice.

Keywords: sustainable packaging, fermented dairy products, consumer perception, packaging communication, heuristics.

Category of the paper: research paper.

1. Introduction

In today's competitive food market, it is increasingly clear that product packaging is far more than a physical barrier or a means of transport. Packaging serves a communicative function, acting as the product's "first impression" in the consumer encounter - conveying signals about quality, functionality, safety, and brand values (Kukreja, Patil, 2025; Patel, 2023; Jain, Hudnurkar, 2022). From a marketing perspective, packaging becomes a carrier of meaning that can shape product perception, build trust, and influence purchase decisions.

The fermented probiotic milk (FPM) segment - which includes products such as drinking yoghurts and kefir - stands out within food categories for several reasons. First, it carries a strong health emphasis, owing to the presence of probiotic cultures, a shorter shelf life, and the requirement for refrigerated storage. Second, consumers expect information about both the product's composition and its microbiological quality and storage conditions. Third, the context of sustainability has become increasingly prominent in recent years, spanning raw material sourcing (e.g. milk from organic farms), the production process (emission reduction, locality), and packaging (renewable materials, recyclability, compostability). In this setting, FPM packaging - as the first point of contact between product and consumer - may serve a pivotal communicative function, from the in-store decision through to the at-home user experience (Ankiel et al., 2025; Francis et al., 2024; Taşkoparan et al., 2025).

At the same time, the packaging sector is increasingly entangled with global challenges around resource management, waste reduction, and the transition towards a circular economy model. Consumers are declaring growing expectations of brands and products regarding their environmental impact, a trend reflected in numerous market reports and academic studies (Despoudi et al., 2025; Du Rietz Dahlström et al., 2024; Maciejewski 2020; Wojciechowska, Wiszumirska, 2022). The number of studies that examine in detail how consumers interpret environmental information on packaging - particularly in the context of fermented food products - remains, however, severely limited.

Despite the growing body of research on packaging and sustainability, several research gaps remain (Ankiel et al., 2025; Klein et al., 2025; Sokolova, 2023):

1. A lack of qualitative studies exploring how consumers interpret sustainability-related packaging information in FPM.
2. A tendency in the literature to focus on broad food product categories, with no studies specific to FPM.
3. The problem lies not in the absence of information but in its comprehensibility and practical usefulness for consumers.

The primary aim of this paper is therefore to examine consumer perceptions of the communicative value of FPM packaging, with particular attention to sustainability. The study will:

1. Identify key packaging elements (visual and textual).
2. Describe the interpretive and associative processes consumers apply to environmental messages.
3. Identify communicative barriers - both cognitive and symbolic.

1.1. Packaging as a communication tool and its informational functions

In the literature, packaging is described as a multidimensional element encompassing physical characteristics (material, construction, barrier properties), visual attributes (colour, shape, graphics), and informational components (labels, symbols). Researchers (Kukreja, Patil, 2025; Li, Li, 2024) argue that packaging is a significant marketing communication tool that affects consumer purchasing behaviour. Two main dimensions of packaging's informational value are typically distinguished:

1. Visual value - graphic elements, symbols, and packaging structure that operate heuristically, enabling rapid inferences ("this product looks natural/ecological").
2. Textual/informational value - labels, health claims, environmental declarations, and post-consumption instructions.

These elements form an important component of the consumer perception process, determining not only whether a product is noticed and understood, but also how its value is interpreted (Patel, 2023; Jain, Hudnurkar, 2022).

Research shows that consumers frequently rely on simplified signals (heuristics) embedded in packaging - for instance, the colour green, a natural paper texture, or a leaf symbol - which can lead to the inference of a higher level of product sustainability, regardless of the actual environmental performance (Sokolova et al., 2023; Li, Li, 2024). The “Paper Meets Plastic” study, for example, found that consumers tend to rate packaging with a higher paper component (even when the plastic content remains constant) as more environmentally friendly - a phenomenon termed the PEF (perceived environmental friendliness) bias - despite life cycle assessment (LCA) evidence pointing in a different direction (Sokolova, Krishna, Döring, 2023; Steiner, Florack, 2023). These findings underscore the need to examine how consumers interpret packaging elements and what meaning they personally attach to packaging information.

1.2. Sustainable packaging and the consumer perspective

The literature on sustainable packaging increasingly acknowledges that environmental claim alone is insufficient to elicit an appropriate consumer response. What matters is the quality and credibility of the message (Lombardi et al., 2023; Sun, Moon, 2024; Wojciechowska, Wiszumirska, 2022).

A study by Orzan, Cruceru, Bălăceanu and Chivu (Orzan et al., 2018) showed that while consumers state a preference for paper, glass, or carton packaging (due to easier recyclability), actual purchases of “ecological” packaging were considerably less frequent - pointing to a gap between declared preferences and actual behaviour.

Similarly, Wojciechowska and Wiszumirska (Wojciechowska, Wiszumirska, 2022) demonstrated that consumer knowledge of sorting rules and recycling labels is insufficient, which limits the effectiveness of packaging communication. Consumers may also assess environmental claims critically, particularly when they sense that a company uses eco-claims as a marketing instrument rather than an expression of genuine change (Sokolova, Krishna, Döring, 2023, Nguyen, Barretta, 2024).

In the FPM context, sustainability messaging may encompass packaging materials, refrigerated transport, the locality of dairy sourcing, and product function (e.g. natural cultures, minimal processing). Consumers, however, may interpret these messages through the lens of their own heuristics and prior knowledge, which can become a bottleneck for effective communication (Ankiel et al., 2025; Francis et al., 2024).

1.3. Mechanisms of perception and interpretation of packaging information

Research on consumer perception of packaging suggests that the information interpretation process typically proceeds in several steps (Kukreja, Patil, 2025;): attention - comprehension - attribution of meaning - decision (use/involvement in decision).

In the context of sustainable packaging, specific challenges emerge: information overload, unclear symbols, scepticism towards claims, and differences in environmental knowledge.

Studies distinguish between consumer groups, such as “engaged in green”, “indolent adopters”, and “ecological objectors”, and these groupings influence how messages are received (Cao et al., 2021; Mladenović et al., 2024; Wojciechowska, Wiszumirska, 2022).

Information overload and conflicting signals on packaging (e.g. paper combined with plastic) can further limit communication effectiveness (Ankiel et al., 2025; Francis et al., 2024; Lang, Heiman, 2024). In the FPM context, health-oriented claims may additionally overshadow sustainability information - raising the question of how consumers weigh different messages and interpret the relationships between them.

1.4. The specific character of fermented milk products (FPM)

FPM such as yoghurts and kefir are characterised by a traditional production process, health-promoting properties, and wide availability (Ankiel et al., 2025; Francis et al., 2024; Tamime, Robinson, 2007; Raats, Shepherd, Sparkes, 1993; Pieniak et al., 2009). The FPM market is marked by strong competition, a diversity of flavour variants and packaging formats, and consumer sensitivity to marketing signals (Ankiel et al., 2025; Euromonitor, 2023, Euromonitor, 2024; Wang et al., 2024; Riswanto et al., 2025). Packaging transitions - for example from plastic to carton - must account for consumer perceptions of product quality and safety (Orzan et al., 2018), which reinforces the importance of packaging’s communicative function in the FPM context (Wang, Wang, Cho, 2022).

2. Methods

2.1. Focus group research

The study was conducted in the form of two focus group interviews (FGI) with FPM consumers in Poland (N = 16, in groups of 8), diversified by age (18-60), lifestyle, and level of environmental engagement, with an equal split between women and men. Given the exploratory nature of the study, the sample size was appropriate: the focus group literature indicates that two to four groups of six to ten participants typically suffice to achieve thematic saturation in qualitative research (Krueger, Casey, 2015). Recruitment was carried out by a research agency based on selection criteria (regular buyers of yoghurts and kefir), and the agency conducted the interviews according to a scenario developed by the research team. Each session lasted approximately 90 minutes and included both exploratory questions and projective elements (association mapping, packaging preference segmentation). The fermented dairy products were selected using a purposive sampling strategy (Table 1), designed to capture the diversity of packaging materials, formats, and functional roles observed in the retail market. The sample included products packaged in single-use plastics, multi-layer cartons, flexible composite

packaging, glass, and reusable ceramic containers, representing both conventional and alternative packaging solutions. This selection was designed to ensure sufficient variability for subsequent analysis of on-pack information and communicative attributes, without restricting the study to a single material or product category.

Table 1.

Characteristics of the studied dairy products and packaging solutions

Product type	ID	Packaging material & structure	Certification & eco-labelling	Key producer messages & visual narrative
Natural yoghurt	A	PP plastic cup, aluminium lid; potentially recyclable depending on local infrastructure	BIO; EU organic farming logo	Organic milk from certified farms; natural taste; live bacterial cultures; simple ingredient list; plain graphics with green accents, naturalness narrative
BIO yoghurt with blueberries	B	PP plastic cup, aluminium lid; single-use, no packaging sustainability declarations	BIO; EU organic farming	BIO ingredients; no artificial colours or flavours; blueberry motif; prominent BIO/organic labelling
Bio Kefir naturalny Klimeko	C	HDPE plastic bottle, PE cap; potentially recyclable; lower environmental performance vs. glass	BIO; EU organic farming logo	Natural; no additives; traditional fermentation; organic milk; green accents, tradition and nature narrative
Flavoured kefir (raspberry)	D	Multi-layer Tetra Pak laminate carton, PP cap; multi-material - technically difficult to recycle	No BIO/ECO certification	Communication limited to flavour and product type; raspberry motif; flavour-product aesthetics
Kefir	E	PET plastic bottle, PP cap; recyclable plastic (material code 5); no declared eco properties or packaging certification	No BIO/ECO certification	"Natural kefir with L. Casei 431® and vitamins"; immune and digestive support; vitamins B6, B12, D3; white label with blue accents; probiotic bacteria and vitamin icons; functional "Janaturalnie" narrative
Natural yoghurt 3%	F	Glass jar, metal lid; paper label; fully recyclable; no plastic components	EU Organic certification (or national equivalent); glass recycling markings	Organic milk from certified farms; simple additive-free composition; natural taste; glass jar as a pro-environmental choice; minimalist green-white label with nature motifs; locality and eco narrative
Natural BIO kefir	G	PP cup, aluminium lid, additional paper sleeve; single-use plastic — potentially recyclable; standard dairy packaging with BIO certification	BIO certificate; EU organic farming logo; no-GMO declaration	"Natural BIO kefir"; organic milk; traditional fermentation; minimalist green-white label; prominent BIO lettering; simplicity and naturalness, no decorative elements
Kefir	H	Multi-layer Tetra Pak laminate, PP cap; recycling possible only in specialised facilities	No BIO/ECO certification	Natural kefir with live bacterial cultures; classic Milko brand aesthetics; communication limited to product type and culture content

Soured milk 4.0%	I	Glazed ceramic jar, aluminium closure, paper label; reusable packaging; highest environmental potential in the sample; entirely plastic-free	BIO; EU organic farming logo	"Matures in the jar"; recommendation to reuse packaging; rustic aesthetics; circularity and tradition narrative
Icelandic-style skyr (strawberry)	J	Doypack-type flexible packaging; multi-layer laminate, PP cap; composite packaging - low recyclability in current waste systems	No BIO/ECO certification	High protein content; "simple ingredients"; on-the-go convenience; bold colours; fruit graphics; modernity narrative

Source: Own elaboration.

2.2. Data Analysis

The research onion framework developed by Saunders et al. (2023) provided the methodological foundation, with the study grounded in critical realism and an abductive approach to theory development. Drawing on Yin's (2018) qualitative case study framework, the study aimed to identify key themes and challenges related to the perception, communication, and assessment of sustainability in fermented dairy products, with particular attention to packaging as a carrier of environmental values.

Participant responses were analysed using qualitative content analysis following Kuckartz (2018), with the support of ATLAS.ti 25 (version 25.0.1.32924). The data analysis procedure was based on the approach described by Kaiser et al. (2024).

In the first stage, one author coded 20% of the material and developed a preliminary coding system. The main coding categories were derived deductively - directly from the questions included in the interview guide (Table 2). Once the coding system had been established, all authors met to discuss and apply it to the full data corpus, reaching interpretive consensus according to agreed criteria. A codebook was also prepared, containing code definitions and anchoring examples, which facilitated interpretive consistency throughout the subsequent coding and discussion phases. The approach followed the logic of Gioia, Corley, and Hamilton (2013), enabling the transition from first-order concepts expressed in participants' own language to second-order themes and theoretically aggregated dimensions.

3. Results

The structuring qualitative content analysis, supplemented by category aggregation in the Gioia logic, yielded five overarching dimensions through which consumers interpret sustainability and the communicative value of FPM packaging: (1) health-framed interpretation

of sustainability, (2) symbolic sustainability indicators, (3) packaging material hierarchy, (4) informational transparency, and (5) conditional consumer engagement (Table 2).

Table 2.

Five overarching dimensions of consumer interpretation of sustainability and communicative value of FPM packaging

Overarching dimension	Analytical category (2nd-order)	1st-order code (in vivo)	Anchoring quote (abbreviated)	Counter-position (abbreviated)
Sustainability interpreted through a health lens	Naturalness as product "cleanliness"	"periodic table" — I put it back	"When I see... a periodic table... I put it... back on the shelf."	
	Functional-nutritional orientation	I need "high-protein"	"...quite a few... yoghurts... high-protein... because... I need protein."	"...production doesn't involve environmental degradation... we're not cutting down forests..." (non-health definition).
	Ingredient list as "OK/not OK" criterion	protein and bacteria "must be there"	"I check whether there's... protein... bacteria... if something else is in there... already not OK."	
Symbolic sustainability indicators	Scepticism towards general eco-claims	"empty slogans" - take with a pinch of salt	"...slogans... are just empty slogans... keep your distance... soon everything will be bio..."	
	Certification as a credibility signal	the certificate obliges, someone monitors it	"...the certificate obliges... someone monitors it... governed by regulations... meets the norms..."	"...commercially... profit-driven." (suspicion of greenwashing/marketing).
	Minimalism as a credibility signal	"too much going on" - I won't take it	"...if the graphic design... has too much going on... I won't choose it."	
	Visual heuristics (colour/nature)	doesn't have to be green to tempt me	"...it doesn't necessarily have to be green... can be colourful... I'll pick it up... start studying it..."	Tension: "green/leaves" appear as an "eco" shortcut but are not a universal indicator.
Packaging material hierarchy	Glass superiority heuristic	I prefer glass over plastic	"...I prefer the product in glass over plastic."	"...glass recycles worse than most plastics..." (heuristic reversal).
	Utility and safety	thicker plastic - won't fall apart	"...plastic is thicker... I wouldn't worry about it falling apart... in my backpack."	
	Format convenience (on-the-go)	plastic, because more convenient	"...most people will probably go for... plastic, because it's more convenient."	Glass preferred "in principle", but loses out to convenience/price.

Informational transparency	Legibility as a prerequisite for consideration	illegible — I put it back	"If something is illegible, I just put it back."	"I don't really read ingredient lists... I buy the ones I already know." ("label-free" decisions).
	Compensating for small print	people read the ingredients on their phones	"...people... use their phones to read those ingredients."	
	Digital solutions on the label	I scan the QR, not through a magnifying glass	"...I scan the QR code... to read the ingredients on my phone... not through a magnifying glass."	Technology helps but does not replace basic on-pack legibility.
Conditional consumer engagement	Price premium: declarations vs. practice	"pay more?" - nobody	"...who would be willing to pay more? ... so nobody."	"I think yes." (single declaration does not carry into group decision).
	Acceptance of systemic solutions	if you could return it — I'd take glass	"That packaging could be returned..."; "I would choose glass."	
	Producer responsibility (EPR in plain terms)	recycling is the producer's problem	"...so that the recycling problem is more the producer's than mine... clear labelling..."	"...it could highlight my choice, but I wouldn't go out of my way to look for it." (low effort propensity).
	Trust deficit in "circularity"	I don't believe it's from recycled material	"I don't believe that... it's from recycled material..."	Counter-point: credibility reinforced by "monitored certificate" (dimension 2).

Source: Own study.

In both groups, the concept of sustainability was frequently interpreted not as a systemic category (e.g. product life cycle, environmental performance) but as an attribute of a “good” product from a health perspective: naturalness, a simple ingredient list, the absence of “chemicals”, and - particularly in group 2 - nutritional functionality (e.g. protein content). This semantic shift meant that “sustainability” was often treated as a synonym for “cleanliness” and “healthiness”, and packaging along with environmental messages was evaluated through the filter of nutritional quality.

Short ingredient lists and the avoidance of “chemicals” emerged as the dominant evaluation logic. In G1, participants described the practice of reading labels as a tool for selecting “clean” products. Characteristic evaluative metaphors appeared: the more extensive the ingredient list, the greater the reluctance to purchase (the “periodic table” metaphor - putting the product back on the shelf). At the same time, a “short ingredient list” was highlighted as simple, transparent, and conducive to a sense of control over one’s choice. In G2, flavoured products were similarly viewed with scepticism as potentially “artificial”; preferences for natural versions were justified by the suspicion that “fruity” means additives rather than real fruit (“more like chemicals than

actual fruit”). The same passages also reflected an expectation of “fewer chemicals” and fewer preservatives, consistent with the health-based interpretation of sustainability as a “cleaner” product.

In G1, a short use-by date functioned as a quality heuristic and was interpreted as a signal of less processing and greater “naturalness” (“the shorter the date... the healthier”). This motif also recurred in projective exercises as a component of the “ideal sustainable product” (alongside a simple ingredient list and legibility). In G2, a comparable heuristic appears in the form of a recurring preference for a “shorter best-before date” as one of the characteristics of a sustainable product, reinforcing the interpretation that “sustainable” means “less processed / fresher”.

In G2, the health dimension also took the form of nutritional functionality: skyr and high-protein products were described as practical “protein supplements” and even cited explicitly as justifications for more frequent purchases. Notably, in the exercise asking participants to define a “sustainable product”, “appropriate protein content” appeared among the first spontaneous associations - illustrating just how deep this semantic shift runs.

While the health-and-ingredients perspective dominated, voices closer to a systemic understanding of sustainability also emerged in both groups. In G2, one participant described sustainability as a characteristic “at every stage of the value chain” (e.g. technologies and energy used in production) - a clear counterpoint to “clean ingredient list” heuristics. Similarly, in G1, a definition referencing the absence of environmental degradation (“we’re not cutting down forests... we’re not draining reservoirs”) was offered, though it remained an exception rather than the dominant interpretive frame.

3.1. Symbolic sustainability indicators

In both groups, participants described sustainability in terms of symbolic signals - brief messages and visual elements that allow a particular meaning to be rapidly assigned to a product (e.g. “eco”, “bio”, “natural”, “local”, “traditional”). At the same time, these very signals were subject to negotiation: some participants treated them as useful cognitive shortcuts, others as marketing devices requiring verification. In G1, the devaluation of general slogans was a particularly strong theme. Participants stressed that messages such as “eco/bio/natural” can be “empty” and overused, demanding interpretive caution (“you have to keep your distance... because soon everything will be bio”). There was also a direct conviction that such claims lose their “power to act” because they are ubiquitous and no longer differentiate products. At the same time, some remarks indicated that such slogans can still catch attention as an initial impulse, but their meaning is “conditional” and requires verification (“worth checking, because the word alone might only be partially backed up”). As a result, these signals function more as an “invitation to investigate” than as a standalone basis for decisions. In G2, similar selectivity was visible: some participants declared that “natural - yes”, but “eco and bio - no”, suggesting different trust thresholds for different labels and semantic categories.

Against the backdrop of general-slogan inflation, a clear shift towards certificates as more credible signals was visible in both groups. In G2, certification is presented as a tool that “commits” the producer, since it implies oversight and standards (“the certificate obliges... someone monitors it... it meets the norms”). Participants did not accept certification uncritically, however. In G1, the motif of “home-made certificates” or ones that are easy to obtain and that do not build trust appeared (“many brands use certificates you can just make up and sign yourself...”). Similarly, in G2, a distinction was drawn between recognised certificates (e.g. international ones) and “badges introduced by companies that really don’t mean anything”. This indicates that a certificate functions as a signal only when participants perceive it as institutionally grounded and difficult to “manufacture” by the brand itself.

In the area of graphics and colour, some participants described classic associations: green and an aesthetic “close to nature” can suggest ecological credentials. In G2, the direct intuition that “green” strengthens identification of a product as bio/eco was articulated. Counterpositions were visible in both groups, however. In G1, some participants declared that “green and natural” graphics do not attract them, and that visual appeal derives more from distinctiveness, novelty, and “colourfulness” than from nature references. In G2, the topic of “rural/pastoral” graphics was raised by the moderator, but responses pointed rather to a limited, situational role for such stimuli (“it has a bit of it...”), without any clear dominance of that particular heuristic.

An important symbolic element was also the assessment of packaging aesthetics as “calm” versus “loud”. In G2, a clear preference for packaging that does not “shout” or demand attention through an excess of stimuli was expressed; yet the discussion also showed that boldness is accepted, provided it does not disorient or impede reception. This minimalism can be interpreted as a credibility heuristic: less graphic “superstructure” means less suspicion of communicative manipulation.

The theme of locality functions as a potential indicator of “non-commerciality” and authenticity (G1), but it is selective in character: some participants associate it with the practice of occasional purchases “from the farmer” or at a market (costly but perceived as high-quality), and in such situations the need for labelling drops (“you go to a specific farmer, you don’t need all the information written out”). In G2, a counter-case appeared: locality and “traditional method” do not necessarily influence the decisions of people who do not feel competent to assess the production process.

3.2. Packaging material hierarchy

In both groups, packaging material served as a quick interpretive “filter”, enabling inferences about product quality and sustainability without recourse to systemic information (e.g. life cycle data). The discussion was dominated by comparisons of material solutions in terms of “better–worse”, though this hierarchy proved conditional and negotiated over the course of the discussion.

In G1, some participants expressed a direct preference for glass over plastic, linking it both to health-related considerations (microplastics) and to the subjective experience of consumption (“it just tastes better to me”). Such remarks arose spontaneously when participants were asked about packaging characteristics, suggesting that glass functions as the cognitively most accessible signal of quality/safety - and, for some, of sustainability. Notably, the same discussion also contained remarks indicating that glass becomes attractive when price is not a barrier (“if price weren’t a factor, then glass”), showing that this preference is embedded in economic conditions rather than purely in declared pro-environmental attitudes.

In parallel, both G1 and G2 featured a strong functional thread: plastic was regarded as a practical solution (durability, resistance to damage, transport convenience). In G1, this argument took the form of a very concrete use context (“in a bag, in a backpack”) and related to material quality and thickness. In G2, the emphasis on functionality was even more pronounced: rather than declaring a material preference as such, participants stressed that in the market “most products will still be plastic anyway, because they’re more convenient”. Some remarks also shifted the focus from the type of material per se (glass vs. plastic) to packaging “quality” parameters (thickness, rigidity, lack of deformation), suggesting a pragmatic approach to assessing packaging that is independent of declared eco-friendliness.

A counter-argument also appeared in the data, undermining the simplified material hierarchy: glass was described as problematic from a recycling perspective (one participant noted that “glass recycles worse than most plastics”), directly challenging the intuitive equation of glass with a pro-environmental choice. This counter-voice serves as a “negative case” for the dominant heuristic and shows that different models of understanding sustainability coexist within a single group. The same discussion sequence also revealed the conditional nature of glass preference: its acceptance increases when a systemic solution is in view (e.g. the possibility of returning the packaging). Participants indicated that “if you could return it”, glass becomes the preferred choice, while without such a mechanism, some remain with plastic “all the same”.

3.3. Informational transparency

In both groups, the legibility and clarity of on-pack information was treated as a necessary prerequisite for even considering a purchase. Participants described transparency primarily in practical terms: “can I quickly find what I need” (e.g. the best-before date, ingredient list, an unambiguous product name) - only secondarily as something that affects brand image or credibility. In G1, when asked about information they “couldn’t imagine buying without”, participants immediately pointed to the best-before date and basic product identification (“so you can tell at a glance whether it’s a kefir...”). The same passage also contained the demand that the product name and type be prominently displayed and written unambiguously (“clearly written, in large type, what the product is”). An analogous emphasis was visible in G2, where participants stressed the importance of whether the best-before date is legible and

easy to locate. In practice, transparency was thus understood as the packaging's "informational efficiency" - its ability to quickly deliver operationally critical content.

In G1, the moderator explicitly noted that participants "had to squint" at some of the labels, and asked about the importance of appropriate font size and legibility. This theme also arose in G2, where legibility was connected to typography and information layout, with participants drawing attention to whether the table of contents and information are "readable" and whether the layout forces "peering" at the text. An important addition to transparency is semantic consistency of the product name: in G2, formulations such as "strawberry yoghurt of the skyr type" were mentioned as capable of triggering suspicions of "playing games" and acting as a "red flag", even though the information is formally present. This shows that transparency does not reduce to the quantity of information but also encompasses its unambiguity.

When legibility is compromised (e.g. small print), participants describe compensatory strategies based on digital tools. In G2, the explicit demand to scan a QR code "to read the ingredients on my phone... not through a magnifying glass" appeared; in G1, participants mentioned apps for scanning and quickly assessing ingredient composition, while stressing the conditional nature of that strategy (it only works if the packaging has the right code).

It is worth noting, however, that the data also contain an opposing standpoint: some participants declared that they do not regularly read labels and base their choice on experience ("the ones I've already drunk... I buy routinely"). This counter-case is methodologically important, showing that even high label legibility does not guarantee that every consumer will use the information in the selection process; transparency then functions more as a "safety net" available when needed than as a constant decision-making tool.

3.4. Conditional consumer engagement

In both groups, engagement with the choice and consumption of FPM within a circular economy logic was conditional: participants declared that pro-environmental solutions are desirable, but their acceptance depends on cost, availability, and whether the cognitive and organisational effort will be shifted onto the consumer. In G2, the question of paying a premium was directly "tested" through a vote. Despite one participant declaring "I think yes", the final result was unambiguous: the group as a whole did not declare willingness to pay a higher price even with the guarantee of 100% packaging recovery by the producer. In G1, more nuanced responses appeared, but pragmatic logic still prevailed: a surcharge - if any - would need to be small ("a few pennies at most"), justified by the need to count costs over the year and by household budget constraints. Some remarks also linked reluctance to pay more with suspicion of producer opportunism ("producers play games too... I'd be paying tens of groszy and they get it for a couple"), indicating that price and trust are intertwined. A counter-position also appeared in G1, with one participant declaring a higher acceptance of a surcharge (of the order of a few to several dozen percent), though it was formulated hypothetically and premised on

the assumption that the products are not “first necessities”, again underlining the conditional character of the decision.

Beyond price, availability was a very strong condition for more frequent FPM purchases. In G2, participants indicated that a purchase becomes more likely if the product does not require “going out of your way” and is available in popular retail channels (e.g. discount stores). This thread suggests that even a positive attitude towards sustainability may not translate into behaviour if it is accompanied by increased time or organisational cost.

An important element of conditional engagement was the need for “sustainability” not to mean additional work at the disposal stage. In G1, participants articulated an expectation that packaging should be designed so that the consumer does not have to separate components or wonder about waste classification (“I don’t want to have to deal with it... the recycling problem is more the producer’s than mine... clear labelling so I know where to throw it”). In this logic, “responsibility” is accepted only when it is operationally simple and does not generate uncertainty.

G1 also raised an important systemic condition: material preferences (e.g. glass) become genuinely acceptable when the infrastructure for packaging return exists (“if you could return it... then glass”). This mechanism shows that some “pro-ecological” choices are hampered not so much by a lack of values as by a lack of solutions that make it easy for the consumer to close the loop.

3.5. Cross-group comparison as a check on pattern stability

The comparative analysis of the two focus group interviews indicates a high degree of consistency in key interpretive patterns across both groups: G1 and G2 participants consistently interpreted sustainability through the lens of health and symbolic heuristics rather than systemic categories, with pro-environmental engagement taking a consistently conditional character constrained by price, availability, and effort.

Differences between the groups were mainly a matter of emphasis and discussion dynamics. G1 produced more counter-positions and corrections of positions (e.g. the thread challenging the automatic equation of glass with a more ecological solution), pointing to a more negotiated character of material hierarchy and ecological criteria. G2 showed stronger pragmatic logic (packaging convenience, purchasing routine, impact of dietary constraints) and a more decisive moment of consensus on the unwillingness to pay more for pro-environmental solutions even given the assumption of full packaging recovery. Taken together, the cross-group comparison suggests that the identified dimensions provide a stable account of the dominant modes of interpreting FPM communicative value in the studied sample, alongside differences in the degree of critical engagement and the conditions under which pro-environmental declarations translate into purchase intentions.

3.6. Proposed conceptual framework

Based on the identified dimensions, an interpretive framework is proposed (Fig. 1) in which communicative stimuli related to the product and its packaging - materiality, symbolism, information, and product attributes (block A) - are processed through interpretive mechanisms (block B): health and material heuristics, uncertainty reduction through certification, a trust filter, and effort cost. The declarative outcomes (block C) are: perceived sustainability, trust, conditional willingness to pay a premium, and choice intention. The transition from B to C is modulated by boundary conditions - price, availability, and systemic solutions. The model does not assume simple causal relationships but rather organises the findings as a set of mechanisms and boundary conditions that can be tested in subsequent research stages (e.g. quantitative or experimental studies). These patterns confirm that the health frame and conditional engagement operate as shared interpretive defaults across both groups, with differences in their specific expression - functional-nutritional in G2, ingredient-cleanliness-based in G1- reflecting group-level variation in lifestyle orientation rather than fundamentally distinct modes of sustainability reasoning.

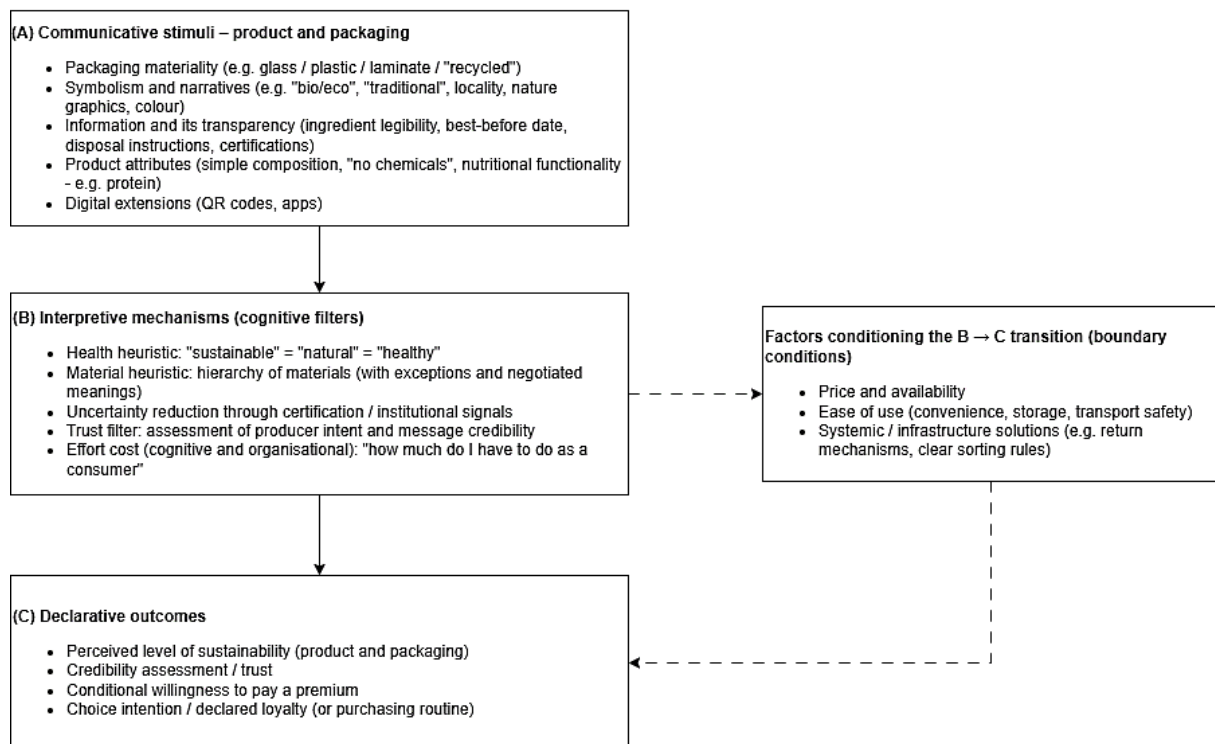


Figure 1. Interpretive framework of FPM sustainability perception based on the communicative value of packaging.

Source: Own elaboration.

4. Discussion

The findings from the two focus group interviews show that in the studied sample, perceptions of FPM sustainability are constructed primarily on the basis of cognitive-symbolic and practical signals (packaging material, legibility, certifications, “ingredient cleanliness”) rather than through systemic categories relating to actual environmental performance (e.g. a life cycle perspective). A common thread across both groups is the tendency to interpret messages via shortcuts - heuristics - and the conditional nature of pro-ecological declarations, constrained by price, availability, and effort on the consumer’s part.

4.1. Sustainability as a health frame: semantic shift and its consequences

One of the key intellectual contributions of this study is the identification of a shift in the meaning of sustainability towards healthiness and naturalness. For a proportion of participants, “sustainable” means primarily “less processed”, “shorter ingredient list”, and “fewer chemicals” - and even “shorter best-before date” - which functions as a practical quality heuristic. In G2, a strong functional component (e.g. protein, skyr) also emerged, suggesting that sustainability communication in the FPM segment competes for attention with health and dietary messaging. The consequence is that environmental messages may be interpreted - or overlooked - through the lens of “health”, and the effectiveness of pro-environmental communication depends on whether it is consistent with expectations regarding nutritional quality.

This observation is not unique in the literature, though it represents a specific and hitherto rarely documented phenomenon in the context of fermented dairy products. Research on perceptions of organic and sustainable food shows that consumers frequently fail to separate the category “healthy” from “environmentally friendly”, treating the two as co-occurring or even synonymous (Schleenbecker, Hamm, 2013; Aschemann-Witzel, Zielke, 2017). This phenomenon is described in the literature as the health halo effect: a positive assessment of one product attribute - here, healthiness - automatically transfers to the assessment of other dimensions, including the environmental one (Schuldt, Hannahan, 2013). As a result, a product perceived as “natural” or “minimally processed” also acquires the attribute of “ecological”, even when the packaging contains no environmental claim at all.

In the present study, this mechanism manifested itself in a particularly clear way. In G1, participants spontaneously described the practice of reading labels as a tool for selecting “clean” products - the more extensive the ingredient list, the greater the reluctance to purchase (the “periodic table” metaphor as a reason to put the product back on the shelf). Equally, a “short ingredient list” was cited as a signal of simplicity, transparency, and a sense of control over one’s choice - cognitive categories that are originally health-related but also interpreted as sustainability indicators. In G2, the same mechanism took a functional form: high-protein products (skyr) were described as “balanced” and “supplementary” - “sustainable” meaning here dietary equilibrium rather than environmental sustainability. Tellingly, in the exercise

asking participants to define a “sustainable product”, “appropriate protein content” appeared among the very first spontaneous associations, illustrating the depth of this semantic shift.

It is worth emphasising that this shift is not only cognitive in character but also communicative. Research on organic food labelling shows that consumers are reluctant to engage with environmental information when it competes with expectations about food quality and safety (Sirieix et al., 2013). In the FPM segment, this tension is particularly strong: the product is by nature defined by health attributes (bacterial cultures, probiotic properties, short shelf life as a freshness indicator), which means the health frame dominates as the primary interpretive filter, and environmental messages are relegated to “second in the queue” for consumer attention. Further confirmation of this dynamic comes from the counter-voices that appeared in both groups: isolated remarks invoking a systemic understanding of sustainability (e.g. “we’re not cutting down forests”, “technologies and energy at every stage of the value chain”) were clear exceptions rather than the dominant interpretive frame - suggesting that systemic sustainability comprehension requires active knowledge and motivation, whereas the health frame is activated automatically. The health frame operated consistently across both groups; its functional variant (protein/dietary balance logic) was more pronounced in G2, while counter-voices invoking systemic sustainability remained isolated in both - confirming the health frame as a cross-group rather than subgroup-specific pattern (as mentioned in the Section 3.6).

The implication for FPM packaging communication design is significant: effective environmental communication should not compete with the health frame but seek to align with it or attach to it. This means that messages such as “natural ingredients”, “minimal processing”, or “no additives” may serve a dual function - health and environmental - acting as “semantic bridges” between the two frames. Purely systemic messages (e.g. carbon footprint, packaging life cycle), by contrast, may prove less effective unless anchored in a nutritional or quality logic that is close to everyday consumer expectations.

4.2. Material heuristic

It has repeatedly been demonstrated that packaging material serves consumers as one of the most important interpretive signals when assessing a product’s degree of sustainability (Boesen et al., 2019; Otto et al., 2021; Thomas et al., 2025). As in the present study and in others, particular significance was attributed to glass, which was intuitively associated with a more ecological, more natural, and higher-quality solution than plastic (Thomas et al., 2025; Kozik-Kołodziej, 2026). Such associations fit well within the mechanism of heuristic consumer inference - a set of simplified evaluation rules in which the packaging material itself becomes the carrier of environmental meaning (Ischen et al., 2022; Otto et al., 2021). Rather than analysing the full product life cycle, a quick assessment is triggered by the belief that a given material is, “in and of itself”, more environmentally friendly (De Feo et al., 2022; Boesen et al., 2019).

This perception can be interpreted in terms of the material heuristic, understood as a special case of the heuristic based on physical product characteristics (Product Sustainability Directory, 2025; Otto et al., 2021). Its essence is that a material property of the packaging is transformed into a cognitive shortcut that organises the assessment of the entire product (van Loo et al., 2022). In this sense, glass is treated not solely as a technical material but also as a symbol of durability, neutrality, cleanliness, and greater alignment with the idea of responsible consumption (Thomas et al., 2025; Groth et al., 2023). Glass thus functions as a salient “green” signal (environmentally friendly packaging cue), influencing not only the assessment of the packaging itself but also the way the entire product is perceived (Ischen et al., 2022; Otto et al., 2021). In consumer studies, glass is simultaneously rated as more premium, safer, and more environmentally friendly than plastic, even when that rating does not derive from an in-depth knowledge of the actual environmental parameters of the solution (Thomas et al., 2025; Kozik-Kołodziej, 2026; De Feo et al., 2022).

This heuristic is conditional, however: within the same empirical material, voices appeared that challenged the automatic equation of glass with a pro-ecological choice, noting that the assessment changes when recycling, weight, and transport are taken into account. The material signal does not disappear, but it ceases to be sufficient in itself. This is confirmed by life cycle assessment (LCA) research, which shows that no universal hierarchy of packaging materials exists in which glass automatically outperforms plastic across all environmental impact categories: the ultimate balance depends on packaging weight, transport distance, energy source, and end-of-life scenario (Boesen et al., 2019; De Feo et al., 2022). Consumers tend to significantly overestimate the ecological credentials of glass relative to LCA findings, while overestimating the environmental impact of plastic (Otto et al., 2021). Glass’s advantage is thus symbolically strong but environmentally ambiguous.

It was also clear that the strength of the material heuristic is tempered by the costs of use. Participants’ remarks showed that the assessment of a packaging’s ecological credentials is not detached from everyday consumption practices. Ease of use, convenience, risk of breakage, ease of carrying, and suitability for travel were factors that weakened the preference for glass. In this sense, plastic was not defended as a more ecological material, but as a more functional one in specific use contexts. This tension between axiological preference and everyday practice is well described in the more recent literature on sustainable packaging, which stresses that positive attitudes towards more ecological solutions frequently collide with the demands of convenience, safety, and ease of use (Miao et al., 2023; Otto et al., 2021).

In participants’ remarks, glass gained in attractiveness only when coupled with a return system or a reuse model - consistent with literature showing that acceptance of return solutions depends on price, convenience, and ease of participation in the cycle (Miao et al., 2023; Theobald et al., 2024). Material thus does not act as a standalone determinant of sustainability, but as an element of a broader system of meanings and institutional conditions (Otto et al., 2021; Groth et al., 2023).

4.3. Informational transparency and uncertainty reduction

Informational transparency is one of the foundational conditions for effective communication between product and consumer. The packaging design literature underlines that packaging serves not only a protective or marketing function but also an informational one - it constitutes the primary communicative interface between producer and user. Information such as product name, ingredient list, nutritional value, allergens, and best-before date is critical for informed consumer decision-making. Its presence and legibility are especially important from the perspective of health safety and producer trust (Thota et al., 2020). The findings of the present study directly confirm this mechanism: in both focus groups, legibility and clarity of information were treated as a necessary prerequisite for considering a purchase at all. In G1, when asked about information they “couldn’t imagine buying without”, participants immediately pointed to the best-before date and unambiguous product identification. In G2, participants stressed the importance of whether the best-before date is legible and easy to find - before they would even reach for additional environmental messages.

Research shows, however, that the mere presence of information on packaging does not guarantee that it will be effectively processed by the consumer. The manner in which content is presented matters greatly - including font size, visual hierarchy, placement of elements, and information density. Packaging communication reviews in the food domain indicate that the way messages are formulated, and their visual layer, can significantly affect product interpretation. Even subtle typographic, stylistic, or graphic elements can shape expectations regarding quality, healthiness, or product character (Schifferstein, de Boer, Lemke, 2021).

At the same time, packaging communication is designed under conditions of limited consumer attention. The packaging design literature notes that consumers frequently use visual elements as rapid interpretive cues about a product. Colour, typography, and graphic symbols can signal product attributes such as naturalness, healthiness, or degree of processing (Underwood, Klein, 2002). In practice, this means that visual packaging communication serves a heuristic function - enabling rapid inference about product properties without the need to read textual information in detail. Legibility and simplicity of the message thus become a key factor in communicative effectiveness. Eye-tracking studies show that consumer attention is strongly determined by visual factors such as element size, position, and colour, while high information density can hinder processing and lead to the omission of part of the messages (Chrysochou, Krystallis, Giraud, 2012). This can be interpreted through cognitive load theory. According to this approach, the human capacity to process information is limited by working memory capacity. When a message contains too many elements or is too detailed, recipients may have difficulty processing it, resulting in simplified handling of information or complete omission. Research on food label design has shown that more aggregated and simplified information formats may be more effective for people with lower working memory capacity, since they reduce cognitive load during decision-making (Avalos, 2025). This mechanism found direct

reflection in participants' remarks. One participant in G1 put it plainly: "If something is illegible, I just put it back" - a response that illustrates how crossing the cognitive threshold results in immediate product rejection, before any assessment of its environmental characteristics can take place. Similarly, in G2, participants drew attention to whether the nutritional table and ingredient information are "readable" and do not require "squinting" - corresponding to the model of cognitive processing cost as a decision-making filter.

The phenomenon of processing fluency - the ease with which an individual can process visual and semantic information - is also relevant here. Research on packaging design shows that simpler and more transparent visual compositions are cognitively easier to process and are typically assessed more positively by consumers than designs with a high level of visual complexity (Xia et al., 2023). When basic on-pack information is difficult to read or incomplete, consumers may resort to compensatory strategies to supplement missing data. Increasingly, this involves digital tools - scanning QR codes, checking information in mobile apps, or searching for product data online. This can be interpreted as a transfer of part of the cognitive effort from the physical packaging to external information sources - a kind of "outsourcing" of the cognitive process beyond the product's communicative artefact. The development of smart and interactive packaging suggests that digital extension of product communication can support consumer decision-making by providing additional information about composition, freshness, or storage (Kamboj et al., 2025). This observation is confirmed by the empirical data: in G2, there was an explicit call for scanning a QR code "to read the ingredients on the phone... not through a magnifying glass", while in G1, participants mentioned apps for scanning and quickly assessing product composition, treating them as a substitute for poorly legible labels. It is worth noting, however, that the data also contain a significant counter-case: some participants stated that they do not regularly read labels and base their choice on experience and routine ("the ones I've already drunk... I buy routinely"). This behavioural pattern shows that even high label legibility does not guarantee its use - transparency then functions as a "safety net available when needed" rather than as a constant decision-making tool. For environmental communication, this is significant: ecological signals on packaging primarily reach those consumers who actively engage with labels, while habitual buyers remain outside the reach of this communicative layer. QR codes and scanning apps emerged in the data as compensatory strategies activated when physical legibility failed rather than as proactively sought channels — positioning digital tools as a second-tier communicative layer that extends packaging information beyond its physical constraints. This suggests that Block A of the conceptual framework should be understood as encompassing not only physical packaging attributes but also their digital extensions, with the boundary between packaging and the broader product communication ecosystem becoming increasingly permeable (Mishra et al., 2025).

In the context of sustainability communication, the problem of basic legibility and informational ergonomics takes on particular significance. Information about a product's environmental impact, the sourcing of raw materials, or the recyclability of packaging often

constitutes an additional communicative layer that must compete for consumer attention with mandatory information and marketing messages. Research on packaging perception shows that ecological signals are frequently difficult for consumers to recognise or interpret, particularly when they appear against a backdrop of many other visual messages (Brance, 2025).

It can accordingly be argued that basic communicative legibility on packaging constitutes a kind of “entry condition” for more complex messages, including environmental communication. If basic information is difficult to locate or process, the consumer may not devote sufficient attention to additional sustainability messages. Under conditions of cognitive overload, environmental signals become just one of many competing visual stimuli, which significantly limits their communicative effectiveness.

4.4. Trust and the credibility of signals

Assessment of environmental messages on packaging is not based solely on their presence, but above all on their credibility (Ischen et al., 2022; Otto et al., 2021). In both groups (G1 and G2), clear ambivalence towards symbolic signals was visible. General slogans such as “eco”, “bio”, “natural”, or “traditional” were, on the one hand, recognised as useful cognitive shortcuts facilitating initial orientation in the range; on the other, they were frequently treated as overused and too general to serve as a standalone basis for trust - a finding consistent with earlier observations (Lombardi et al., 2023; Kozik-Kołodziej, 2026). The data reveal a clear motif of “devaluation” of such terms: the more frequently they are used, the less they differentiate products, and the more often they trigger interpretive distance rather than automatic acceptance. Consequently, general environmental claims function more as a prompt for further product scrutiny than as a signal that closes the evaluation process - consistent with observations about growing scepticism towards “green” marketing language (Mladenović et al., 2024; Young et al., 2010).

These observations fit into a broader debate about what has been called eco-claim inflation (OECD, 2024; European Commission, 2024). As the volume of environmental declarations in the market increases, the risk grows that some will be perceived as formulaic, overly general, or poorly documented (OECD, 2024). Institutional documents stress that the spread of products and services bearing environmental claims has intensified concerns about greenwashing - false, misleading, or unverified environmental statements - which undermines consumers’ ability to distinguish credible messages from superficial ones (Persakis et al., 2025; OECD, 2024). From this perspective, what matters is not the existence of a claim per se, but the possibility of its verification, comparison, and grounding in a credible reference system (European Commission, 2024; Ischen et al., 2022).

Against the backdrop of general-slogan inflation, certification takes on particular importance. The data make clear that certificates are perceived as more credible than general producer declarations, but only when they are external, recognisable, and embedded in a system of oversight. In participants’ remarks, a certificate functions as a signal that “someone checks

it” - as a tool for uncertainty reduction; at the same time, not every mark works in the same way. Both groups drew a distinction between recognised certificates, associated with standards and external control, and “badges” created by companies themselves, which do not build trust. This finding corresponds well with literature showing that traditional labels based on clearly defined criteria (e.g. organic) are more likely to be treated as credible than general, unspecified claims of the “green” or “environmentally friendly” type (Lombardi et al., 2023; Ischen et al., 2022). The importance of this mechanism is also confirmed by more recent empirical research on eco-label trust. Yang et al. show that trust in environmental labels is strongly associated with both label knowledge and institutional trust in the certifying bodies (Yang et al., 2024). Both factors have a significant positive effect on eco-label trust, with transparency and information accessibility strengthening trust through enhanced knowledge and confidence in the certification system (Yang et al., 2024).

The findings indicate that the key problem is not the volume of environmental communication but its credibility. An excess of general and repetitive messages leads to scepticism, and the greenwashing literature confirms that imprecise or hard-to-verify environmental declarations undermine consumer trust in both specific brands and the entire category of environmental communication (Persakis et al., 2025; OECD, 2024).

Consumer trust in environmental signals is not, moreover, purely cognitive in character. It is also assessed through the lens of a general evaluation of producer intent: consumers ask not only whether a given claim formally exists, but also whether it seems honest, whether it is backed by something beyond packaging aesthetics, and whether the brand gives the impression of genuinely wanting to communicate responsibility rather than merely exploiting “green” marketing language (Young et al., 2010; Lombardi et al., 2023). In this sense, the credibility of a claim is relational - it derives not only from the content of the message but from the relationship between content, source, form of verification, and sender reputation (Carrington et al., 2010; Yang et al., 2024).

From a theoretical perspective, a transition can thus be observed from simple semantic signals to institutionally grounded ones (Ischen et al., 2022; Otto et al., 2021). General terms such as “eco”, “bio”, or “natural” remain important as elements of first contact with a product, but increasingly they are not sufficient for building trust (Lombardi et al., 2023). The function of uncertainty reduction is assumed instead by marks that are recognisable, externally verifiable, and embedded in a broader system of control (Yang et al., 2024; OECD, 2024). In practice, this means that the credibility of an environmental signal depends not on its intensity but on whether the consumer regards it as verifiable, independent, and institutionally grounded (European Commission, 2024; Persakis et al., 2025).

Against the backdrop of general-slogan inflation, certification emerged as a more credible signal, but only when perceived as externally governed. The data reveal a consistent two-tier distinction: internationally recognised, third-party-verified certifications (“the certificate obliges... someone monitors it”) versus company-created marks perceived as easy to self-issue

and therefore trust-deflating ("badges introduced by companies that really don't mean anything"). This aligns with evidence that eco-label credibility depends on the perceived independence of the certifying body rather than visual salience (Yang et al., 2024; Lombardi et al., 2023).

4.5. Conditional engagement

Declared pro-environmental attitudes were conditional: even where sustainability was assessed positively, willingness to pay more was limited or absent, and in G2 a clear moment of consensus on this issue emerged. Consumers also articulated an expectation that packaging and the broader system should "take off" the organisational cost (sorting, separating components, unclear rules), shifting responsibility towards producers and infrastructure. This indicates that in the studied sample, pro-environmental choices are more likely when they are "easy by default" and compatible with everyday purchasing practices (price/availability).

The attitude-behaviour gap in sustainable consumption is well-established in the literature. Consumers consistently declare strong support for environmental protection, but these declarations do not always translate into actual purchasing decisions. Research shows that factors such as price, convenience, and product availability often prove stronger determinants of consumer choices than environmental values (Carrington, Neville, Whitwell, 2010; Young et al., 2009). In practice, even those who declare pro-ecological attitudes may forgo more sustainable products if they entail additional financial or organisational costs. The perception of responsibility for pro-environmental action also plays an important role: participants expressed a clear expectation that the production and distribution system should minimise the effort required of the consumer - pointing to difficulties with sorting multi-material packaging, separating components, and unclear recycling rules. Responsibility for resolving these problems was frequently transferred in their remarks to producers, packaging designers, and systemic infrastructure.

This can be interpreted through the concept of system-enabled sustainable behaviour. According to this approach, pro-environmental consumer behaviours are more likely in situations where they are supported by appropriately designed institutional and infrastructural structures. Rather than relying solely on individual consumer motivation, it may be more effective to design systems that make pro-environmental behaviours the easiest or default option (Thøgersen, 2005).

Similar conclusions emerge from behavioural economics research, which stresses that consumer decisions are strongly shaped by the choice context. According to choice architecture and the default options mechanism, people tend to select solutions that require the least cognitive or organisational effort (Thaler, Sunstein, 2008). Price and availability are key enabling conditions for translating pro-environmental intentions into actual consumer choices (Vermeir, Verbeke, 2006).

The analysis suggests, therefore, that in the sample studied, pro-environmental consumer choices take the form of conditional engagement - becoming more likely when specific structural conditions are met: above all, a competitive product price, easy availability, and minimisation of the additional organisational effort required of the consumer. When these conditions are not met, declared environmental values may give way to more pragmatic selection criteria.

4.6. Limitations

The study is exploratory in nature and draws on two focus group interviews (N = 16), so the conclusions should be treated as a description of interpretive mechanisms and boundary conditions within the studied sample rather than as population-level generalisations. First, FGIs are sensitive to group dynamics (dominance of some participants, conformism, social desirability of responses), which can amplify certain themes and suppress others. Second, the analysis concerns declarative statements made in a moderated discussion setting and does not include observation of actual purchasing behaviour, precluding inference about the actual influence of individual signals on real-world in-store choices. Third, the study is embedded in the context of a single country and a specific product category (FPM), which limits the transferability of conclusions to other markets and categories without additional comparative research. The use of a selected set of packaging stimuli also captured diverse interpretive strategies but does not exhaust the full range of packaging formats and communicative practices present in the market. Then, participants did not consistently name specific certification schemes, which limits conclusions regarding recognition differentials between individual labels; future research using named certification stimuli would allow more precise mapping. And finally, digital tool usage was captured only as self-reported behaviour; future research using interaction logging or in-store observation would allow fuller mapping of the phygital packaging communication experience.

4.7. Practical implications

For the design of FPM packaging communication, the findings point to three directions: (1) environmental communication should align with the health frame, as this often organises interpretation; (2) legibility and informational ergonomics are a prerequisite for “unlocking” the reception of environmental messages; and (3) credibility is built through recognisable certifications and by limiting the “inflation” of general claims, not through their multiplication.

5. Conclusions

The findings indicate that consumers interpret FPM sustainability primarily through a set of cognitively accessible signals rather than systemic categories. Symbolic sustainability indicators function as rapid interpretive shortcuts, but their effectiveness is undermined by the inflation of meanings and scepticism towards general eco-claims. Consequently, trust shifts from verbal declarations towards more institutional signals - certificates in particular - and towards communicative elements that reduce “information noise” (minimalism and high legibility). At the same time, “eco” graphics (e.g. green colours, nature motifs) and narratives of locality and tradition operate selectively and do not constitute universal decision determinants.

Packaging material proved to be an important but ambiguous sustainability signal. Glass frequently functions as an intuitive indicator of a “better” choice, but its advantage is constrained by utility criteria (convenience, durability, ease of transport) and by counter-arguments relating to the realities of recycling. As a result, sustainability assessment in the materials domain is conditional and negotiated in the course of discussion.

Informational transparency operates as an uncertainty reduction mechanism and a basic prerequisite for considering a purchase: consumers expect to be able to quickly locate key information (best-before date, unambiguous product identification, ingredient list). Ambiguous naming and low legibility undermine communicative credibility, and some participants compensate for these limitations through digital solutions (QR codes, apps), while others limit label reading and base their decisions on routine and prior experience.

Consumer engagement with sustainable FPM consumption takes the form of conditional readiness. Declarations of support for pro-environmental solutions coexist with low acceptance of price premiums, high sensitivity to availability, and an expectation that the burden of recycling organisation and clarity of rules will largely be assumed by producers or systemic solutions. Taken together, the findings suggest that effective sustainability communication in FPM should balance environmental signals with expectations regarding healthiness, legibility, and ease of use.

Acknowledgements

This work was realized as part of the Inter-University Research Grant SGH-UEW-UEK-UEP-UEKat entitled “Communication value of sustainable products and consumer behaviour”.

During the preparation of this work, the authors used Chat GPT and Grammarly to check the grammar and rewrite some sentences. After using this tool, the authors reviewed and edited the content as needed, and take they full responsibility for the content of the publication.

References

1. Ankiel, M., Halagarda, M., Piekara, A., Sady, S., Żmijowska, P., Popek, S., Pacholek, B., Jefmański, B., Kucia, M., Krzywonos, M. (2025). Role of Certifications and Labelling in Ensuring Authenticity and Sustainability of Fermented Milk Products. *Sustainability*, 17(18), 8398. <https://doi.org/10.3390/su17188398>
2. Aschemann-Witzel, J., Zielke, S. (2017). Can't buy me green? A review of consumer perceptions of and behavior toward the price of organic food. *Journal of Consumer Affairs*, 51(1), 211-251. <https://doi.org/10.1111/joca.12092>
3. Avalos, C. (2025). Food label granularity and working memory: Effects on food choice in a randomized controlled trial. *Journal of Health, Population, and Nutrition*, 44, 375. <https://doi.org/10.1186/s41043-025-01076-xavalos>
4. Boesen, S., Bey, N., Niero, M. (2019). Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment? *Journal of Cleaner Production*, 210, 1193-1206. <https://doi.org/10.1016/j.jclepro.2018.11.055>
5. Branca, G. (2025). Packaging Design, Sustainability and the Consumer Perspective. International Series in Advanced Management Studies. In: *Virtual Reality, Real Intentions* (chapter 3, pp. 29-54., Springer. DOI: 10.1007/978-3-032-10142-6_3
6. Cao, D.Z., Zheng, Y., Liu, C., Yao, X., Chen, S. (2021). Consumption values, anxiety and organic food purchasing behaviour considering the moderating role of sustainable consumption attitude. *British Food Journal*, 124, 3540-3562. <https://doi.org/10.1108/BFJ-06-2021-0647>
7. Carrington, M.J., Neville, B.A., Whitwell, G.J. (2010). Why ethical consumers don't walk their talk: Towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. *Journal of Business Ethics*, 97(1), pp. 139-158. <https://doi.org/10.1007/s10551-010-0501-6>
8. Chrysochou, P., Krystallis, A., Giraud, G. (2012). Quality assurance labels as drivers of customer loyalty in the case of traditional food products. *Food Quality and Preference*, 25(2), 156-162. <https://doi.org/10.1016/j.foodqual.2012.02.013>
9. De Feo, G., Ferrara, C., Minichini, F. (2022). Comparison between the perceived and actual environmental sustainability of beverage packagings in glass, plastic, and aluminium. *Journal of Cleaner Production*, 333, 130158. <https://doi.org/10.1016/j.jclepro.2021.130158>
10. de Oliveira, M.M., Lago, A., Guilherme, N., Pinto, M., de Oliveira, C., Velho, J.P. (2025). Systematic review of innovations in food packaging with a focus on circularity and the reduction of food loss and waste. *Discover Applied Sciences*, 7(10), 1133. <https://doi.org/10.1007/s42452-025-07788-3>

11. Despoudi, S., Keyue, Wu, K., Nedelkou, E., Zhu, J. (2025). Consumers' Attitudes and Behaviors Toward Circular Food Supply Chain Practices and Sustainable Food Purchase. *Circular Economy and Sustainability*, 5, 4469-4486. <https://doi.org/10.1007/s43615-025-00573-9>
12. Du Rietz Dahlström, S., Kremel, A. (2024). Consumer Behavior as a Challenge and Opportunity for Circular Food Packaging - a Systematic Literature Review. *Circular Economy and Sustainability*, 4, 413-438. <https://doi.org/10.1007/s43615-023-00290-1>
13. Euromonitor (2023). Global Market Overview of Milk. *Euromonitor International*, November.
14. Euromonitor (2024). Dairy Products and Alternatives: Half-Year Update H1 2024. *Euromonitor International*, April.
15. European Commission (2024). *Green Claims Initiative: Guidance on environmental claims in the EU single market*. Brussels: European Commission.
16. Francis, D.V., Dahiya, D., Gokhale, T., Nigam, P.S. (2024). Sustainable packaging materials for fermented probiotic dairy or non-dairy food and beverage products: challenges and innovations. *AIMS Microbiology*, 10(2), 320-339. <https://doi.org/10.3934/microbiol.2024017>
17. Gioia, D.A., Corley, K.G., Hamilton, A.L. (2013). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. *Organizational Research Methods*, 16, 15-31. <https://doi.org/10.1177/1094428112452151>
18. Groth, C., Wegmann, C., Meyerding, S.G. (2023). Perception of product sustainability: The case of processed tomatoes – A qualitative study in Germany. *Journal of Retailing and Consumer Services*, 71, 103214. <https://doi.org/10.1016/j.jretconser.2022.103214>
19. Ischen, C., Meijers, M.H.C., Vandeberg, L., Smit, E.G. (2022). (Not) communicating the environmental friendliness of food packaging to consumers: An attribute and cue based concept and its application. *Journal of Food Products Marketing*, 28(1), pp. 31-48. <https://doi.org/10.1080/10454446.2022.2038757>
20. Jain, P., Hudnurkar, D. M. (2022). Sustainable packaging in the FMCG industry. *Cleaner and Responsible Consumption*, 7, 100075. <https://doi.org/10.1016/j.clrc.2022.100075>
21. Kaiser, V., Krzywonos, M., Maisch, B. (2024). *Emphasizing sustainability in entrepreneurship education: Lessons learned from a case study*. European Conference on Innovation and Entrepreneurship. Academic Conferences International Limited, pp. 290-298.
22. Kamboj, A., Kaur, G., Jain, H., Singh, L. (2025). The role of smart packaging and consumer psychology in reducing food waste: A review. *Food and Humanity*, 5, 100826. <https://doi.org/10.1016/j.foohum.2025.100826>
23. Klein, M., Neumair, C., Primoceri, M., Tacker, M., Apprich, S. (2025). Fit for the Future: An Assessment of the Sustainability Parameters of Liquid Dairy Product Packaging in the

- DACH Region and the Implications of Upcoming Regulatory Changes. *Foods*, 14(2). <https://doi.org/10.3390/foods14020195>
24. Kozik Kołodziej, N. (2026). Consumer attitudes and perceptions toward sustainable packaging: A systematic literature review. *Sustainability*, 18(3), 1235. <https://doi.org/10.3390/su18031235>
25. Krueger, R.A., Casey, M.A. (2015). *Focus groups: A practical guide for applied research (5th ed.)*. SAGE Publications.
26. Kuckartz, U. (2018). *Qualitative Inhaltsanalyse: Methoden, Praxis, Computerunterstützung (4th ed.)*. Beltz Juventa.
27. Kukreja, N., Patil, P.C. (2025). Packaging as a Strategic Communication Tool: Influencing Consumer Perception in Processed Food Markets. *Journal of Marketing & Social Research*, 2(2), 487-498. <https://doi.org/10.61336/jmsr/25-02-45>
28. Li, R., Li, H. (2024). The Impact of Food Packaging Design on Users' Perception of Green Awareness. *Sustainability*, 16(18), 8205. <https://doi.org/10.3390/su16188205>
29. Lombardi, A., Califano, G., Caracciolo, F., Del Giudice, T., Cembalo, L. (2023). Eco packaging in organic foods: Rational decisions or emotional influences? *Organic Agriculture*, 14, 125-142. <https://doi.org/10.1007/s13165-023-00442-5>
30. Maciejewski, G. (2020). Konsumenci Wobec Zrównoważonej Konsumpcji Żywności. Consumers Towards Sustainable Food Consumption. *Marketing Instytucji Naukowych i Badawczych*, 36(2). DOI: 10.2478/minib-2020-0014
31. Miao, X. et al. (2023) Switching to reuse? An exploration of consumers' perceptions and behaviour towards reusable packaging systems. *Resources, Conservation and Recycling*, 193, 106972. <https://doi.org/10.1016/j.resconrec.2023.106972>
32. Mladenović, M., van Trijp, H., Piqueras Fiszman, B. (2024) (Un)believably green: The role of information credibility in consumer responses to green food packaging. *Environmental Communication*, 18(6), pp. 743-760. <https://doi.org/10.1080/17524032.2024.2317910>
33. Nguyen, T.P., Barretta, P.G. (2024) Green Marketing or Greenwashing: How Consumers Evaluate Environmental Ads. *Journal of Applied Business and Economics*, 26(1). <https://doi.org/10.33423/jabe.v26i1.6808>
34. OECD (2024). *Environmental Claims: Helping Consumers Choose Sustainable Goods*. Paris: OECD Publishing.
35. Orzan, G., Cruceru, A.F., Bălăceanu, C.T., Chivu, R.-G. (2018). Consumers' Behavior Concerning Sustainable Packaging: An Exploratory Study on Romanian Consumers. *Sustainability*, 10(6), 1787. <https://doi.org/10.3390/su10061787>
36. Otto, S., Strenger, M., Maier Nöth, A., Schmid, M. (2021). Food packaging and sustainability – Consumer perception vs. correlated scientific facts: A review. *Journal of Cleaner Production*, 298, 126733. <https://doi.org/10.1016/j.jclepro.2021.126733>

37. Patel, K.R. (2023). Harmonizing sustainability, functionality, and cost: navigating responsible packaging innovations in modern supply chains. *American Journal of Economic and Management Business (AJEMB)*, 2(8), 287-300.
38. Persakis, A., Nikolopoulos, T., Negkakakis, I.C., Pavlopoulos, A. (2025). Greenwashing in marketing: a systematic literature review and bibliometric analysis. *International Review on Public and Nonprofit Marketing*, 22(4), 957-992. <https://doi.org/10.1007/s12208-025-00452-x>
39. Pickering, J., Beswick-Parsons, R., Diprose, K. (2026). Rethinking consumer convenience as a barrier to reusable packaging systems. *Consumption and Society*, 1-20. <https://doi.org/10.1332/27528499Y2025D0000000067>
40. Pieniak, Z., Verbeke, W., Vanhonacker, F., Guerrero, L., Hersleth, M. (2009). Association between traditional food consumption and motives for food choice in six European countries. *Appetite*, 53(1), 101-108. <https://doi.org/10.1016/j.appet.2009.05.019>
41. Product Sustainability Directory (2025). *Heuristic cue*. *Product Sustainability Directory*. Available at: <https://product.sustainability-directory.com/term/heuristic-cue/>, 20 March 2026.
42. Raats, M.M., Shepherd, R., Sparks, P. (1993). Attitudes, obligations and perceived control: predicting milk selection. *Appetite*, Jun., 20(3), 239-41. doi:10.1006/appe.1993.1027
43. Riswanto, A.L., Kim, S., Williady, A., Ha, Y., Kim, H.S. (2025). How Visual Design in Dairy Packaging Affects Consumer Attention and Decision-Making. *Dairy*, 6(1). <https://doi.org/10.3390/dairy6010004>
44. Saunders, M.N.K., Lewis, P., Thornhill, A. (2023). *Research methods for business students* (9th ed.). Pearson.
45. Schifferstein, H.N.J., de Boer, A., Lemke, M. (2021). Conveying information through food packaging: A literature review comparing legislation with consumer perception. *Journal of Functional Foods*, 86, 104734. <https://doi.org/10.1016/j.jff.2021.104734>
46. Schleenbecker, R., Hamm, U. (2013). Consumers' perception of organic product characteristics: A review. *Appetite*, 71, 420-429. <https://doi.org/10.1016/j.appet.2013.08.020>
47. Schuldt, J.P., Hannahan, M. (2013). When good deeds leave a bad taste: Negative inferences from ethical food claims. *Appetite*, 62, 76-83. <https://doi.org/10.1016/j.appet.2012.11.004>
48. Sirieix, L., Delanchy, M., Remaud, H., Zepeda, L., Gurviez, P. (2013). Consumers' perceptions of individual and combined sustainable food labels: A UK pilot investigation. *International Journal of Consumer Studies*, 37(2), 143-151. <https://doi.org/10.1111/j.1470-6431.2012.01109.x>
49. Sokolova, T., Krishna, A., Döring, T. (2023). Paper Meets Plastic: The Perceived Environmental Friendliness of Product Packaging. *Journal of Consumer Research*, 50(3), 468-491. <https://doi.org/10.1093/jcr/ucad008>

50. Steiner, K., Florack, A. (2023). The Influence of Packaging Color on Consumer Perceptions of Healthfulness: A Systematic Review and Theoretical Framework. *Foods*, 12(21), 3911. <https://doi.org/10.3390/foods12213911>
51. Sun, K.A., Moon, J. (2024). Relationships Among Psychological Risk, Eco-Friendly Packaging, Price Fairness, and Brand Trust of Bottled Water Consumers: Moderating the Impact of Nutritional Disclosure. *Foods*, vol. 13(23), 3800. <https://doi.org/10.3390/foods13233800>
52. Tamime, A.Y., Robinson, R.K. (2007) *Yoghurt: Science and Technology*. 3rd Edition. Cambridge: Woodhead Publishing Limited, 11-118.
53. Taşkoparan, S., Altınay, C., Özer, B.H. (2025). Recent updates of probiotic dairy-based beverages. *Food Funct.*, 16, 1656-1669. <https://doi.org/10.1039/D4FO06322H>
54. Thaler, R.H., Sunstein, C.R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.
55. Theobald, K., Mich, A., Hillesheim, S., Hartard, S., Rohn, H. (2024). One year of mandatory reusable packaging in Germany: opportunities and obstacles from the perspective of consumers and companies. *Sustainability*, 16(13), 5439. <https://doi.org/10.3390/su16135439>
56. Thøgersen, J. (2005). How may consumer policy empower consumers for sustainable lifestyles? *Journal of Consumer Policy*, 28(2), 143-177.
57. Thomas, L., Dlamini, N.N., Cichy, K., Swada, J., Mayhew, E.J. (2025). Toward Sustainable Food and Packaging Choices: Consumer Perception of Quality and Sustainability of Pulses Packaged in Metal, Glass, and Plastic. *J. Food. Sci.*, 90(10), e70585. doi: 10.1111/1750-3841.70585
58. Thota, M., Kollias, S., Swainson, M., Leontidis, G. (2020). *Multi-source deep domain adaptation for quality control in retail food packaging*. ArXiv. <https://arxiv.org/abs/2001.10335>
59. Underwood, R.L., Klein, N.M. (2002). Packaging as brand communication: Effects of product pictures on consumer responses to the package and brand. *Journal of Marketing Theory and Practice*, 10(4), 58-68.
60. Vermeir, I., Verbeke, W. (2006). Sustainable food consumption: Exploring the consumer “attitude-behavioural intention” gap. *Journal of Agricultural and Environmental Ethics*, 19(2), 169-194. <https://doi.org/10.1016/j.ecolecon.2007.03.007>
61. Wang, F., Wang, H., Cho, J.H. (2022). Consumer preference for yogurt packaging design using conjoint analysis. *Sustainability*, 14(6). <https://doi.org/10.3390/su14063463>
62. Wang, F., Wang, Y., Han, Y., Cho, J.H. (2024). Optimizing brand loyalty through user-centric product package design: A study of user experience in dairy industry. *Heliyon*, 10(3), e25484. <https://doi.org/10.1016/j.heliyon.2024.e25484>

63. Wojciechowska, P., Wiszumirska, K. (2022). Sustainable Communication in the B2C Market-The Impact of Packaging. *Sustainability*, 14(5). <https://doi.org/10.3390/su14052824>
64. Xia, T., Fan, X., Zhang, J., Liu, T. (2023). Influence of complexity in low-fat food packaging on consumers' purchase intentions. *Sustainability*, 15(4), 3697.
65. Yang, Y., Xue, F., Qiao, G. (2024). The impact of information acquisition ability on consumers' trust in eco-labels in China: Insight of food sustainability. *Frontiers in Sustainable Food Systems*, 8, 1449848. <https://doi.org/10.3389/fsufs.2024.1449848>
66. Yin, R.K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications Inc.
67. Young, W., Hwang, K., McDonald, S., Oates, C.J. (2009). Sustainable consumption: Green consumer behaviour when purchasing products. *Sustainable Development*, 18(1), 20-31. <https://doi.org/10.1002/sd.394>

QUALITY IMPLICATIONS OF VIRTUAL REALITY ASSISTED DISTRACTION PROTOCOLS IN PEDIATRIC DENTAL CARE: A SYSTEMATIC REVIEW

Monika ROGALSKA¹, Liliana HAWRYSZ^{2*}

¹ Faculty of Management, Department of Management Systems and Organizational Development, Wrocław University of Science and Technology; monika.rogalska@pwr.edu.pl, ORCID: 0009-0003-4395-4699

² Faculty of Management, Department of Management Systems and Organizational Development, Wrocław University of Science and Technology; Liliana.hawrysz@pwr.edu.pl, ORCID: 0000-0002-0357-9930

* Correspondence author

Purpose: The increasing integration of immersive technologies into healthcare has stimulated interest in their potential to enhance pediatric patient experience, particularly in procedures associated with high levels of anxiety and stress. This study aims to systematically evaluate the application of Virtual Reality (VR) as a distraction modality in pediatric dentistry and to assess the extent to which quality-of-care indicators are incorporated into existing research.

Design/methodology/approach: A structured literature review was conducted using PubMed and Scopus databases in accordance with PRISMA guidelines. Predefined eligibility criteria were applied, and data were extracted using a standardized protocol. The analysis focused on the effectiveness of VR interventions and the presence of quality-of-care dimensions in the reviewed studies

Findings: The review identified a limited but growing body of evidence indicating that VR interventions effectively reduce perceived pain and anxiety during pediatric dental procedures. However, the findings reveal a significant gap in the literature, as most studies do not incorporate comprehensive quality-of-care indicators, such as process reliability, patient-centeredness, or outcome-based performance measures.

Research limitations/implications: The study is limited by the relatively small number of available studies and the heterogeneity of research designs. Future research should incorporate validated quality indicators and adopt more standardized methodologies to enable a more comprehensive evaluation of VR-supported care in pediatric dentistry.

Practical implications: The findings suggest that VR can be a valuable supportive tool for improving patient experience in pediatric dentistry. However, its implementation should be accompanied by systematic quality assessment frameworks to ensure its contribution to overall care quality.

Social implications: By reducing anxiety and improving the treatment experience for children, VR interventions may enhance patient well-being and increase acceptance of dental care. This has broader implications for public health, including improved oral health outcomes and reduced long-term treatment avoidance.

Originality/value: This study contributes to the literature by combining a systematic evaluation of VR effectiveness with a critical assessment of quality-of-care measurement in pediatric dentistry. It highlights an important gap between technological innovation and quality management in healthcare.

Keywords: virtual reality, pediatric distraction, quality indicators, dental care, patient experience.

Category of the paper: literature review.

1. Introduction

Dental anxiety in children is a persistent challenge that disrupts behavioral cooperation, prolongs clinical procedures, and contributes to patterns of avoidance that compromise both individual health outcomes and the operational efficiency of dental services (Marshman et al., 2016; Grisolia et al., 2021). Studies show that 36% of children globally experience dental anxiety and 20% dental fear and anxiety (Grisolia et al., 2021; Sun et al., 2024). Numerous children witness also dental phobia what causes the avoidance of visits and continuity of a treatment (Rosa et al., 2023). Virtual Reality (VR) has emerged as a promising behavioral guidance tool capable of modulating attention and mitigating anxiety through immersive distraction (Gerçeker et al., 2021; Yıldırım, Gerçeker 2023).

Previous research has substantially advanced the understanding of dental anxiety in pediatric populations and the potential role of VR as a non-pharmacological distraction tool in dental care. Epidemiological studies and meta-analyses have demonstrated that dental fear and anxiety are highly prevalent among children and adolescents and constitute a clinically significant barrier to effective and efficient dental treatment (Grisolia et al., 2021; Sun et al., 2024). Elevated anxiety levels are associated with poorer patient cooperation, prolonged procedures, and avoidance of dental visits, which negatively affect both treatment outcomes and the quality-of-care processes. At the same time, a growing body of empirical evidence indicates that VR-based distraction interventions can reduce perceived pain, anxiety, and physiological stress responses during pediatric dental procedures, with additional indications of improved cooperation and treatment experience (Cunningham et al., 2021; Yan et al., 2023; Zhao et al., 2023; Rosa et al., 2023; Goodship, Taylor, 2025). Clinical studies further suggest that the benefits of VR may be procedure-dependent, with more pronounced effects observed during longer and more demanding interventions that require sustained attention and cooperation from the child (Zaidman et al., 2023). Collectively, these findings position VR as a promising supportive tool for enhancing selected patient-centered aspects of care in pediatric dentistry. Despite these advances, the existing literature remains fragmented and heterogeneous with respect to both the VR technologies employed and the outcome measures used to evaluate their impact. Research to date has predominantly focused on short-

term effectiveness indicators, such as reductions in anxiety and pain, while broader quality-of-care dimensions, including process-related indicators, physiological stress markers, safety, acceptability of the intervention, and overall patient experience, have received comparatively limited attention (Cunningham et al., 2021; Yan et al., 2023; Zhao et al., 2023). The lack of a systematic synthesis integrating evidence on the technological characteristics of VR interventions and the quality metrics applied across studies limits comparability and hinders the development of coherent, evidence-based recommendations for clinical practice. This gap provides a clear rationale for conducting a systematic review that systematically organizes existing evidence on the use of VR in pediatric dental distraction protocols and critically examines how quality-of-care indicators are incorporated into current research.

At the same time, the perspective of the pediatric patient constitutes a central reference point for evaluating the quality of dental care. Dental fear and anxiety are highly prevalent among children and adolescents and have a substantial impact on patient cooperation, the course of clinical procedures, and long-term attitudes towards oral health care (Grisolia et al., 2021; Sun et al., 2024). In pediatric contexts, quality of care cannot be assessed solely in terms of the technical correctness of procedures but should also encompass the child's subjective experience, comfort, perceived safety, and ability to cope with the clinical environment. Technology-based distraction interventions, such as VR, directly target these experiential dimensions by modulating anxiety levels, pain perception, and emotional and physiological responses during treatment (Yan et al., 2023; Zhao et al., 2023). From a quality-of-care perspective, this implies that the evaluation of VR and other emerging technologies should be embedded within a patient-centered care framework, in which the experiences and needs of pediatric patients constitute a key criterion for assessing the value of clinical interventions (Cunningham et al., 2021).

Understanding the factors that contribute to dental anxiety and dental phobia is essential, as it influences further steps as avoidance of the dental visits, what shifts care from preventive to symptom driven. The delays of appointments caused by anxiety is the beginning of the cycle (Kapil et al., 2021) (Fig. 1, Fig. 2).

As healthcare systems increasingly prioritize patient centered care, non-pharmacological strategies that enhance comfort, reduce distress, and support predictable treatment flow have become integral to quality improvement efforts in pediatric areas. It is also essential to recognize that improving the process requires simultaneous consideration of three key factors: quality, response time, and cost (Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance, 1998).



Figure 1. Factors of children's dental anxiety (Kapil et al., 2021).

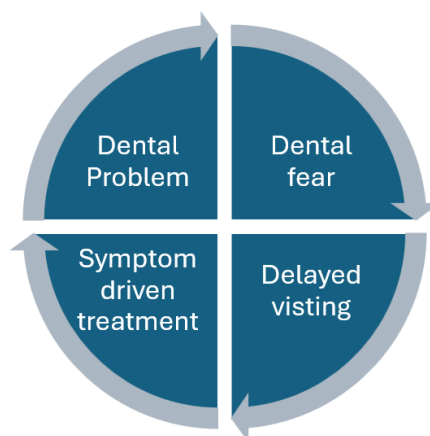


Figure 2. Vicious cycle of dental fear (Kapil et al., 2021).

Current evidence base is marked by heterogeneity in VR content, delivery methods, study designs, and outcome measures. There is limited number of clinical trials, and the existing literature remains fragmented and heterogeneous with respect to both the technological interventions employed and the ways in which their impact on quality of care is assessed. Prior empirical research has predominantly focused on narrowly defined, short-term effectiveness outcomes, such as reductions in anxiety and pain, while less attention has been devoted to a broader set of quality metrics, including process-related indicators, physiological stress markers, safety, acceptability of the intervention, and overall patient experience (Cunningham et al., 2021; Yan et al., 2023; Zhao et al., 2023). The lack of a systematic synthesis of evidence regarding which new technologies are being used in distraction protocols and which specific quality metrics are applied to evaluate their impact limits comparability across studies and hinders the development of coherent, evidence-based recommendations for clinical practice. Therefore, there is a clear rationale for conducting a systematic review that organizes the existing empirical evidence on the use of new technologies, such as VR, in pediatric distraction protocols and critically examines the quality metrics employed to assess their effects on quality of care.

2. Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. A PICO search was defined, and studies that fulfilled the following criteria were selected: population (P): young adults, youth, children (0-18), intervention (I): Use of Virtual Reality (VR) distraction in dentistry across different clinical use cases, comparison (C): standard care without VR or alternative distraction/behavior management techniques, outcomes (O): quality indicators.

Questions for the systematic review was: Does the use of virtual reality in dental anxiety in pediatric patients impact quality of the process? Which of the quality-of-care indicators are incorporated into existing research?

All English-language human studies reporting on children and adolescents under 18 undergoing dental treatment involving virtual reality. The exclusion criteria were studies exclusively adults, non-dental studies, non-English language papers, using VR as educational/training tool for medical staff. No exclusions were made from comparison groups. Search was performed without filtering limited time frame (1998-2026).

The search strategy was conducted on two databases by combining subject heading terms with keywords and text words. Search terms were “virtual reality”, “pediatric”, “quality”. The final search was carried out on 11th of January 2026.

All relevant studies fulfilling the inclusion criteria were included in this review (see figure 3). After removing duplication, a list of 383 abstract remained. The title and abstract screening were prepared to include only publications relevant to dentistry. Based on eligibility criteria 24 articles were assessed.

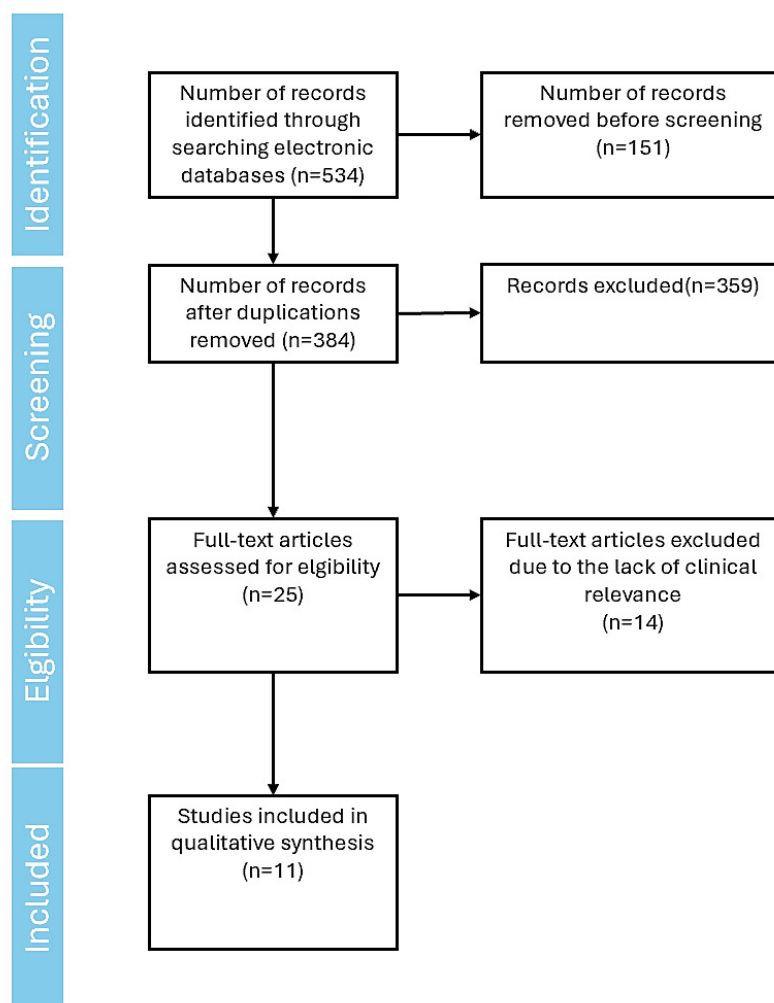


Figure 3. PRISMA diagram.

The applied PRISMA-based approach ensured a systematic, transparent, and reproducible study selection process. The final sample of studies ($n = 11$) constitutes a relevant and methodologically consistent basis for examining the impact of virtual reality interventions on pediatric dental anxiety and their integration with quality-of-care indicators.

3. Results

Dental anxiety among children and adolescents constitutes a significant public health problem that has a substantial impact on the quality of dental care, both in clinical and experiential terms. Global meta-analyses indicate that the prevalence of dental fear and anxiety in pediatric populations remains high, with a considerable proportion of children experiencing pronounced anxiety in relation to dental visits (Grisolia et al., 2021; Sun et al., 2024). Elevated levels of dental anxiety directly affect the course of treatment by reducing patient cooperation, increasing avoidance of dental appointments, and intensifying the subjective experience of pain.

In routine clinical practice, high anxiety is also associated with a greater need for pharmacological behavior management techniques, which increases the burden on healthcare systems and may expose patients to additional risks of adverse effects.

Consequently, the identification and implementation of effective non-pharmacological strategies for anxiety reduction represent an important pathway towards improving the overall quality of pediatric dental care. Within this context, virtual reality has emerged as a promising supportive intervention for managing anxiety and procedural stress. Systematic reviews and meta-analyses of clinical studies demonstrate that the use of VR as a sensory distraction technique leads to a significant reduction in situational anxiety among pediatric patients during dental procedures (Yan et al., 2023; Zhao et al., 2023). This effect is primarily attributed to the high level of immersion afforded by VR, which engages children's attentional resources and limits the cognitive processing of anxiety-provoking stimuli, such as the sounds of dental instruments or tactile sensations associated with treatment. Reductions in anxiety have direct implications for quality of care, as they increase patients' tolerance of clinical procedures, reduce avoidance behaviors, and limit oppositional reactions during treatment, thereby facilitating a more predictable and efficient clinical workflow (Goodship, Taylor, 2025). An important dimension of the impact of VR concerns pain perception and overall patient comfort. Empirical studies indicate that VR effectively reduces the subjective experience of pain in children undergoing dental treatment, a finding that can be explained by attentional theories suggesting that immersive virtual environments compete with nociceptive stimuli for limited cognitive resources, thereby attenuating the perception of aversive sensations (Zhao et al., 2023). The meta-analysis by (Yan et al., 2023) further suggests that VR-based interventions may be more effective in reducing anxiety and discomfort than traditional distraction techniques, such as watching videos on tablets or listening to music. Improvements in patient comfort are relevant not only from a subjective perspective but also in procedural terms, as children who experience less pain and anxiety are more likely to remain still during treatment. This facilitates more precise execution of clinical procedures, shortens treatment duration, and reduces the risk of complications arising from sudden patient movements (Goodship, Taylor, 2025).

Another mechanism through which VR may enhance the quality of pediatric dental care relates to improved patient cooperation and clinical efficiency. The level of cooperation displayed by children is a critical determinant of treatment success, and although conventional behavior guidance techniques, such as tell-show-do, modelling, and positive reinforcement, constitute the foundation of pediatric dental practice, their effectiveness may be limited in highly anxious patients (Kapil et al., 2021). In this regard, VR can function as a complementary tool that strengthens the impact of traditional behavioral approaches by providing children with an engaging and emotionally positive alternative focus of attention. Reviews of the literature indicate that VR is associated with increased engagement of pediatric patients in the treatment process and reduced oppositional behaviors, thereby creating more favorable conditions for the

delivery of care in accordance with clinical standards and potentially enhancing the technical quality of performed procedures (Cunningham et al., 2021; Rosa et al., 2023). Contemporary conceptualizations of healthcare quality emphasize the importance of patient experience as a central dimension of quality of care. Positive experiences during dental visits in childhood play a crucial role in shaping long-term attitudes towards oral health-related behaviors in later life.

Evidence suggests that VR may contribute to more positive perceptions of dental visits by reducing the salience of negative memories associated with pain and fear and by enhancing acceptance of dental procedures (Rosa et al., 2023; Yan et al., 2023). Over the longer term, such positive experiences may translate into greater regularity of follow-up visits, improved cooperation in subsequent stages of treatment, and higher adherence to preventive recommendations. In this sense, VR may influence quality of care directly by improving the immediate conditions under which procedures are performed, and indirectly, by fostering more favorable attitudes towards dental care.

Despite the documented benefits, the effectiveness of VR is not universal and appears to be contingent upon several factors, including the child's age, level of cognitive development, individual sensory sensitivity, the type of VR technology used, and the nature of the dental procedure. Systematic reviews consistently point to substantial heterogeneity in study findings and variability in methodological quality, which limits the strength of conclusions that can be drawn regarding best practices for clinical implementation (Cunningham et al., 2021; Zhao et al., 2023). Moreover, a large proportion of available studies focus on short-term reductions in anxiety and pain, thereby constraining inferences about the durability of VR effects and their long-term implications for the quality of pediatric dental care across the broader treatment trajectory (figure 3).

The collective findings demonstrate that VR-based interventions consistently reduced pain, anxiety, and related physiological stress responses in pediatric dental settings, with several studies also indicating improvements in behavioral cooperation (Cunningham et al., 2021; Yan et al., 2023; Zhao et al., 2023; Rosa et al., 2023; Kapil et al., 2021; Fahim et al., 2022; Goodship, Taylor, 2025). Although methodological quality varied, the overall pattern of results suggests that VR functions as a reliable nonpharmacological method capable of enhancing the patient's experience across multiple dental procedures (see table 1).

Table 1.

An explanatory note for the summary of the systematic review

LP	Authors	Title	Tools	Age group	Pain and Anxiety	Key points in the context of quality of the process	Limitations
1	Rosa, A., Pujia, A.M., Docimo, R., Arcuri, C.	Managing Dental Phobia in Children with the Use of Virtual Reality: A Systematic Review of the Current Literature	VR	Children ≤ 18 years (pediatric focus); some adult data included but not primary	Anxiety measured via MDAS, VAS; pain measured via VAS, FLACC; VR generally reduced pain in children; anxiety reduction mixed and not always significant	Pain Management and understanding of the mechanisms in managing DP, Improvement of the dental experience, ethical considerations, technical constraints, individual variations, costs, enhance positive dental experiences, improve cooperation, and facilitate behavior change	Ethical considerations; technical constraints; cost; individual variation in VR response; VR not adequate for children with severe anxiety; heterogeneity of included studies; limited number of high-quality RCTs
2	Cunningham, A., McPolin, O., Fallis, R., Coyle, C., Best, P., McKenna, G.	A systematic review of the use of virtual reality or dental smartphone applications as interventions for management of paediatric dental anxiety	VR eyeglasses, VR smartglasses, VR box, audiovisual glasses; bespoke smartphone app, tablet device (active distraction comparator)	4-15 years	VR reduced pain and anxiety in three perioperative studies; anxiety measured via pulse rate and MCDAS; pain measured via Wong-Baker FACES, FLACC, Faces Pain Scale-Revised. Smartphone apps reduced behavioural distress and procedural attempts in ASD population	The Ambiguity of the 'Behaviour' Parameter, oral health-related quality of life, behavioural management (Tell-Show-Do), home-based preparation, long-term management of a dentally phobic child, individual variations (ASD)	Limited number of studies; small sample sizes; heterogeneity of interventions and outcome measures; exclusively perioperative use (no preoperative VR trials); methodological weaknesses; lack of blinding; high risk of bias; no standardised VR protocols; no long-term follow-up; exclusion of non-English studies; absence of meta-analysis due to insufficient comparable data

Cont. table 1.

3	Fahim, S., Maqsood, A., Das, G., Ahmed, N.; Saqib, S., Lal, A., Khan, A.A.G., Alam, M.K.	Augmented Reality and Virtual Reality in Dentistry: Highlights from the Current Research	VR, Augmented Reality (AR) visual tools	Children (exact ages not specified)	VR reduced anxiety and pain; decreased heart rate and pain scores when children watched cartoons via VR goggles	Effective communication, pre-treatment preparation, Improvement of dental experience, behavioural management	forming technological standards with high- quality data and developing scientifically proven AR/VR gadgets for dental practice
4	Fan, L., Zeng, J., Ran, L., Zhang, C., Wang, J., Yu, C., Zhao, N.	Virtual reality in managing dental pain and anxiety: a comprehensive review	VR	Children aged 4-17 years (majority between 4-10 years).	VR significantly reduced pain in most pediatric studies, including during local anesthesia, endodontic treatment, and dental surgery.	behavioural management, adverse reactions, individual variations (mild intellectual disabilities)	VR technology may cause certain adverse reactions, and it is recommended to evaluate and personalize its application before the dental procedure screening.
5	Goodship, N., Taylor, G.	Can virtual reality reduce anxiety and pain in dental patients?	VR	Children and adults; majority of included studies ($\approx 70\%$) focused on paediatric patients.	VR significantly reduced anxiety in children; no significant effect on adult anxiety. VR significantly reduced pain in both children and adults.	standardization of VR content needed effectiveness across different pediatric age groups and dental procedures	Heterogeneity of VR interventions; inconsistent outcome measures; small sample sizes; limited standardization of VR content; some studies lacked blinding; cybersickness reported in a minority of patients; no long-term follow-up; variability in procedure types; no preoperative home-based VR studies in children.
6	Kapil, D., Saraf, B.G., Sheoran, N., Kalra, G., Elizabeth, S.	Contemporary Behavior Guidance Techniques to Outsmart Child's Anxious Mind	VR	4-8 years	VR reduced anxiety and pain; measured using Wong-Baker FACES, MCDAS, pulse rate, oxygen saturation, salivary cortisol	behavioural management (Tell- Show-Do or Tell- Play-Do), quality oral health care safely, quality dental treatment	None (no VR-specific barriers reported in the review)

Cont. table 1.

7	Yan, X., Yan, Y., Cao, M., Xie, W., O'Connor, S., Lee, J.J., Ho, M.H.	Effectiveness of virtual reality distraction interventions to reduce dental anxiety in paediatric patients: A systematic review and meta-analysis	VR glasses; VR head-mounted display; VR box (smartphone-based)	4-12 years	VR significantly reduced anxiety, pain and heart rate on caries treatment, dental fillings, pulp therapy and inferior alveolar nerve block, but no significant effect on teeth extraction; measuring using MCDAS-f, CFSS-DS, FIS, CPMAS and VPT	general oral health, effectiveness	High heterogeneity; methodological weaknesses; inadequate allocation concealment; absence of double blinding; limited database search; predominance of pediatric and female samples reducing generalizability; lack of standardized VR protocols; inconsistent outcome measures; insufficient control of confounders
8	Gandhi, M., Lakade, L., Kunte, S., Patel, A., Shah, P., Chaudhary, S.	Effect of Virtual Reality and Musical Earplug Temporal Tap Technique in Reduction of Gag Reflex in Pediatric Patients	VR, Musical Earplug Temporal Tap Technique (METTT); Standard leg-lift distraction (baseline)	6-12 years	Heart rate, oxygen saturation, and Faces version of MCDAS were measured; METTT reduced heart rate (anxiety indicator); VR showed no significant effect	Quality dental care, effectiveness	However, neither VR nor METTT helped mitigate the gag reflex. There is minimal literature evidence; therefore, more research is needed to manage or reduce the gag reflex during impression making and creating a comfortable experience for the patient
9	Parakh, H., Thosar, N.	Evaluation and comparison of the effectiveness of kaleidoscope and virtual reality goggles to reduce dental anxiety in young children undergoing administration of local anesthesia	Kaleidoscope, VR	5-8 years old	Study not yet started; no empirical results available.	Standardized procedures (local anesthesia for pulpectomy or extraction) exist, effectiveness, quality dental care, behavior management	Exclusion of children with past dental experience may limit generalizability; lottery randomization less robust than computerized methods; limited literature on kaleidoscope use; potential variability in behavioral responses; resource constraints (e.g., software for randomization).

Cont. table 1.

10	Stan, D., Voicu, D., Zainea, P., Toma, A., Ciubară, A.	Reframing Dental Anxiety: Cognitive Behavioral Therapy and Its Role in Phobia Treatment-A Narrative Review	VR	No specific age ranges provided	VR reported to reduce pain and anxiety in pediatric dentistry according to cited scoping reviews and RCTs; VR shown to reduce procedural anxiety and discomfort during invasive procedures.	Quality of life, Cost-effectiveness, long-term comparative trials, behavior management	Yet, regulatory, ethical, and privacy issues remain barriers to clinical deployment. Limited long-term data; lack of standardized VR protocols; insufficient high-quality pediatric trials; variability in study designs; accessibility issues; need for tailored approaches for children with developmental or psychiatric comorbidities.
11	Pradnya, D., Pathak Laxmi, S., Lakade Krishna, V., Patil Preetam, P., Shah Alok, R., Patel Rucha, N., Davalbhakta	Clinical evaluation of feasibility and effectiveness using a virtual reality device during local anesthesia and extractions in pediatric patients	VR	6-12 years	The use of virtual reality devices in children is not able to reduce pain following deciduous molar extraction, measuring using VPT, WBS, FLACC	Quality dental care, behavior management methods, effectiveness	For the age group of six to eight years old, the device was hefty and the headphones were not well fitted, which made it challenging to totally muffle outside noises. The larger size of the device led to difficulty in assessing the facial expression component of the FLACC score. The smaller sample size and the inability to blind could have led to certain biases.

Abbreviations: MDAS – Modified Dental Anxiety Scale; MCDAS – Modified Child Dental Anxiety Scale; FIS – Facial Image Scale, VAS – Visual Analogue Scale; VPT – Venham’s Picture Test; CFSS-DS – Children’s Fear Survey Schedule-Dental Subscale, FLACC – Face, Legs, Activity, Cry, Consolability Scale; ASD – Autism Spectrum Disorder; METTT – Multidimensional Evaluation Tool for Therapeutic Technologies, CPMAS – Children’s Perioperative Multidimensional Anxiety Scale, Wong-Bakers Faces pain rating scale (WBS).

Research on the use of virtual reality in pediatric dentistry most frequently relies on patient-oriented quality metrics, commonly referred to as patient-reported outcomes. These include, in particular, measures of dental anxiety, subjective pain perception, and satisfaction with the dental visit, often incorporating the perspectives of parents or caregivers. Dental anxiety is typically assessed using standardized psychometric instruments such as the Children's Fear Survey Schedule, Dental Subscale, the Modified Child Dental Anxiety Scale, and the Facial Image Scale. These tools are widely employed in clinical studies and systematic reviews, which allow for a certain degree of comparability across investigations. The meta-analysis of randomized controlled trials conducted by (Yan et al., 2023) identified dental anxiety as one of the primary quality-related outcomes used to evaluate the effectiveness of VR-based distraction interventions. Similarly, the review by (Rosa et al., 2023) highlighted CFSS-DS and MCDAS as the most commonly applied and well-established instruments for measuring dental anxiety in pediatric populations. In clinical trials such as the study by (Zaidman et al., 2023), the Facial Image Scale and behavioral observation measures were used to capture children's emotional responses during dental procedures. The widespread use of these instruments reflects the central role of subjective patient experience in contemporary conceptualizations of quality of care. Another key patient-oriented quality dimension concerns pain perception, which in pediatric dental research is most commonly measured using visual or pictorial rating scales, including the Wong-Baker FACES Pain Rating Scale and the Visual Analogue Scale. The meta-analysis by (Yan et al., 2023) demonstrated that pain intensity constitutes one of the core clinical quality outcomes in studies assessing VR interventions during dental treatment. Likewise (Zhao et al., 2023), identified pain reduction as a central quality indicator closely linked to patient comfort and overall procedural experience. In pediatric contexts, pain perception is particularly relevant, as heightened discomfort not only affects the child's immediate experience but also influences cooperation during treatment and shapes longer-term attitudes towards dental care, thereby serving as an important marker of care quality. In addition to anxiety and pain, patient and parent satisfaction is frequently included as a broader indicator of quality of care and user experience. Unlike anxiety and pain, satisfaction is rarely assessed using a single standardised instrument; instead, study-specific questionnaires are commonly employed to capture perceptions of the visit and acceptance of technology.

The systematic review by (Cunningham et al., 2021) noted that satisfaction with VR interventions and acceptance of the technology by children and caregivers are important components of perceived quality of care and are often reported as supplementary outcomes in studies examining technological distraction in pediatric dentistry. These measures provide insight into the feasibility and acceptability of VR in real-world clinical settings and inform assessments of its potential for routine implementation. Beyond subjective patient-reported outcomes, studies of VR in pediatric dentistry also incorporate physiological indicators that serve as objective proxies for procedural stress and quality of the treatment experience. Heart rate is the most commonly used physiological metric, interpreted as an indicator of

autonomic arousal and stress during dental procedures. Yan et al. (2023) included heart rate measures as objective quality-related outcomes in their synthesis of randomized controlled trials, reporting that VR-based interventions were associated with reductions in physiological arousal. Similarly (Zaidman et al., 2023), assessed heart rate before and during dental procedures to compare stress responses in VR-assisted and standard care conditions. Other autonomic measures, such as blood pressure, have been used less frequently and are mainly reported in individual trials included in meta-analyses (Yan et al., 2023). These physiological metrics complement self-reported measures by providing objective indicators of stress and emotional regulation during treatment, with lower physiological arousal interpreted as reflecting higher procedural quality. Process-related quality metrics constitute another important category of outcomes in research on VR-assisted distraction. These indicators focus on the course of treatment and patient behavior during dental procedures. Patient cooperation and behavioral responses are often assessed using observational instruments such as the Frankl Behavior Rating Scale, which categorizes children's behavior from highly negative to highly positive. In the crossover trial by (Zaidman et al., 2023), behavioral ratings were used to compare cooperation during procedures performed with and without VR. The review by (Cunningham et al., 2021), further indicated that patient cooperation is among the most frequently reported process quality indicators in studies evaluating distraction technologies. Additional process-related measures include procedure duration and the number of interruptions during treatment. Some of the randomized trials included in the meta-analysis by (Yan et al., 2023), reported shorter procedure times or fewer interruptions in VR conditions, although these variables were typically treated as secondary or exploratory indicators rather than primary outcomes.

Research on the use of VR in pediatric dentistry has developed along several complementary streams, which together make it possible to understand both the scale of dental anxiety among children and the potential of VR as a tool for improving the quality of care. The first stream comprises epidemiological studies and meta-analyses of the prevalence of dental anxiety in children and adolescents. Although these studies do not directly test VR interventions, they provide crucial justification for the search for effective non-pharmacological methods of anxiety management. Grisolia et al. (2021) conducted a global systematic review with meta-analyses of the prevalence of dental anxiety in pediatric populations, demonstrating that this problem is widespread and clinically significant.

These findings provide an important starting point for designing interventions aimed at improving the quality of care, as high levels of anxiety are associated with poorer patient cooperation, avoidance of dental visits, and the prolongation of clinical procedures. Similarly, (Sun et al., 2024), focusing on early childhood, estimated the global prevalence of dental fear and anxiety and identified key risk factors, such as lack of previous dental visit experience and the presence of dental caries. The authors emphasized that anxiety-reduction interventions should be implemented at an early stage of children's contact with the dental care system.

From a quality-of-care perspective, these studies establish the fundamental premise that effective pediatric dental care requires strategies to reduce anxiety, as elevated anxiety levels significantly impair the quality and efficiency of treatment processes.

The second stream of research consists of teams synthesizing empirical evidence on the effectiveness of VR as a distraction technique and its impact on clinical indicators and patient experience (Cunningham et al., 2021) conducted a systematic review of studies on the use of VR and mobile dental applications in pediatric dentistry, indicating that although the number of empirical studies was limited at the time, the available evidence suggested beneficial effects of these technologies on the reduction of pain and anxiety, as well as potential improvements in the treatment process. In subsequent years, (Yan et al., 2023) carried out a systematic review and meta-analysis of randomized clinical trials involving several hundred pediatric patients, demonstrating statistically significant effects of VR in reducing anxiety, pain, and physiological parameters such as heart rate during dental treatment. At the same time, the authors highlighted substantial heterogeneity of results and the risk of bias in some studies, which is important for assessing the overall quality of the evidence base. A comprehensive review of the effectiveness of VR in reducing pain and anxiety during oral procedures was also provided by who emphasized the need for standardization of VR protocols, including the selection of content, duration of exposure, and patient eligibility criteria. A critical summary of the evidence from an evidence-based dentistry perspective was presented by (Goodship, Taylor, 2025), who concluded that VR is a promising adjunctive intervention for reducing anxiety and pain in pediatric dental patients, but that its routine implementation requires further high-quality clinical trials and the development of standardized application guidelines. Similar conclusions were drawn by (Rosa et al., 2023), who, in their review of studies involving children with dental phobia, identified VR as an effective method of distraction and preparatory intervention, while also noting limitations related to the small number of available studies and their heterogeneous methodological quality. From a quality-of-care perspective, this stream of research suggests that VR improves key patient-centered quality indicators, such as anxiety, pain, and physiological stress responses, and may facilitate the clinical process, while simultaneously underscoring the need to strengthen the empirical evidence base.

The third stream comprises clinical studies directly testing VR-assisted distraction protocols in dental practice settings, which most explicitly link the use of the technology to quality understood in terms of patient comfort, cooperation during treatment, and the technical conditions of clinical procedures. (Zaidman et al., 2023) conducted a randomized crossover trial among children aged 4 to 12 years, comparing dental visits with and without VR goggles during local anesthesia administration and rubber dam placement. The results indicated that VR significantly reduced perceived pain during more time-consuming procedures that require sustained attention and cooperation from the child, such as rubber dam placement, whereas its effect on pain associated with local anesthetic injection was limited and inconclusive (Zaidman et al., 2023). These findings suggest that improvements in the quality of care attributable to

VR are selective and procedure-dependent, which has important implications for the design of quality-oriented protocols and the rational implementation of this technology in routine clinical practice.

The need for additional behavior management strategies, including pharmacological interventions or intensified behavioral techniques, has also been reported in reviews as an indirect indicator of treatment facilitation and process quality (Cunningham et al., 2021, Rosa et al., 2023). Clinical outcome metrics that directly reflect the technical quality of care are less frequently reported but remain important for a comprehensive assessment of VR interventions. These include indicators such as procedural success or treatment completeness, defined as the extent to which planned dental procedures can be completed as intended. Such outcomes are occasionally reported in clinical trials and systematic reviews, including the work by (Cunningham et al., 2021), typically as secondary indicators of intervention effectiveness. In a limited number of studies, the number of visits required to complete treatment has also been examined as a proxy for process efficiency, although this metric is not routinely included and remains underrepresented in literature. Finally, safety and acceptability metrics form an integral component of quality assessment in studies of VR-based interventions. Systematic reviews report that potential adverse effects associated with VR use, such as dizziness, nausea, or sensory discomfort, are monitored in some studies, although their incidence appears to be relatively low (Cunningham et al., 2021; Zhao et al., 2023). Acceptance of VR technology by children and their caregivers, often assessed through brief questionnaires or subjective ratings, is also treated as an important dimension of implementation quality, as it determines the feasibility of integrating VR into routine clinical practice (Cunningham et al., 2021; Rosa et al., 2023). Taking together, the pattern of quality metrics employed in the literature indicates a strong emphasis on subjective patient experience and stress-related indicators, whereas strict clinical and organizational outcomes remain comparatively underexplored. This imbalance highlights an important gap in the current evidence base and points to the need for more comprehensive, multidimensional frameworks for evaluating the quality of VR-assisted care in pediatric dentistry.

4. Discussion

The key findings extracted from the reviewed publications collectively demonstrate that virtual reality has measurable potential to enhance the quality of pediatric dental care processes, although the evidence base remains heterogeneous and methodologically constrained. Across most studies, VR contributed to reductions in pain and anxiety, particularly in younger children and during procedures such as local anesthesia, restorative treatment, and endodontic therapy. Several reviews reported consistent decreases in pain scores measured with different

scales: VAS, FLACC, or Wong–Baker scales, and reductions in physiological anxiety indicators such as heart rate and salivary cortisol (Rosa et al., 2023; Cunningham et al., 2021; Kapil et al., 2021; Yan et al., 2023; Gandhi et al., 2024; Pathak et al., 2023). These outcomes align with quality-oriented objectives by improving patient experience and reducing procedural distress what leads to smoother behavioral management during treatment.

From a process-quality perspective, the included studies highlight several mechanisms through which VR may strengthen clinical workflows. Improvements in cooperation, reductions in behavioral disruptions, and enhanced patient engagement were repeatedly emphasized as contributors to more predictable appointment flow and more efficient delivery of care. For instance, Rosa et al. (2023) and Cunningham et al. (2021) underscored VR's role in improving cooperation and facilitating behavior change, while other reviews linked VR to better communication, pre-treatment preparation, and safer delivery of care within behavior guidance frameworks such as Tell-Show-Do or Tell-Play-Do. These findings suggest that VR can function as a distraction tool but also as an enabler of broader organizational efforts to modernize behavioral guidance practices and reduce reliance on more resource intensive or invasive anxiety management strategies.

However, the evidence also reveals substantial limitations that constrain the translation of VR into standardized, high-quality clinical process. A recurring issue across studies is the absence of standardized VR protocols, including variability in device type, content, duration of exposure, and timing of use. Multiple reviews explicitly noted heterogeneity in interventions and outcome measures, lack of blinding, small sample sizes, and insufficient control of confounders, all of which limit the comparability of findings and impede the development of evidence-based implementation guidelines. Importantly, none of the included publications assessed quality indicators in a structured manner or incorporated perspectives from all key stakeholders: patients, parents, and dental practitioners.

The limitations identified also underscore operational challenges that must be addressed before VR can be integrated as a routine component of pediatric dental care. Technical constraints, device ergonomics, and potential adverse reactions (e.g., cybersickness) were noted in several studies. Pathak et al. (2023) reported that VR headsets were too heavy for younger children, interfering with both comfort and the ability to assess facial expressions for FLACC scoring. Other reviews highlighted ethical considerations, cost barriers, and the need for personalized screening to account for individual variations, including children with ASD or mild intellectual disabilities. These factors illustrate the importance of structured implementation strategies that incorporate risk assessment, staff training, and workflow redesign.

Taken together, the results indicate that VR represents a promising tool for healthcare organizations seeking to advance quality and efficiency in pediatric dental services. The observed benefits are reduced pain, lower anxiety, improved cooperation, and enhanced

patient experience. It aligns with core quality improvement priorities and support the potential for VR to strengthen patient-centered care processes. Currently the evidence base also reveals a clear need for standardized procedures, stakeholder-inclusive design, and rigorous evaluation of the frameworks. Future research should therefore focus on developing and validating implementation protocols that integrate VR into routine care without extending visit duration, while ensuring that quality, safety, and equity considerations are systematically addressed.

5. Conclusions

The literature review demonstrates that the majority of studies report a substantial positive effect of virtual reality interventions on reducing anxiety and stress in pediatric dentistry. However, in procedures such as tooth extraction and in cases involving the gag reflex, the use of VR does not appear to produce statistically significant improvements.

Most authors emphasize the relevance of high-quality dental care and its contribution to the patient's overall quality of life. Nevertheless, none of the reviewed studies employ formal quality indicators to assess how the care process changes with and without VR support. Although some researchers refer to treatment effectiveness, they do not operationalize it through standardized quality metrics. Virtual Reality primarily reduces pain and anxiety and supported by various measurement tools, including self-report scales, heart rate monitoring, and salivary cortisol levels. These outcomes align with quality-oriented goals by enhancing patient experience and lowering procedural stress. Current research, however, remains focused on improving comfort for anxious pediatric patients, and no study proposes VR as an integrated component of standard clinical protocols.

References

1. Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance (1998). *Choice Reviews Online*, 35(10).
2. Cunningham, A., McPolin, O., Fallis, R., Coyle, C., Best, P., McKenna, G. (2021). A Systematic Review of the Use of Virtual Reality or Dental Smartphone Applications as Interventions for Management of Paediatric Dental Anxiety. *BMC Oral Health*, 21(1).
3. Fahim, S., Maqsood, A., Das, G., Ahmed, N., Saquib, S., Lal, A., Khan, A.A.G., Alam, M.K. (2022). Augmented Reality and Virtual Reality in Dentistry: Highlights from the Current Research. *Applied Sciences (Switzerland)*, vol. 12(8). MDPI.

4. Gandhi, M., Lakade, L., Kunte, S., Patel, A., Shah, P., Chaudhary, S. (2024). Effect of Virtual Reality and Musical Earplug Temporal Tap Technique in Reduction of Gag Reflex in Pediatric Patients. *International Journal of Clinical Pediatric Dentistry*, 17(9), 981-986.
5. Gerçeker, G.Ö., Bektaş, M., Aydınok, Y., Ören, H., Ellidokuz, H., Olgun, N. (2021). The Effect of Virtual Reality on Pain, Fear, and Anxiety during Access of a Port with Huber Needle in Pediatric Hematology-Oncology Patients: Randomized Controlled Trial. *European Journal of Oncology Nursing*, 50, 101886.
6. Goodship, N., Taylor, G. (2025). Can Virtual Reality Reduce Anxiety and Pain in Dental Patients?: Paediatric Dentistry. *Evidence-Based Dentistry*, vol. 26(1). Springer Nature, 59-60.
7. Grisolia, B.M., dos Santos, A.P.P., Dhyppolito, I.M., Buchanan, H., Hill, K., Oliveira, B.H. (2021). Prevalence of Dental Anxiety in Children and Adolescents Globally: A Systematic Review with Meta-analyses. *International Journal of Paediatric Dentistry*, 31(2), 168-183.
8. Kapil, D., Saraf, B.G., Sheoran, N., Kalra, G., Elizabeth, S. (2021). Contemporary Behavior Guidance Techniques to Outsmart Child's Anxious Mind. *Journal of South Asian Association of Pediatric Dentistry*, vol. 4(1). Jaypee Brothers Medical Publishers (P) Ltd, 41-49.
9. Marshman, Z., Morgan, A., Porritt, J., Gupta, E., Baker, S., Creswell, C., Newton, T., Stevens, K., Williams, C., Prasad, S., Kirby, J., Rodd, H. (2016). Protocol for a Feasibility Study of a Self-Help Cognitive Behavioural Therapy Resource for the Reduction of Dental Anxiety in Young People. *Pilot and Feasibility Studies*, 2(1).
10. Pathak, P.D., Lakade, L.S., Patil, K.V., Shah, P.P., Patel, A.R., Davalbhakta, R.N. (2023). Clinical Evaluation of Feasibility and Effectiveness Using a Virtual Reality Device during Local Anesthesia and Extractions in Pediatric Patients. *European Archives of Paediatric Dentistry*, 24(3), 379-386.
11. Rosa, A., Pujia, A.M., Docimo, R., Arcuri, C. (2023). Managing Dental Phobia in Children with the Use of Virtual Reality: A Systematic Review of the Current Literature. *Children*, vol. 10(11). Multidisciplinary Digital Publishing Institute (MDPI).
12. Sun, I.G., Chu, C.H., Lo, E.C.M., Duangthip, D. (2024). Global Prevalence of Early Childhood Dental Fear and Anxiety: A Systematic Review and Meta-Analysis. *Journal of Dentistry*, 142, 104841.
13. Yan, X., Yan, Y., Cao, M., Xie, W., O'Connor, S., Lee, J.J., Ho, M.H. (2023). Effectiveness of Virtual Reality Distraction Interventions to Reduce Dental Anxiety in Paediatric Patients: A Systematic Review and Meta-Analysis. *Journal of Dentistry*, vol. 132. Elsevier Ltd.
14. Yıldırım, B.G., Gerçeker, G.Ö. (2023). The Effect of Virtual Reality and Buzzy on First Insertion Success, Procedure-Related Fear, Anxiety, and Pain in Children during Intravenous Insertion in the Pediatric Emergency Unit: A Randomized Controlled Trial. *Journal of Emergency Nursing*, 49(1), 62-74.

15. Zaidman, L., Lusky, G., Shmueli, A., Halperson, E., Moskovitz, M., Ram, D., Fux-Noy, A. (2023). Distraction With Virtual Reality Goggles in Paediatric Dental Treatment: A Randomised Controlled Trial. *International Dental Journal*, 73(1), 108-113.
16. Zhao, N., Fan, L., Zeng, J., Ran, L., Zhang, C., Wang, J., Yu, C. (2023). Virtual Reality in Managing Dental Pain and Anxiety: A Comprehensive Review. *Frontiers in Medicine*, vol. 10. Frontiers Media SA.

INTER-ORGANIZATIONAL COOPERATION IN THE INNOVATIVE ACTIVITIES OF INDUSTRIAL ENTERPRISES IN POLAND – IN THE CONTEXT OF OPEN INNOVATION

Danuta ROJEK

Warsaw University of Technology, Faculty of Management; Danuta.Rojek@pw.edu.pl,
ORCID: 0000-0002-7390-9341

Purpose: Inter-organizational cooperation of industrial enterprises aligns with the assumptions of the Open Innovation paradigm. The study aims to identify and assess the structure of partners in inter-organizational cooperation within the innovative activities of industrial enterprises in Poland in 2016-2024, and to identify key partner groups in innovative processes.

Design/methodology/approach: The analysis was based on literature review and examination of selected secondary research findings. The basic research method is desk research, i.e. the analysis of existing documents.

Findings: Based on the analysis of the structure of partners involved in inter-organizational cooperation of industrial enterprises in 2016-2024, a group of dominant partners in this period was identified, and the role of universities in this structure was determined. The findings also revealed a shift in the partner group structure starting in 2017-2019.

Research limitations/ implications: A limitation of the study is the exclusion of industrial micro-enterprises, as well as the specificity of the desk research method.

Practical implications: The results of the study indicate that managers should focus on management factors supporting the intensification of inter-organizational cooperation, including the patterns of cooperation with universities.

Social implications: The implementation of recommendations by managers should have a positive impact on the development of inter-organizational cooperation in innovative activities.

Originality/value: The study results have significant scholarly value, highlighting the dominant patterns of cooperation between industrial enterprises in Poland and enterprises outside their own group, as well as the relatively low share of enterprises cooperating with universities in innovative activities. Recommendations aimed at increasing the scale of cooperation in coupled Open Innovation processes were formulated.

Keywords: Open Innovation, cooperation, industrial enterprises.

Category of the paper: general review; research paper.

1. Introduction

Poland has consistently ranked among the lowest-performing European Union (EU) member states in terms of innovation. In the 2025 European Innovation Scoreboard (EIS) Poland was classified as an ‘emerging innovator’, ranking 23rd among 27 countries (European Commission, 2025). The EIS ranking takes into account a number of criteria, such as the “innovators” indicator, which reflects the outcomes of firms’ innovative activities in terms of introducing product and business process innovations. One factor supporting the effectiveness of innovative activities is inter-organizational cooperation, recognized as one of the basic dimensions of innovative activity of enterprises (OECD/Eurostat, 2018). Enterprises are increasingly moving away from the traditional closed innovation model, based solely on their own research and development resources, towards knowledge flows between organizations, which is in line with the popular Open Innovation paradigm.

The present study focuses on inter-organizational cooperation in the innovative activity of industrial enterprises in Poland. The group of industrial enterprises was selected because of the EU's strategic assumption that industry plays a key role in the ongoing ecological and digital transformation (European Council, 2026). Consequently, in order to maintain the innovation activity and face the digitalization and sustainability challenges associated with the new regulatory framework, companies need to collaborate (Peiró-Signes et al., 2024).

The following research questions were posed: which inter-organizational cooperation partners dominate in the innovative activities of industrial enterprises in Poland in the period 2016-2024? What is the role of universities within the structure of partners involved in this cooperation? Has the structure of partners in this cooperation changed in the analyzed period?

The study aims to identify and assess the structure of partners in inter-organizational cooperation in the innovative activities of industrial enterprises in Poland in 2016-2024, and to determine which groups of partners play a key role.

The considerations and analyses were based on literature review and examination of selected secondary research findings. The basic research method is desk research. The study utilizes the results of selected secondary research published by Statistics Poland.

In the process of pursuing the study’s stated objectives the author presented the Open Innovation paradigm, the concept of innovative activity of enterprises, and various aspects of inter-organizational cooperation.

2. The Open Innovation paradigm

The Open Innovation (OI) paradigm aims to open up innovation processes implemented within the organization, with the goal of increasing the innovation and competitiveness of enterprises. The paradigm is based on the assumption that in their innovative activities enterprises should not rely solely on their own knowledge resources, but should also take advantage of external resources. Henry Chesbrough, the creator of the Open Innovation concept, defines it as:

- the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation (Chesbrough, 2006).
- a distributed innovation process based on purposefully managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model (Chesbrough, Bogers, 2014).

The open innovation model distinguishes three basic open innovation processes: **centripetal, centrifugal and coupled** (Gassmann, Enkel, 2004). The centripetal process (inbound flow) is one where knowledge flows to the enterprise from other enterprises, suppliers, customers, users, as well as from universities and research units. The centrifugal process (outbound flow) is one where knowledge flows to the external environment from the enterprise, which consciously shares its solutions with other organizations. Coupled processes are based on the enterprise's **cooperation** with other organizations, including collaboration implemented within business associations, alliances, innovation networks, combining centripetal and centrifugal processes (Bigliardi, Galati, 2016). The author of the OI concept emphasizes that open innovation requires **collaboration** among distributed but interdependent actors who rely on each other's capabilities in value co-creation and value capture (Chesbrough et al., 2018). Although there are several definitions of open innovation, they all emphasize the importance of developing relationships and **collaboration** in order to create something new with the resources at hand (Arvaniti et al., 2022).

The adoption of the OI concept as a model of interactive innovation management in an enterprise should lead to an increase in its innovativeness, understood as the ability to systematically create and implement innovations, as well as absorb innovations. By sharing resources and collaborating with external partners, enterprises can develop their capabilities, take full advantage of patents and Intellectual Property, as well as reduce the risks and costs of innovation (Hong et al., 2019). However, researchers also emphasize that „collaborating with an external partner entails managerial complexities and additional challenges, that can lead to OI failures” (Cricelli et al., 2023). Among other things, analysts draw attention to partners' concerns resulting from lack of experience in technology transfer, possible conflicts concerning intellectual property rights, or difficulties in managing relationships. Eliminating these

limitations is therefore a challenge for managers basing innovation management on the concept of OI, while also including efforts to protect the sources of their own competitive advantage.

The development of digital technologies is driving a transformation of classic Open Innovation models into dynamic innovation ecosystems that integrate enterprises, academic institutions, technology suppliers, end users, and other stakeholders. Digital ecosystems use advanced technologies such as artificial intelligence, the Internet of Things (IoT), and blockchain to redefine traditional value chains.

A key role in these ecosystems is played by digital collaborative platforms that coordinate innovation processes, constituting “the main symbiotic interface for value co-creation within the innovation ecosystem” (Xing et al., 2024, p. 4). These platforms, “powered by deep technologies such as AI and IoT, promote transparency and collaboration across industrial actors” (Barile et al., 2026, p. 11).

Contemporary research focuses on data-driven innovation ecosystems and networks. In these models, data serves as the direct foundation of the innovation process (Rizk et al., 2022).

The latest international research shifts the focus towards complex structures in which industrial enterprises operate within multilateral cooperation networks (Türkcan, İnce Yenilmez, 2025). In this approach, the multi-directional flow of knowledge evolves towards a culture of co-creation, based on enhanced creativity and the use of collective intelligence.

3. Cooperation in the innovative activities of enterprises

Innovation activities include “all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm” (OECD/Eurostat, Oslo Manual, 2018, p. 68). Companies can use the results of this activity solely for their own benefit or they can share the results with other organizations.

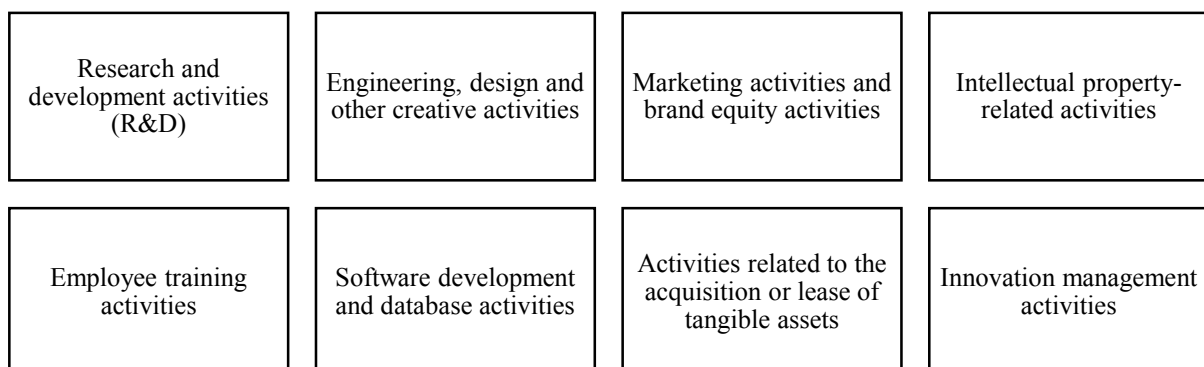


Figure 1. Areas of innovative activities of enterprises.

Source: OECD/Eurostat, Oslo Manual 2018.

The Oslo Manual indicates eight types of activities that can be undertaken by firms in pursuit of innovation (Figure 1), either independently or in cooperation with other entities. Inter-organizational cooperation, which is consistent with the assumptions of the *Open Innovation* concept, is a desirable element of industrial enterprises' innovative activity. Contemporary researchers emphasize that it enables enterprises to create value and support innovation, which provides benefits through the pooling of resources, sharing risks and facilitating access to diverse specialized knowledge (Ozdemir et al., 2023). Collaboration requires coordinated efforts of different parties, aimed at solving a jointly defined problem, with the participation of all partners; it may involve formal agreements on the sharing of inputs, risks and potential benefits (OECD/Eurostat, Oslo Manual, 2018). The partners in inter-organizational cooperation pursued as part of firms' innovative activities include organizations from various sectors. The classification of partners is based on the **quadruple helix model**, promoting the inclusion of business, academic, public administration and social organizations in cooperation with enterprises (Cai, Lattu, 2022).

Forms of this cooperation include alliances, consortia, joint ventures and other partnership forms, including cluster organizations. In alliances and consortia, companies participate with other organizations in joint activities or pool their resources to achieve a common goal. Participants retain their separate legal status while agreements set out the rights and obligations of each participant. Consortia based on contractual relationships between participants do not need to be registered. Joint ventures arise when at least two enterprises invest equity capital in the creation of a third company, which is their joint property, and into which they can also bring their intellectual property rights.

4. Benefits of inter-organizational cooperation in innovative activities

Cooperation with partners is recognized as a factor that enhances the outcomes of innovative activities, provides a competitive advantage, and sustains the firm's growth and development (Acs et al., 2016; Franco, Haase, 2015). The benefits of collaboration depend on its form, as well as the technical level of the collaborating companies (Poznańska, 2016). Aspects of inter-organizational cooperation in the innovative activities of enterprises have been the subject of research efforts undertaken in recent years. For example, surveys and interviews conducted in 2013-2015 on a sample of 24 enterprises led to the following conclusions (Pałucha, 2016):

- the main objectives of cooperation in innovative activities included improving the quality of manufactured products and services, reducing costs, introducing new products to production and onto the market, building a strong competitive position,

- about 60% of the respondents pointed out that ongoing innovative collaboration allowed for the creation and implementation of new products that were the result of cooperation between enterprises themselves as well as enterprises' cooperation with R&D entities.

Moreover, the results of research conducted on a purposively selected sample of 48 enterprises from all over Poland, with a time range covering the years 2014-2016, basically confirmed the positive impact of inter-organizational cooperation on the outcomes of the surveyed enterprises' innovation activities. This research showed a statistically significant relationship between the degree of diversification of firms' external links and the level of novelty of innovations introduced, as well as between the number of links with external entities and the number of innovations introduced (Wściubiak, 2018).

The author's own research, carried out in 2014-2015 on a purposive sample of 180 innovative small and medium-sized industrial enterprises, aimed to determine the strategic factors of enterprise innovativeness. Using factor analysis and structural equation modeling it was shown that in the area of strategic organizational factors, the factor with the most significant positive impact on innovativeness of enterprises is "enterprise's active external cooperation" (Rojek, 2018).

It is worth noting the results of surveys of Turkish enterprises (N = 5863) conducted in the years 2006-2008. Researchers confirmed the benefits of inter-organizational cooperation, but pointed to the existence of optimal levels of breadth for both innovation objectives and cooperation in innovative activities (Temel et al., 2023).

5. Methods

The study aims to identify and assess the composition of partners in inter-organizational cooperation within the innovative activities of industrial enterprises in Poland in 2016-2024, and to determine which groups of partners are of primary importance.

The analyses are based on a comprehensive literature review and an examination of the findings of selected secondary sources. The basic research method is desk research. It is "especially useful for gaining a broad understanding of a subject, identifying trends, or gathering historical data" (Mangarin, Rodriguez, 2024, p. 849). The strengths of this research method include data accessibility and cost-effectiveness. One weakness lies in the fact that the reliability of secondary data cannot always be verified (Bednarowska, 2015). The use of the desk research method made it possible to conduct a long-term analysis of the structure of innovative cooperation partners of industrial enterprises in Poland. The author used the systematically collected, comparable statistical data from Statistics Poland, which constitute a robust foundation for analyzing trends in the area under investigation.

It should be emphasized, however, that the exclusive use of secondary statistical data is associated with certain research limitations. This data does not permit an in-depth interpretation of the quality of partner relationships or barriers to cooperation within the Open Innovation model. The lack of triangulation with qualitative methods, such as individual in-depth interviews, case studies or surveys, precludes a full explanation of the observed phenomena and the identification of factors affecting the choice of cooperation partners. The results of the analyses should be interpreted as an identification of trends and relationships occurring in inter-organizational cooperation of industrial enterprises.

The author's analyses are based on literature review and an examination of the findings of selected secondary research. The basic research method is desk research. The analysis of aspects of inter-organizational cooperation in innovative activities relates to industrial enterprises in Poland, and in particular to innovation-active enterprises within that broader group. The research uses the results of cyclical surveys conducted by Statistics Poland, in particular those included in reports on innovative activities of enterprises in Poland. These surveys cover all medium-sized and large enterprises and 25% of small enterprises, excluding micro-enterprises. The survey results concerning the percentage of industrial enterprises cooperating in innovative activities, broken down by type of partner, are available in publications of Statistics Poland starting from the period 2016-2018. Therefore, the time range of the study covers the years 2016-2024.

For the purposes of surveys conducted by Statistics Poland, cooperation in innovative activities was defined as “active participation in joint projects with other enterprises or non-commercial institutions”, which does not include “ordering works from external contractors, without active participation in their implementation” (Statistics Poland, 2025, p. 79). The above definition of cooperation, referred to as “inter-organizational cooperation”, was adopted for the purposes of the present study.

Table 1.

Partners of inter-organizational cooperation in the innovative activities of enterprises

Partners of inter-organizational cooperation in the innovative activities of enterprises
Enterprises belonging to the same group of enterprises ¹
Enterprises outside the same group of enterprises, including: consulting companies (consultants), commercial laboratories, private research institutes and universities, suppliers of equipment, materials, components or software, customers, competitors, other enterprises
Universities
Public research institutes (including research institutes of the Polish Academy of Sciences)
Public sector entities (national and local government administration bodies, i.e. public offices, organizations, agencies, public schools and educational entities, health care facilities and other entities providing public services)
Non-profit organizations

Source: Statistics Poland, 2025.

¹ A group of enterprises means enterprises that are legally independent, but are economically interdependent due to links existing between them in terms of corporate control and/or ownership. (Statistics Poland, 2026).

As part of the study of inter-organizational cooperation in the innovative activities of industrial enterprises, partner organizations were categorized into groups (Table 1).

The findings were obtained using structure analysis, comparison of average values in the period 2016-2024 and assessment of changes over time.

6. Inter-organizational cooperation in the innovative activities of industrial enterprises in Poland: Results of a desk research study

Figure 2 presents the share of industrial enterprises that collaborated in innovative activities in individual years of the period 2016-2024, relative to the total number of industrial enterprises in Poland. This share reached 9.7% in 2024, marking an increase from the previous year (9.1%). This was the highest value recorded during the entire study period.

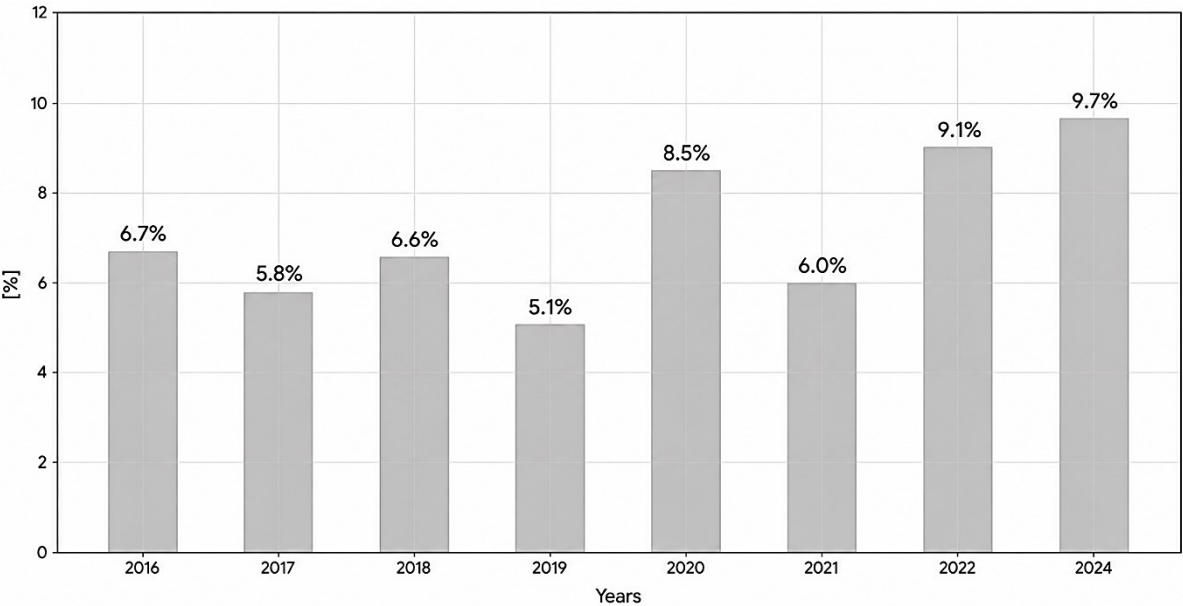


Figure 2. Industrial enterprises in Poland that cooperated in innovative activities (as % of total number of industrial enterprises).

Source: Statistics Poland, Local Data Bank.

Table 2 shows the data on the share of cooperating enterprises in the group of innovation-active industrial enterprises. Over the course of the entire analyzed period, i.e. from 2016 to 2024, this share first fluctuated around 25% in 2016-2018, and subsequently decreased. Starting from 2020, this share followed an upward trend, and reached 26.5% in the last analyzed period of 2022-2024. The 1.8-percentage points increase compared with the previous period represents a favorable shift (Table 2).

Table 2.

Innovative industrial enterprises in Poland that cooperated in innovative activities – percentage share

Period	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022	2022-2024
Percentage share	25.4	23.4	23.6	22.7	24.7	26.5

Share – relative to the total number of innovative industrial enterprises [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

The size of the enterprise undertaking inter-organizational cooperation is also of importance. In the years 2022-2024, the share of large innovation-active industrial enterprises that cooperated with entities from their environment in innovative activities was 51.1%. The percentage of small and medium-sized innovation-active industrial enterprises involved in such cooperation was lower and amounted to 19.4% and 29.4%, respectively (Statistics Poland, 2025). There was an increase in these shares compared to the previous period.

When it comes to the groups of partners that dominated in the inter-organizational cooperation of the surveyed enterprises in the period 2016-2024, the analysis of the data shown in Table 3 leads to the conclusion that **enterprises from outside a firm's own enterprise group** are – according to the results of cyclical surveys – the dominant group of cooperation partners of innovation-active industrial enterprises, starting from the years 2017-2019.

Table 3.

Innovation-active industrial enterprises that cooperated in innovative activities with individual organizations in 2016-2024 – structure [%]

Entity involved in inter-organizational cooperation	Period					
	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022	2022-2024
Enterprises outside the firm's own enterprise group	22.5	67.6	67.4	70.6	71.8	73.4
Universities	47.7	55.6	39.1	50.5	38.7	33.5
Public research institutes	33.8	33.2	25.6	31.3	25.7	20.8
Enterprises belonging to the firm's own enterprise group	31.4	29.5	34.9	29.5	17.0	16.8
Public sector entities	11.9	10.7	8.6	11.0	10.4	9.1
Non-profit organizations	5.8	5.8	4.8	5.7	6.6	6.7

Share - relative to all innovation-active industrial enterprises that cooperated in innovative activities with partners headquartered in Poland [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

Shares of firms involved in cooperation with partners from outside their own enterprise group, with headquarters in Poland, fluctuate around 70% in the period 2017-2022, with an upward trend starting from 2019. These values systematically increase, reaching 73.4% in the last reviewed period, i.e. in the years 2022-2024.

Starting from the period 2017-2019, **universities** have ranked second among partners in cooperation undertaken by innovative industrial enterprises in Poland. The percentage share in this case ranges from 55.6% to 33.5%, as recorded in the last studied period, reflecting a downward trend in recent years.

However, back in 2016-2018 – in light of the results of secondary research – universities were the dominant group of cooperation partners of industrial enterprises (accounting for 47.7% of responses), ahead of public research institutes (33.8%) and enterprises belonging to a firm's own enterprise group (31.4%). Enterprises outside the firm's own enterprise group only ranked fourth in the period 2016-2018, with a share of 22.5% (Table 3).

The shares of innovation-active industrial enterprises that cooperated with enterprises from outside their own group are shown below, along with an indication of entities with headquarters located outside Poland. The cooperation partners among these entities were primarily enterprises based in the EU and EFTA countries (Table 4).

Table 4.

Innovation-active industrial enterprises that cooperated in innovative activities with enterprises outside their own group in 2016-2024 - share [%]

Period	Country of the cooperating entity's headquarters		
	Poland	EU and EFTA countries	Other countries
2022-2024	73.4	28.1	10.3
2020-2022	71.8	28.0	12.2
2019-2021	70.6	31.2	14.4
2018-2020	67.4	27.1	10.7
2017-2019	67.6	34.6	14.6
2016-2018	22.5	6.7	2.6

Share – relative to the total number of innovation-active industrial enterprises that cooperated in innovative activities [%].

Source: own compilation on the basis of: Statistics Poland, 2025; 2022; 2021; 2020; 2019.

Detailed data on the recently examined period, i.e. 2022-2024, regarding partners in inter-organizational cooperation of industrial enterprises in Poland, including the country of the collaborating entity's headquarters, is presented in Table 5. The results of the latest research, on the period 2022-2024, show that innovation-active industrial enterprises most often cooperated with enterprises outside their own group of enterprises, with headquarters located in Poland (73.4%), in the EU and EFTA countries (28.1%), and in other countries (10.3%). The second most frequent cooperation partners were universities – mainly based in Poland (33.5%). The third most frequent cooperation partners were public research institutes in Poland (20.8% of responses), followed by enterprises from the company's own group (16.8%). In 2022-2024, public sector entities and non-profit organizations were identified as cooperation partners by 9.1% and 6.7% of the surveyed enterprises, respectively.

Table 5.

Innovation-active industrial enterprises that cooperated in innovative activities with individual organizations in 2022-2024 – structure [%]

Entity involved in inter-organizational cooperation	Country of the cooperating entity's headquarters		
	Poland	EU and EFTA countries	Other countries
Enterprises outside the firm's own enterprise group	73.4	28.1	10.3
Universities	33.5	3.1	0.5
Public research institutes	20.8	2.2	0.2

Cont. table 5.

Enterprises belonging to the firm's own enterprises group	16.8	18.5	6.0
Public sector entities	9.1	0.5	0.3
Non-profit organizations	6.7	0.7	0.4

Share – relative to the total number of innovation-active industrial enterprises that cooperated in innovative activities [%].

Source: own compilation on the basis of: Statistics Poland, 2025.

One limitation of the analyzes in question, based on the results of secondary research, is the exclusion of micro-enterprises, but also the sole consideration of the occurrence of inter-organizational cooperation, without taking into account its scope and intensity.

7. Discussion

An assessment of the state of inter-organizational cooperation in the innovative activities of industrial enterprises in Poland – carried out in the study using the desk research method, based on an analysis of the results of cyclical surveys of Statistics Poland² – shows that in the period 2022-2024, more than a quarter of the surveyed enterprises (26.5%) engaged in inter-organizational cooperation. Over the entire study period of 2016-2024, the share of cooperating enterprises initially fluctuated around 25% in the years 2016-2018, and then decreased, but subsequently exhibited an upward trend in recent years, marking a favorable shift.

In response to research questions concerning the period 2016-2024, it was determined that in the group of innovation-active industrial enterprises cooperating in innovative activities, the dominant cooperation partners are **enterprises from outside the firm's own enterprise group**, with headquarters in Poland. This trend has continued since 2017-2019, with the percentage share of this category of partners increasing annually and exceeding 73% in the years 2022-2024.

On the other hand, cooperation with **universities** in Poland, which have ranked second among cooperation partners in innovative activities starting from 2017-2019, is currently pursued by less than 34% of innovation-active industrial enterprises. In recent years, the share of this partner group has exhibited a noticeable downward trend (Figure 3).

There was a visible change in terms of the most-frequently chosen inter-organizational cooperation partners starting from 2017. The changes observed in the period of 2017-2019 have continued in subsequent years. Based on the research results it can be concluded that the structure of cooperation partners in industrial enterprises' innovative activities changed in the analyzed period.

² The surveys relate to all large enterprises and to 25% of SMEs, and exclude micro-enterprises, which is a limitation of the analysis.

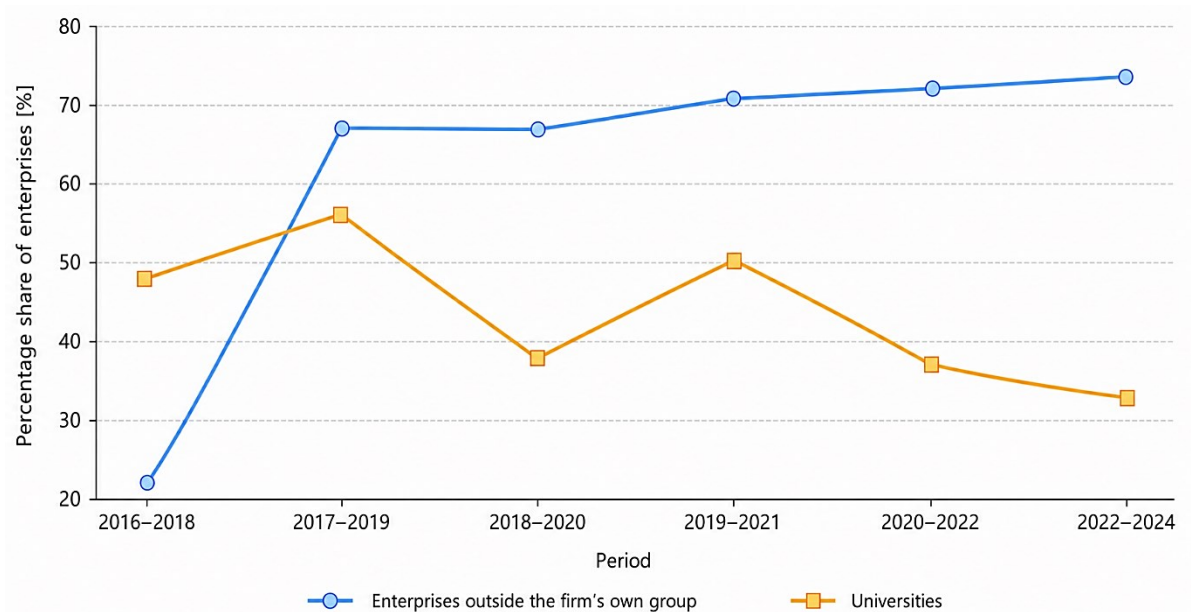


Figure 3. Industrial enterprises in Poland that cooperated in innovative activities – with selected groups of partners (as % of total number of industrial enterprises).

Source: own compilation on the basis of: Statistics Poland, 2025; 2023; 2022; 2021; 2020; 2019, using the Google Gemini application.

A noticeable change in the model of inter-organizational cooperation – towards more open market relations – may be viewed as a positive phenomenon, confirming the adoption of the Open Innovation paradigm by enterprises that cooperate with each other in the implementation of innovative projects and thus go beyond the boundaries of their own enterprise group. The results of the research and analyses provide a basis for further exploration of factors supporting continued increases in industrial enterprises' cooperation with market partners, in particular with universities, in the area of innovative activities.

On the other hand, the decreasing role of universities, whose share declined from 55.6% in 2017-2019 to 33.5% in 2022-2024, despite the theoretical emphasis on knowledge transfer and Open Innovation ecosystems, necessitates further investigation. The decline in the importance of universities as partners of inter-organizational cooperation of industrial enterprises regarding innovative activities may indicate that the academic sector has not sufficiently aligned its research output with the current needs of enterprises operating in the conditions of dynamic technological transformation. Enterprises may prefer to collaborate with partners that provide faster access to practical expertise and greater organizational flexibility, such as technology suppliers or consulting companies. The observed trend may also be a consequence of institutional barriers and the limited effectiveness of mechanisms for the commercialization of the results of scientific research.

8. Conclusions

Developing mechanisms to foster inter-organizational cooperation in the innovative activities of industrial enterprises remains a persistent challenge for both researchers and managers interested in increasing the innovativeness of managed enterprises.

From the point of view of the enterprise, the key element is managers' involvement in initiating and implementing inter-organizational cooperation with enterprises, supplemented by greater use of the potential offered by universities and other partners within the framework of the open innovation system. A strategic approach to innovation management, based on the Open Innovation concept, is recommended.

Researchers emphasize that understanding the goals, scope and levels of cooperation supports managerial decision-making in the practice of cooperation for innovation (Temel et al., 2023). One important aspect is the careful selection of partners from among the available options. According to researchers (Chrupała-Pniak et al., 2017; Fujiwara, Watanabe, 2017), this requires assessments based on various criteria, in order to ensure the potential partner is able to provide the firm with economic, cultural, socio-psychological benefits (trust, honesty and responsibility of the partner).

One factor crucial for increased inter-organizational cooperation is the development of **managerial competences**, including both negotiation skills in Open Innovation processes (Barchi, Greco, 2018) and organizational skills needed to effectively solve possible problems resulting from the implementation of open innovation, without disrupting the functioning of the organization (Lam et al., 2021). Cooperation involves the joint performance of tasks among partners and striving to achieve mutual benefits, but such actions require the **trust** and commitment of collaborating partners (Li et al., 2017). This increases the importance of fostering an **organizational culture** that supports not only the aforementioned processes of selecting partners or negotiations, but also the important of creating a climate that facilitates cooperation and mutual trust among partners from different backgrounds.

In the era of digital transformation, it is important to adopt an innovative approach to the way inter-organizational cooperation is organized. For example, it is worth establishing a platform on which partners will cooperate (Jun, Kim, 2022). Inter-organizational cooperation should therefore be actively supported by solutions associated with the concept of Industry 4.0, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics or cyber-physical systems. Analysts recommend that in order to enhance firms' innovation effectiveness through OI practices, policies should be implemented to support firms in developing internal capabilities for processing data that arise from adopting Industry 4.0 technologies and exchanging such data with external parties (Kim, Park, 2024).

The results of the analyses presented in the study, indicating high and growing activity of industrial enterprises in cooperation with entities outside their own group and a simultaneous decline in cooperation with universities, shed new light on the determinants of digital transformation. The implementation of key technologies of Industry 4.0 naturally ties into the logic of Open Innovation, according to which enterprises deliberately cross organizational boundaries in order to acquire external knowledge and technological resources. This trend may indicate a shift towards deployment-oriented partnerships, aimed at rapid and scalable implementation of AI-based solutions, process automation, advanced robotics, or real-time data architecture. The IoT and Big Data technologies further strengthen these processes, increasing the importance of ongoing data exchange in value chains and requiring the integration of information sources within coherent digital ecosystems. In this approach, cooperation with specialized technology suppliers serves as a key element of open innovation ecosystems, which are typical for Industry 4.0.

At the same time, the rapid evolution of digital technologies and the pressure for swift market implementation (time-to-market) may explain why the share of cooperation between industrial enterprises and universities is almost 50% lower and continues to decline. In the context of Industry 4.0, traditional research and development cycles of academic entities may be perceived as less flexible compared to the ready-made, commercial digital ecosystems offered by enterprises from the high-tech sector. In this context, researchers point out that “engagement between scholars and managers remains ad hoc, such that much of the scholarship in OI is unknown to the managers, while many new management practices are not well known by academics” (Radziwon et al., 2024, p. 20).

One important element of this transformation, especially in the context of building innovation capabilities, is **cooperation with universities**. These entities possess current scientific knowledge, along with research and development facilities, which is why their active inclusion in cooperation in the area of innovative activities promotes knowledge transfer and efficient implementation of innovative solutions in business practice. This means that although universities do not constitute the dominant group in the quantitative structure of innovative cooperation partners of industrial enterprises in Poland, they can become a key partner in qualitative terms.

One major challenge is the development of systemic support mechanisms for greater participation of universities in the innovation ecosystem – both through appropriate financing mechanisms and the establishment of cooperation platforms and incentives for both sides of cooperation. The author’s recommendations include, among other things, establishing rules for the distribution of European funds for the economy in such a way as to mobilize enterprises participating in the grant competitions to utilize the obtained funds in inter-organizational cooperation with universities, as part of innovative activities.

It should be emphasized that the presented interpretations result from the analysis of the observed trends in the area of inter-organizational cooperation of industrial enterprises, rather than a direct measurement of the impact of individual technologies on the composition of cooperation partners. The applied desk research methodology yielded an analysis that serves as a foundation for future primary research in the analyzed problem area.

These findings provide a baseline for continued exploration of factors conducive to further strengthening of industrial enterprises' cooperation with market partners, in particular with universities, in the field of innovative activities, especially in the context of technology transfer, implementation projects and development of expertise in the era of Industry 4.0.

9. Summary

The article examines the cooperation of industrial enterprises in the context of the Open Innovation paradigm, focusing on the identification and analysis of the structure of cooperation partner groups of industrial enterprises in Poland in innovative activities in the years 2016-2024. The author bases the analysis on literature review and examination of secondary research findings, with particular emphasis on the available Statistics Poland research on the innovative activity of enterprises. Based on the analysis of the research results, it was found that in the structure of partners involved in inter-organizational cooperation in innovative activities of industrial enterprises in 2017-2024, enterprises from outside firms' own capital group dominate, while cooperation with universities occurs less frequently. This status has been observed since 2017-2019, while in the period 2016-2018 universities were the dominant group of cooperation partners. The article concludes with practical recommendations for managers with regard to factors supporting inter-organizational cooperation and calls for wider utilization of instruments available as part of funding programs that could stimulate cooperation with universities.

References

1. Acs, Z.J., Audretsch, D.B., Lehmann, E.E., Licht, G. (2016). National systems of entrepreneurship. *Small Business Economics*, Vol. 46(4), pp. 527-535. DOI: 10.1007/s11187-016-9705-1
2. Arvaniti, E.N., Dima, A., Stylios, C.D., Papadakis, V.G. (2022). A New Step-by-Step Model for Implementing Open Innovation. *Sustainability*, Vol. 14(10), 6017. Retrieved from: <https://doi.org/10.3390/su14106017>, 29.04.2026.

3. Barchi, M., Greco, M. (2018). Negotiation in Open Innovation: A Literature Review. *Group Decis Negot*, Vol. 27, pp. 343-374. DOI:10.1007/s10726-018-9568-8
4. Barile, D., Secundo, G. (2026). Digital innovation ecosystem: a systematic mapping to understand how digital technologies are transforming innovation ecosystem. *Technovation*, Vol. 155. DOI: 10.1016/j.technovation.2026.103573
5. Bednarowska, Z. (2015). Desk research - wykorzystanie potencjału danych zastanych w prowadzeniu badań marketingowych i społecznych [Desk Research - Exploiting the Potential of Secondary Data in Market and Social Research]. *Marketing i Rynek*, No. 7, pp. 18-26.
6. Bigliardi, B., Galati, F. (2016). Which factors hinder the adoption of open innovation in SMEs? *Technology Analysis & Strategic Management*, Vol. 28(8), pp. 869-885. DOI:10.1080/09537325.2016.1180353
7. Cai, Y., Lattu, A. (2022). Triple Helix or Quadruple Helix: Which Model of Innovation to Choose for Empirical Studies? *Minerva*, Vol. 60, pp. 257-280. Retrieved from: <https://link.springer.com/article/10.1007/s11024-021-09453-6>, 29.04.2026.
8. Chesbrough, H. (2006). Open innovation: A new paradigm for understanding industrial innovation. In: H. Chesbrough, W. Vanhaverbeke, J. West (eds.), *Open innovation: Researching a new paradigm*. Oxford: Oxford University Press, pp. 1-12.
9. Chesbrough, H., Bogers, M. (2014). Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation. In: H. Chesbrough, W. Vanhaverbeke, J. West (eds.), *New Frontiers in Open Innovation*. Oxford: Oxford University Press, pp. 3-28.
10. Chesbrough, H., Lettl, C., Ritter, T. (2018). Value Creation and Value Capture in Open Innovation. *Journal of Product Innovation Management*, 2018, Vol. 35(6), pp. 930-938. Retrieved from: <https://doi.org/10.1111/jpim.12471>, 25.04.2026.
11. Chrupała-Pniak, M., Grabowski, D., Sulimowska-Formowicz, M. (2017). Trust in effective international business cooperation: mediating effect of work engagement. *Entrepreneurial Business and Economics Review*, Vol. 5(2), pp. 27-50. Retrieved from: <https://eber.uek.krakow.pl/eber/article/view/238>, 20.04.2026.
12. Cricelli, L., Mauriello, R., Strazzullo, S. (2023). Preventing open innovation failures: A managerial framework. *Technovation, Elsevier*, Vol. 127(C), pp. 1-16. DOI: 10.1016/j.technovation.2023.102833.
13. European Commission (2025). *European Innovation Scoreboard 2025*. Publications Office of the European Union 2025. Retrieved from: https://ec.europa.eu/assets/rtd/eis/2025/ec_rtd_eis-country-profile-pl.pdf, 20.03.2026.
14. European Council (2026). *Council of the European Union, EU industrial policy*. Retrieved from: <https://www.consilium.europa.eu/en/policies/eu-industrial-policy/>, 20.04.2026.
15. Franco, M., Haase, H. (2015). Interfirm alliances: a taxonomy for SMEs. *Long Range Planning*, Vol. 48(3), pp. 168-181. Retrieved from: <https://doi.org/10.1016/j.lrp.2013.08.007>, 30.04.2026.

16. Fujiwara, A., Watanabe, T. (2017). Knowledge management using external knowledge. *International Journal of Innovation Management*, Vol. 21(4), pp. 1-16. DOI: 10.1142/S1363919617500311.
17. Gassmann, O., Enkel, E. (2004). *Towards a Theory of Open Innovation: Three Core Process Archetypes*, R&D Management Conference (RADMA), Lissabon 2004. Retrieved from: https://www.academia.edu/29990890/Towards_a_theory_of_open_innovation_three_core_process_archetypes, 20.04.2026.
18. GUS (Statistics Poland) (2026). *Pojęcia stosowane w statystyce publicznej*. Retrieved from: <https://stat.gov.pl/metainformacje/slownik-pojec/pojecia-stosowane-w-statystyce-publicznej/1740,pojecie.html>, 01.05.2026.
19. GUS, BDL (2026). Bank Danych Lokalnych, *Działalność innowacyjna*. Retrieved from: <https://bdl.stat.gov.pl/bdl/dane/podgrup/temat>, 25.06.2026.
20. Hong, J.F.L., Zhao, X., Stanley Snell, R. (2019). Collaborative-based HRM practices and open innovation: a conceptual review. *Human Resource Management.*, Vol. 30, pp. 31-62. Retrieved from: <https://doi.org/10.1080/09585192.2018.1511616>, 25.04.2026.
21. Jun, Y., Kim, K. (2022). Developing an Open Innovation Attitude Assessment Framework for Organizations: Focusing on Open Innovation Role Perspective and Locus of Activity. *Behavioral Sciences*, Vol. 12(46). Retrieved from: <https://doi.org/10.3390/bs12020046>, 20.04.2026.
22. Kim, J.M., Park, J.-H. (2024). When is digital transformation beneficial for coupled open innovation? The contingent role of the adoption of industry 4.0 technologies. *Technovation*, Vol. 136. Retrieved from: <https://doi.org/10.1016/j.technovation.2024.103087>, 25.04.2026.
23. Lam, L., Nguyen, P., Le, N., Tran, K. (2021). The relation among organizational culture, knowledge management, and innovation capability: Its implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, Vol. 7(1), 66. Retrieved from: <https://doi.org/10.3390/joitmc7010066>, 30.04.2026.
24. Li, L., Jiang, F., Pei, Y., Jiang, N. (2017). Entrepreneurial orientation and strategic alliance success: the contingency role of relational factors. *Journal of Business Research*, Vol. 72, March, pp. 46-56. Retrieved from: <https://doi.org/10.1016/j.jbusres.2016.11.011>, 25.04.2026.
25. Mangarin, R.A., Rodriguez, K.J.T. (2024). Teaching Business Concepts Effectively: A Desk Research Approach. *International Journal of Research and Scientific Innovation (IJRSI)*, Vol. 11(9), pp. 848-859. DOI: <https://doi.org/10.51244/IJRSI.2024.1109072>
26. OECD/Eurostat (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities*. Paris/Eurostat, Luxembourg: OECD Publishing. Retrieved from: <https://doi.org/10.1787/9789264304604-en>, 01.04.2026.
27. Ozdemir, S., Carlos Fernandez de Arroyabe, J., Sena, V., Gupta, S. (2023). Stakeholder diversity and collaborative innovation: Integrating the resource-based view with

- stakeholder theory. *Journal of Business Research*, Vol. 164, Article 113955, pp. 1-16. Retrieved from: <https://doi.org/10.1016/j.jbusres.2023.113955>, 20.04.2026.
28. Pałucha, K. (2016). Współpraca przedsiębiorstw w procesie budowania ich potencjału innowacyjnego. *Zeszyty Naukowe Politechniki Śląskiej*, Vol. 93(1957), pp. 393-403. Retrieved from: <https://bibliotekanauki.pl/articles/322684>, 20.04.2026.
29. Peiró-Signes, Á., Díez-Martínez, I., Segarra-Oña, M. (2024). The drivers of cooperation for innovation and the role of environmental orientation. *Corporate Social Responsibility and Environmental Management*, Vol. 31(4), pp. 2929-2952. Retrieved from: <https://doi.org/10.1002/csr.2726>, 25.04.2026.
30. Poznańska, K. (2016). Współpraca małych i średnich przedsiębiorstw z podmiotami zewnętrznymi w zakresie innowacyjności. *Studia Ekonomiczne. Zeszyty Naukowe UE w Katowicach*, No. 280, pp. 143-156.
31. Radziwon, A., Chesbrough, H., West, J., Vanhaverbeke, W. (2024). *The Future of Open Innovation*. In: H. Chesbrough, A. Radziwon, W. Vanhaverbeke, J. West, J. (Eds.), *The Oxford Handbook of Open Innovation (Chapter 57)* (pp. 914-934). Oxford University Press. Retrieved from: <https://doi.org/10.1093/oxfordhb/9780192899798.013.57>, 20.05.2026.
32. Rizk A., Stahlbroest A., Elragal A. (2022). Data-driven innovation processes within federated networks. *European Journal of Innovation Management*, Vol. 25(6), pp. 498-526. DOI 10.1108/EJIM-05-2020-0190.
33. Rojek D. (2018). The Organizational Factors of the Innovativeness of Enterprises in a Strategic Perspective. In: K. Szczepańska-Woszczyna, Z. Dacko-Pikiewicz (eds.), *Innovation Processes in the Social Space of the Organization* (pp. 55-78). New York: Nova Science Publishers.
34. Statistics Poland (2019). *Działalność innowacyjna przedsiębiorstw w latach 2016-2018*. Warszawa/Szczecin: Statistical Office in Szczecin.
35. Statistics Poland (2020). *Działalność innowacyjna przedsiębiorstw w latach 2017-2019*. Warszawa/Szczecin: Statistical Office in Szczecin.
36. Statistics Poland (2021). *Działalność innowacyjna przedsiębiorstw w latach 2018-2020*. Warszawa/Szczecin: Statistical Office in Szczecin.
37. Statistics Poland (2022). *Działalność innowacyjna przedsiębiorstw w latach 2019-2021*. Warszawa/Szczecin: Statistical Office in Szczecin.
38. Statistics Poland (2025). *Działalność innowacyjna przedsiębiorstw w latach 2020-2024*. Warszawa/Szczecin: Statistical Office in Szczecin.
39. Tartari, V., Salter, A., D'Este, P. (2012). Crossing the Rubicon: Exploring the Factors that Shape Academics Perceptions of the Barriers to Working with Industry. *Cambridge Journal of Economics*, Vol. 36, pp. 655-677.

40. Temel, S., Mention, A.-L., Yurtseven, A.E. (2023). Cooperation for innovation: more is not necessarily merrier. *European Journal of Innovation Management*, Vol. 26(2), pp. 446-474. Retrieved from: <https://doi.org/10.1108/EJIM-10-2020-0392>, 25.04.2026.
41. Türkcan, B., İnce Yenilmez, M. (2024). Open Innovation in Complex Ecosystems: Knowledge Networks and Beyond. *Bilgi Ekonomisi ve Yönetimi Dergisi*, Vol. 19(2), pp. 131-146. DOI: 10.54860/beyder.1503811
42. Wściubiak, Ł. (2018). Współpraca międzyorganizacyjna a działalność innowacyjna przedsiębiorstw produkcyjnych w Polsce. *Studia Ekonomiczne UE w Katowicach*, No. 359, pp. 162-174.
43. Xing, X., Zhu, C., Lin, Y., Liu, T. (2024). Can digital platform empowers inbound and outbound open innovation? From the perspective of the innovation ecosystem. *Humanities & Social Sciences Communications*, Vol. 11. Retrieved from: <https://doi.org/10.1057/s41599-024-03523-2>, 20.05.2026.

SUCCESSION IN SMALL FAMILY ORGANIC FARMS IN POLAND – CONDITIONS AND BARRIERS

Paweł SIEMASZKIEWICZ

University of Łódź, Faculty of Management; pawel.siemaszkiwicz@uni.lodz.pl,
ORCID: 0000-0002-5733-2474

Purpose: The purpose of this article is to present the results of research on the determinants of succession in small family farms engaged in organic production in Poland. Particular attention is given to identifying farm owners' attitudes toward the process of transferring the farm to the next generation.

Design/methodology/approach: The study was based on an analysis of surveys conducted among 128 small farms, as well as on in-depth individual interviews (IDIs) carried out with 15 participants. The survey questionnaire included questions regarding the age of farmers, the presence of a potential successor, willingness to transfer the farm, and the attractiveness of the farm to successors. The interview questionnaire included questions concerning the reasons for perceiving a farm as attractive and the reasons for developing farms when the goal is their transfer.

Findings: The research results indicate a clear succession problem in small organic farms in Poland, mainly resulting from the aging of farmers and the limited number of potential successors. Despite a high declared willingness to transfer farms to the next generation, only a small proportion of respondents have a clearly identified successor, which indicates a low level of actual succession planning.

Research limitations/implications: The main limitations of the study concern the relatively small number of organizations surveyed, which may limit the ability to generalize the results. Additionally, the analysis is based on subjective assessments by respondents, which may lead to some measurement errors.

Practical implications: The research results provide practical guidance for farm owners and institutions supporting agricultural development, emphasizing the importance of early and deliberate succession planning.

Originality/value: The article contributes a new, empirical perspective to the literature on succession processes in small family organic farms in Poland. It provides data on the actual identification of successors and the factors that stimulate or hinder the succession process. It also stands out by taking into account the specific characteristics of organic farms, allowing for a better understanding of the challenges and barriers to succession in the context of modern, sustainable agriculture.

Keywords: Succession, Small family farms, Strategy, Organic farming, Management.

Category of the paper: Research paper.

1. Introduction

The aim of the article is to identify the role of succession as a factor determining the development strategies of small organic farms, with particular emphasis on the impact of the lack of an identified successor on their modernization and long-term sustainability. The study tested the main hypothesis (H1) that the absence of an identified successor significantly constrains the growth orientation of the farm and the owners' propensity to invest. Two secondary hypotheses were also formulated: (H1a) in small organic farms, there is a significant discrepancy between the declared willingness to transfer the farm and the actual level of successor identification; (H1b) the presence of an identified successor significantly increases the owners' propensity to undertake investment and modernisation activities.

Empirical research was conducted using two complementary methods. In the quantitative phase, a standardized survey questionnaire was applied to a sample of 128 small organic family farms (up to 10 ha of agricultural land), selected through systematic random sampling from the IJHARS register. In the qualitative phase, 15 in-depth individual interviews (IDIs) were carried out with farm owners randomly selected from entities meeting the research criteria. Both studies were conducted in the following voivodeships: Łódź, Kuyavian-Pomeranian, Masovian, and Greater Poland.

Small family farms have long formed the foundation of Polish agriculture, combining food production with the preservation of traditions and local socio-cultural identity. In recent years, growing interest in organic products has given these farms renewed importance. They are increasingly becoming places where innovative production solutions are implemented, sustainable farming methods are tested, and added value is created in both local and national markets. At the same time, their continued operation faces numerous economic, demographic, and institutional constraints.

One of the most important issues determining the future of family farms is the process of succession, understood as the transfer of the farm to the next generation. This process includes not only the formal transfer of ownership, but also the transfer of knowledge, experience, and production and organizational practices that enable the continuation of farm operations. In the case of small organic farms, the issue of succession takes on particular significance, as it also involves maintaining organic certification, adapting to market requirements, and implementing new production and management technologies.

Effective succession planning should therefore be regarded as one of the key factors ensuring the sustainability of family farms and their ability to adapt to the changing conditions of the agricultural sector.

2. Literature review

2.1. Succession in Family Organic Farms

Family farms constitute the foundation of the agricultural system of the Republic of Poland, which is directly reflected in Article 23 of the Polish Constitution (Konstytucja, Art. 23). This provision highlights their particular importance not only in economic terms, but also in social and cultural dimensions. In practice, these farms account for approximately 99% of all agricultural holdings in Poland, forming the primary organizational structure of individual farming (Czekaj, 2016). Their role extends beyond production functions and also includes social, environmental, cultural-civilizational, and rural settlement functions. Family farms are simultaneously places where farming families live and act as repositories of intergenerational values, traditions, and cultural norms shaping the identity of rural areas (Zolotnytska, 2021).

Organic farms operate within a distinct business model compared to conventional farms. Organic production is more labor-intensive and requires substantial knowledge resources, while also obliging farmers to comply with specific environmental standards and certification systems. These farms are also more likely to rely on short supply chains, direct sales, and stronger connections with local markets. As a result, succession in such farms involves not only the transfer of assets and managerial functions, but also the transfer of specialized production knowledge and values related to sustainable farming.

A defining feature of family farms is the close link between the production unit and the household, where ownership, management, and economic responsibility remain in the hands of a single family. From a management perspective, succession in such entities is a multidimensional process burdened with a significant level of risk. It includes not only the transfer of ownership, but also the transfer of decision-making power, economic responsibility, and informal resources such as knowledge and relationships (Zajkowski, 2018; Ingram, 2023). Farm management is personal and long-term in nature, and economic decisions are strongly embedded in the family context (Soczewka et al., 2014). For this reason, ownership and managerial functions are traditionally passed from the senior generation to the junior generation, which constitutes the essence of succession. Today, this process represents one of the greatest and most important challenges faced by agricultural holdings, as its success or failure largely determines their economic viability and the sustainability of social structures in rural areas (Ślusarczyk et al., 2019).

In academic literature, succession is perceived not as a one-time legal act, but as a dynamic and multi-stage process involving the transfer of three key pillars of family farm functioning: knowledge, management, and ownership. This process should take place with respect for the values developed both by the family and by the farm itself (Fig. 1) (Lewandowska et al., 2017).

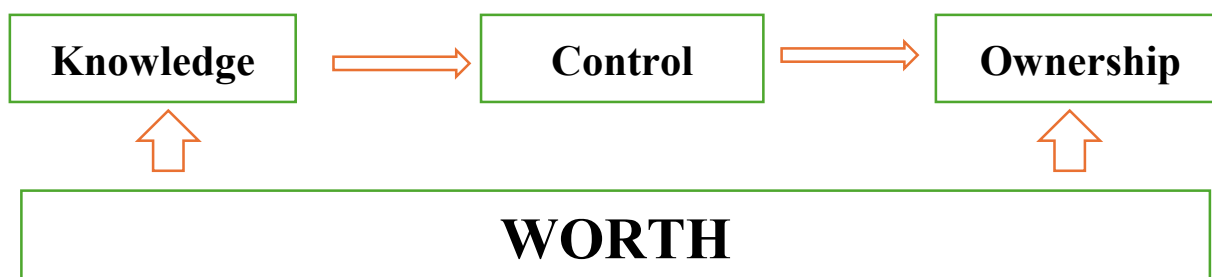


Figure 1. Succession – the transfer of knowledge, power, and ownership based on values.

Source: Own elaboration based on Lewandowska, 2015, p. 82.

The analysis of the subject literature indicates that the main areas of research on succession include planning the succession process, its course, and the identification of factors and barriers affecting the effectiveness of transferring the farm to the next generation (Szymczak, 2023; Dźwigoł-Barosz, 2018). The succession process is long-term in nature, and the succession plan is often conceptualized as a sequence of successive stages involving the gradual involvement of the successor in farm operations, the transfer of competencies, and the gradual reduction of the senior generation's professional activity (Fig. 2).

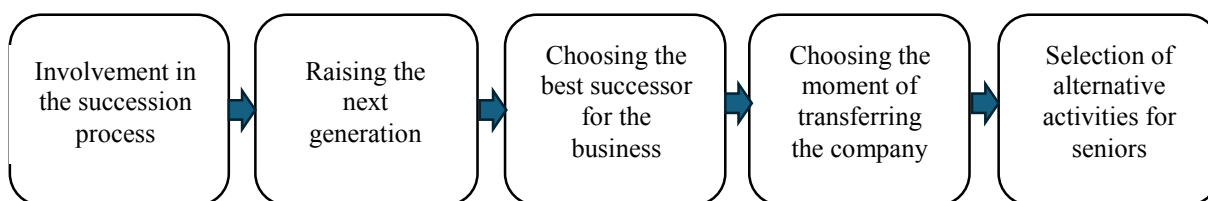


Figure 2. Elements of a succession plan in family businesses.

Source: Own elaboration based on Lewandowska, Greser, Jakubowski, 2012.

The duration of the succession process depends on the specific characteristics of the farm and the individual situation of the farming family (Polkowska et al., 2024). In many cases, this process begins at a very early stage of the successor's life, starting with education and initial involvement in basic farm work. A critical moment is the transfer of managerial functions, that is, responsibility for making strategic investment and organizational decisions. In legal terms, succession most often takes place through donation, which is associated with strong emotional ties and the obligation to care for the senior, often legally secured in the form of usufruct rights. The specific nature of agricultural holdings means that the final stage of succession is often marked by the death of the senior, as, according to the common model of farm functioning, all generations of the family are involved in agricultural activity to varying degrees. Even after the formal transfer of responsibilities, seniors frequently continue to play an advisory role, supporting the successor with their experience and informal knowledge.

The literature indicates that a properly planned succession process may take from 7 to 10 years (Lewandowska, Andrzejczak, 2017), although in some approaches it may extend to as much as 20 years or even encompass the entire lifetime of the individuals involved (Zajkowski, 2018). Assuming a scenario in which the successor begins active participation in management

after completing higher education, full responsibility for the farm is typically assumed between the ages of 30 and 35 (Czekaj, 2016). For this reason, it is recommended to initiate succession-related discussions even 10-15 years before the planned retirement of the senior (Czekaj, 2018), as sudden and unplanned transfers of authority are among the main causes of failure in family businesses (Roszko-Wójtowicz, 2016).

The succession process should be considered not only in terms of generational change, but also as an element of the long-term development strategy of the farm. Decisions made during this period influence the direction of production specialization, the structure of assets, and the willingness to undertake investment risk. In this perspective, succession becomes a critical moment for redefining the farm's objectives, its competitive position, and its ability to adapt under increasing market and regulatory pressure. A lack of coherence between the senior's vision and the successor's plans may lead to developmental stagnation, whereas a well-planned and gradual transfer of authority fosters continuity in management and supports rational strategic decision-making.

Particular importance is also attached to the transfer of intangible capital, including practical knowledge, relationships with business partners, and the farm's reputation. The younger generation represents a significant source of innovation, especially in terms of digitalization of management processes, implementation of precision agriculture technologies, and the search for new distribution channels. However, the course and outcomes of succession vary significantly depending on the farm's economic potential, its functions, and the family's sources of income, which means that there is no single universal model of generational change and that an individualized approach is necessary.

Intergenerational cooperation in family farms is often based on the concept of intermentoring, which assumes the mutual exchange of knowledge, values, and competencies between the senior and the successor (Wiktorowicz, 2020). The younger generation brings a higher level of formal education, openness to innovation, and familiarity with modern information technologies, while the older generation offers practical experience, knowledge of local market conditions, and a greater propensity for responsible financial decision-making.

The takeover of farms by young successors is one of the key factors supporting structural change and increasing the competitiveness of agriculture. Young farmers are more likely to introduce changes in management style, diversify income sources, and implement organic farming, which is perceived as an opportunity to achieve higher added value and benefit from environmental subsidies (Ślusarczyk et al., 2019). At the same time, differences in approaches to modernization may generate conflicts. Older generation farmers more frequently report communication difficulties, noting that younger individuals tend to favor exclusively modern solutions at the expense of proven methods (Ginter et al., 2016).

2.2. Factors Stimulating Succession

The decision to transfer a farm results from a combination of economic, institutional, and personal factors. A key role is played by support instruments offered under the Common Agricultural Policy, including structural pensions and premiums for young farmers. For example, under the CAP Strategic Plan 2023-2027, it is possible to obtain a “young farmer premium” of up to PLN 200,000 to start agricultural activity or modernize a farm (Baer-Nawrocka, Kiryluk-Dryjska, 2023). Family tradition and the desire to preserve the “family heritage” also remain important motivating factors (Ślusarczyk et al., 2019). Demographic and health conditions of the senior generation, as well as social insurance system requirements determining eligibility for retirement and disability benefits, are also significant (Wojewodzic, 2017).

Factors delaying generational change are economic, social, psychological, and structural in nature. These include, among others, the low profitability of small farms, the outflow of young people to urban areas, the strong attachment of seniors to land, and agrarian fragmentation, all of which significantly slow down the pace of succession (Market Research World, 2025; Florek-Łuszczki, 2023; Stępniewska, 2013).

The absence of potential successors is one of the main factors leading to the liquidation of farms. Despite systemic support, Polish agriculture is facing a growing demographic crisis. The farming population is aging—between 2010 and 2020, the average age of farmers increased by three years, and the share of individuals aged 55-64 rose from 17% to 26%. One in three small farms reported a lack of successors, which in the long-term leads to farm closure or leasing land outside the family (Dudek, 2023). However, this phenomenon is secondary to the low economic attractiveness of agriculture. Changes in the work and lifestyle model of rural populations mean that demanding labor combined with relatively low and unstable agricultural income—especially in farms with limited economic potential—is perceived as an unattractive option.

As a consequence of these conditions, the phenomenon of apparent or deferred succession has emerged (Wojewodzic, 2013). It can be described as a compromise that allows current owners to access full retirement benefits while not forcing potential successors to abandon their personal aspirations. In such cases, the beneficiary becomes a farmer (the formal owner of the farm) somewhat against their will, while the actual farm work continues to be carried out by the senior generation.

It should be emphasized that in farms with lower economic potential, owners often rely on multiple sources of income. Agricultural production and investment are frequently limited, and the farm may serve residential or investment functions (Chmielewska, Zegar, 2022). An additional factor is the persistent masculinization of agriculture, which limits women’s participation in succession processes (Dudek, 2023; Rodriguez-Lizano et al., 2020). As a result,

this leads to a reduction in family labor resources, affecting not only small but also large farms (Zegar, 2023).

Existing research on farm succession focuses primarily on conventional holdings or examines the agricultural sector as a whole, without distinguishing the specific characteristics of organic farms. While the literature does identify general barriers to succession — demographic, economic, and cultural — it largely overlooks the question of whether belonging to the organic sector, objectively regarded as promising and supported by systemic policy instruments, modifies owners' attitudes toward intergenerational transfer planning. There is also an absence of empirical studies addressing simultaneously three dimensions in relation to small farms of up to 10 hectares: the level of succession readiness, the farm's growth orientation, and the owner's subjective assessment of its attractiveness for potential successors. Existing analyses rarely operationalize the gap between declared willingness to transfer the farm and the actual identification of a successor as a distinct diagnostic variable.

3. Methods

The research procedure was divided into two complementary phases, encompassing both quantitative and qualitative approaches. In the first phase, a survey method was applied using a standardized questionnaire. The study covered a sample of 128 farms selected through systematic random sampling. The unit of analysis was a farm defined in accordance with the definition provided in the Civil Code (Dz.U. 2019, poz. 1145, art. 553). For the purposes of this study, organic production was defined in line with Council Regulation (EC) No. 834/2007 of 28 June 2007 on organic production and labeling of organic products (Dz.U. L 189 z 20.07.2007 r., art. 2 lit. a).

In the second phase of the research, the Individual In-Depth Interview (IDI) method was employed, allowing for a more detailed analysis of respondents' attitudes, motivations, and experiences related to the succession process in farms. This phase involved 15 farms selected through simple random sampling from among entities meeting the adopted research criteria.

Both stages of the study were conducted in four voivodeships: Łódzkie, Kujawsko-Pomorskie, Mazowieckie, and Wielkopolskie. Farms included in the study met the following criteria: agricultural land area not exceeding 10 hectares (Sass, 2021), engagement in certified organic production, and operation within the territory of Poland. Due to the lack of access to online contact data, both the survey and interviews were conducted through direct, face-to-face meetings with respondents.

The applied sampling frame was based on an official register of organic farms; however, it should be noted that the database did not contain information on the total area of agricultural holdings, but only on the area under organic production. To ensure consistency with the adopted research criteria, each respondent was asked to provide information on the total farm size prior to the interview. In cases where the farm did not meet the defined threshold (up to 10 hectares), the interview was discontinued.

Despite the use of a formal sampling frame and randomization procedures, the obtained research sample cannot be considered fully representative of the population of small organic farms in Poland. This limitation results primarily from difficulties in accessing respondents. Owners of small family farms often demonstrate low willingness to participate in research, which leads to non-response bias and restricts the ability to generalize findings. Additionally, the necessity of conducting the study through direct contact further constrained the pool of potential respondents, favoring individuals more open to interaction and potentially more engaged in farm management.

Another factor affecting representativeness is the lack of complete structural data in the sampling frame, which prevented full control over the distribution of key characteristics of the population, such as total farm size or economic strength. As a result, the sample may not fully reflect the heterogeneity of the population of small organic farms.

The structure of the sample indicates a dominance of farmers aged 36-55, with a relatively low share of young farmers, which reflects broader demographic trends in Polish agriculture but may also influence the observed attitudes toward succession and investment. Therefore, the results should be interpreted with caution, particularly in terms of extrapolation to the entire population.

The study is also subject to potential measurement error resulting from the use of self-reported data. Respondents' answers may be influenced by subjective perceptions, social desirability bias, and difficulties in accurately assessing future intentions, especially in relation to succession planning. This is particularly relevant for variables such as willingness to transfer the farm or perceived attractiveness for successors, which have a declarative character.

To mitigate these limitations, a mixed-methods approach was applied. The qualitative phase (IDI) served to deepen the interpretation of quantitative results and to identify underlying mechanisms shaping farmers' decisions. The triangulation of methods allowed for increasing the internal validity of the study, although it does not eliminate the limitations related to external validity.

A key element of the research design was the selection of analytical variables, which was directly guided by the identified research gap. The literature review indicates that existing studies on farm succession focus primarily on conventional farms or analyze the agricultural sector in an aggregated manner, without distinguishing the specific characteristics of organic farms. While the literature identifies general barriers to succession—demographic, economic,

and cultural—it rarely attempts to operationalize these factors in the context of small organic farms and their development strategies.

In response to this gap, three complementary analytical dimensions were adopted: the level of succession readiness, the developmental orientation of the farm, and the owner's subjective assessment of the farm's attractiveness for potential successors. Within these dimensions, key research variables were operationalized, including: identification of a successor, declared willingness to transfer the farm, propensity to undertake investments, and perceived attractiveness of the farm.

Particular importance was assigned to the variable capturing the discrepancy between the declared willingness to transfer the farm and the actual identification of a successor. In this study, this discrepancy was treated as a distinct analytical category. This approach extends existing research, in which this aspect is typically implicit or analyzed only indirectly.

Thus, the selection of variables was both theoretically grounded and exploratory in nature. On the one hand, it was based on insights derived from the literature on succession; on the other, it addressed the need to operationalize phenomena that have so far been insufficiently captured empirically, especially in relation to small organic farms.

A further methodological limitation concerns the scope of the statistical analysis. The quantitative phase of this study employs descriptive statistics. This decision reflects the exploratory nature of the research design and the constraints associated with the sample size ($n = 128$). Applying inferential tests, such as chi-square or Mann–Whitney U, to a sample that cannot be considered fully representative of the target population would risk producing results that are statistically significant yet theoretically or practically misleading. The relationships identified in this study should therefore be regarded as preliminary findings, subject to verification in future research conducted on larger, representative samples and employing inferential statistical methods, including logistic regression or structural equation modelling.

4. Results

The age of farmers is an important factor influencing their investment decisions as well as succession issues. The analysis of the age structure allows for the identification of three main groups: young farmers (up to 35 years), middle-aged farmers (36–55 years), and older farmers (over 55 years). From the perspective of farm development dynamics, three types of populations can also be distinguished: developing (25–35 years), stabilized (36–55 years), and declining (over 55 years).

The vast majority of the surveyed farmers (66%) fall within the 36–55 age range, which indicates that the studied population is relatively stable in terms of professional activity and production experience. However, attention should be drawn to the relatively low share of

young farmers. Farmers aged 25-35 account for only 6% of respondents, while those aged 36-45 represent 13%. This small proportion of young farmers suggests that most farms are managed by individuals in their most active working years, combining production experience with full work capacity.

The significant share of farmers aged 46-55 (53%) also indicates that in the coming years many farms will face the necessity of addressing succession issues. This is particularly important given that as many as 28% of respondents are over the age of 55, which confirms the widely observed trend of an aging farming population.

The influence of age on farmers' willingness to pursue farm development is clearly supported by the empirical data. Farmers under the age of 45 show the highest acceptance of this goal (83%), while among those aged 46-55 this share drops to 47%, and among those over 55 it falls further to 44%. Notably, farmers aged 46-55 most frequently report not pursuing this goal at all (41% of respondents in this group), while farmers over 55 most commonly express indifference toward farm development as an objective (44% of respondents). These figures directly quantify the conservative turn observed among older farmers: the transition from the 36-45 to the 55+ group corresponds to a near-halving of active development orientation, from 83% to 44%. This pattern corroborates the qualitative findings from the IDIs, which indicate that reduced investment activity among older farmers stems from a perceived sufficiency of current farm development and, above all, from the absence of a potential successor.

Farmers in the 55+ age group possess substantial experience, established production orientations, and a relatively strong economic position. In theory, these factors should determine a strong development potential; however, in practice, this group tends to adopt conservative strategies. The dominance of a cautious approach to management limits the full utilization of available resources in the process of farm modernization. This conservative attitude results from several interrelated factors (Fig. 3).

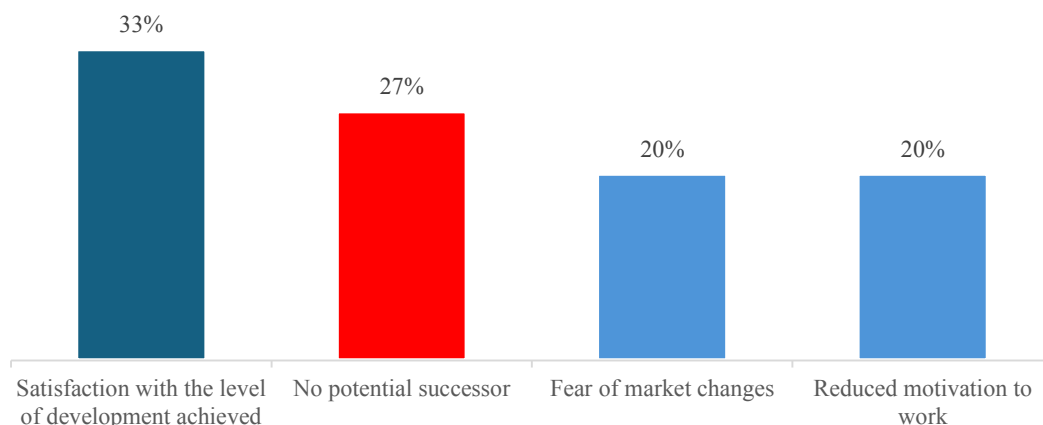


Figure 3. Reasons for limiting strategic investments in farms by farmers aged over 55.

Source: Own study based on individual in-depth interviews.

A key factor contributing to the decline in investment activity is the subjective perception of having reached an optimal level of farm development, ensuring economic stability and satisfaction of financial needs until retirement. From this perspective, further modernization is seen as economically unjustified or burdened with excessive risk. An equally significant barrier is the lack of a potential successor. In the opinion of respondents, the absence of a successor directly translates into a decline in motivation to undertake new initiatives. The absence of any prospect of farm transfer creates a self-reinforcing, self-destructive feedback loop: the farmer sees no purpose in further developing an entity that will cease to exist upon their withdrawal, which in turn leads to increasing professional apathy and disengagement from intensive farm management. In this context, other factors identified by respondents—such as fear of market volatility or a general decline in willingness to work—can also be viewed as derivatives of the absence of succession. The fear of market risk becomes more acute when there is no one to inherit the accumulated achievements, and the lack of a successor effectively removes the motivation to cope with a dynamic business environment.

Empirical data reveals a fundamental deficit in succession preparation processes among the surveyed farmers, indicating a discrepancy between the declarative and the actual implementation of intergenerational transfer. Although 34% of respondents declared having a potential successor, only 46% of this group were able to identify a specific individual, meaning they possessed at least a preliminary succession plan. Such a significant disparity demonstrates that, in the majority of farms, succession remains hypothetical and is characterized by a low level of operationalization. In light of the findings, succession issues extend beyond individual farmer decisions and constitute a structural challenge requiring more effective mechanisms to stimulate intergenerational transfer of agricultural assets.

To statistically verify the relationship between farmer age and the ability to identify a potential successor, a chi-square goodness-of-fit test was applied. At a significance level of $\alpha = 0.01$, the null hypothesis of independence between the two variables was rejected, confirming the existence of a statistically significant stochastic relationship between farmer age and the likelihood of identifying a successor. This result provides statistical support for the descriptive findings presented above: younger farmers demonstrate a markedly lower propensity to have identified a successor, while the oldest age group (55+) shows the greatest divergence between declared willingness to transfer the farm and actual successor identification. The chi-square test thus reinforces the conclusion that age is not merely a demographic background variable, but a structurally significant determinant of succession readiness in small organic farms.

Despite the low level of successor identification, a pro-succession orientation dominates within the studied group—79% of respondents plan to transfer their farms to the younger generation. Farmers aged 46-55 and those over 55 show the greatest readiness to hand over their farms. This suggests the existence of a pro-succession orientation that becomes more pronounced as professional activity declines. The analysis of the succession structure confirms

the strong embeddedness of traditional inheritance patterns in small farms. This aligns with existing literature, pointing to the phenomenon of patrilineal succession. In the vast majority of cases (92%), sons were indicated as potential successors, highlighting the persistent dominance of male offspring in the farm transfer process. This phenomenon is multidimensional, as it stems from entrenched socio-cultural norms and a conservative division of roles within rural families (Fig. 4).

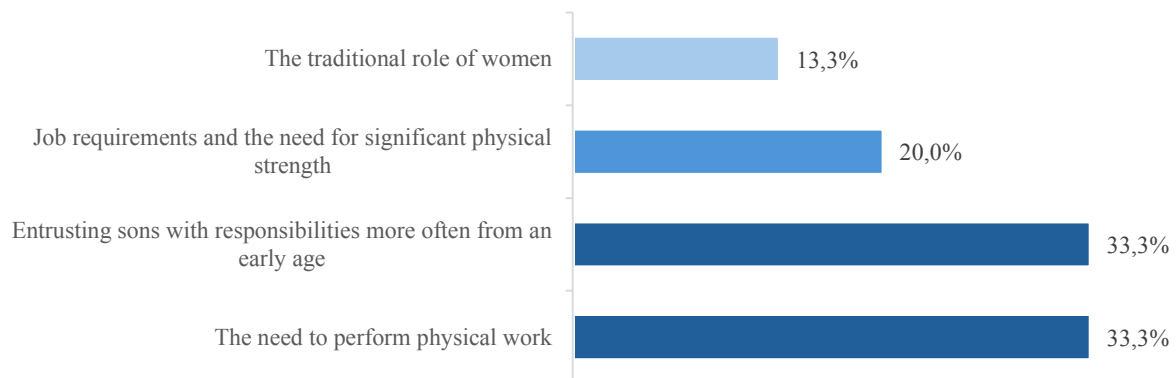


Figure 4. Why are farms more often inherited by sons rather than daughters?

Source: Own study based on individual in-depth interviews.

The dominance of sons in the succession structure is conditioned by deeply rooted socio-cultural constructs that shape perceptions of professional predispositions. In common understanding, agricultural work is associated with physical labor, which naturally directs farm owners' preferences toward male offspring. However, it should be noted that the ongoing mechanization and automation of production processes in modern agriculture significantly reduce the demand for heavy physical labor, making this argument increasingly less justified in light of actual operational requirements.

An important factor sustaining this model is the nature of early socialization within farming families. The long-term and systematic involvement of sons in farm work facilitates the transfer of practical knowledge and the internalization of the successor role, thereby reinforcing a sense of "natural" generational continuity along the male line. This process, strengthened by normative expectations within local rural communities, creates a specific "succession pathway", in which choosing a son is perceived as the solution most consistent with tradition.

A consequence of this phenomenon is the marginalization of daughters in the succession process. Although they increasingly possess higher qualifications and managerial competencies - key assets in managing modern farms - they remain outside the main succession stream. This leads to a mismatch between the competency profile of potential candidates and the culturally embedded model of a successor, which in the long term may limit the innovative potential of farms. This phenomenon reflects the underutilization of the educational potential of the female part of the younger generation, which, in the context of agricultural modernization, may constitute a barrier to improving farm management efficiency.

A key determinant of the dynamics of succession processes, alongside the declared willingness to transfer ownership, is the subjective perception of farm attractiveness from the perspective of potential successors. Research results indicate a relatively high level of optimism in this regard—75% of respondents perceive their farm as potentially attractive to the younger generation. However, a more detailed analysis reveals that these assessments vary significantly depending on the respondents' age.

The highest share of positive evaluations was observed among farmers aged 46-55 and, to some extent, among those over 55. This may be attributed to their well-established professional experience and the fact that their farms have reached a stage of developmental stability, which enhances their perception of the farm's market value and socio-economic prestige. On the other hand, the most critical views were identified among the oldest respondents (over 55). Despite their strong emotional attachment to the land, these farmers make a rational assessment of the structural barriers affecting small farms. Their skepticism results from an objective evaluation of profitability, which, in their opinion, often cannot compete with alternative employment opportunities available in the modern labor market.

Consequently, the assessment of succession attractiveness is dichotomous. On the one hand, it is a derivative of the emotional capital of the owners and the perceived intrinsic value of the farm, and on the other, reflect a sober appraisal of the real economic conditions that determine the chances for long-term continuation of the business in the future.

The results of in-depth interviews indicate a gradual redefinition of the role of small farms in the perception of their current owners. Respondents demonstrate a high level of economic realism, acknowledging that under current market conditions these farms are losing their primary function as the main source of livelihood and are increasingly becoming supplementary or complementary activities (Fig. 5).

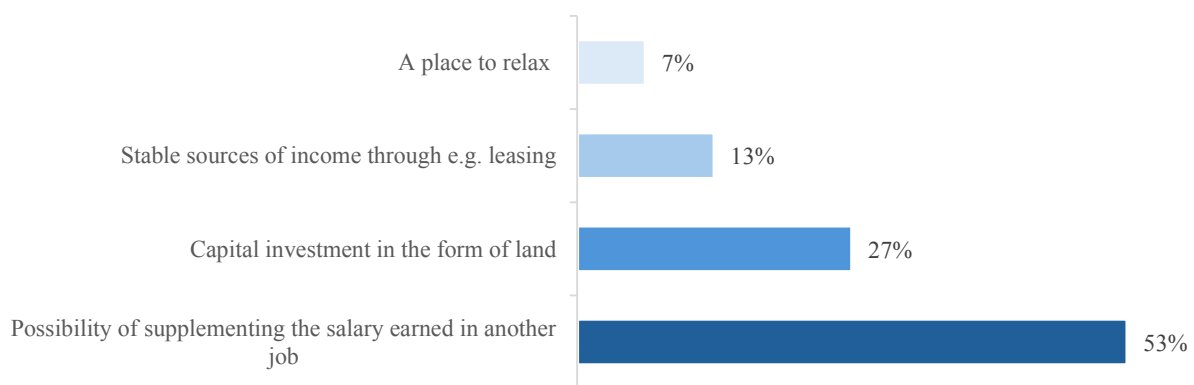


Figure 5. What factors influence the perception of a small family farm as attractive for future generations?

Source: Own study based on individual in-depth interviews.

Farm owners recognize that the small scale of production, combined with increasing mechanization, opens up new opportunities for so-called pluriactivity. The dominant factor determining the attractiveness of a farm and enabling its continuation—indicated by more than half of respondents—is the possibility of generating additional income, which significantly supplements household budgets primarily based on off-farm employment. In this model, agricultural production evolves into a supporting activity which, due to reduced labor intensity, allows for the effective combination of multiple professional roles without the need to abandon rural living.

An equally important pillar of the attractiveness of small farms is their capital dimension, understood as treating land as a secure store of value. Ownership of agricultural land is perceived by respondents as a stable financial safeguard and, through leasing arrangements, allows for the generation of passive land rent. This makes it possible to retain economic benefits from landownership while eliminating the need to engage in direct, labor-intensive crop or livestock production. A less frequently mentioned, yet still present, factor is the non-productive function of the farm, seen as a place of relaxation and a space for maintaining ties with the region. Overall, the findings suggest that the contemporary attractiveness of small farms is based on a hybrid model combining an income function (as a source of supplementary earnings) with a capital accumulation function, where land becomes a strategic asset for future generations.

The presence of a potential successor is a key factor influencing the development activity of the studied farms. Empirical analysis reveals an important interaction between the succession structure and the declared pro-development orientation (Fig. 6).

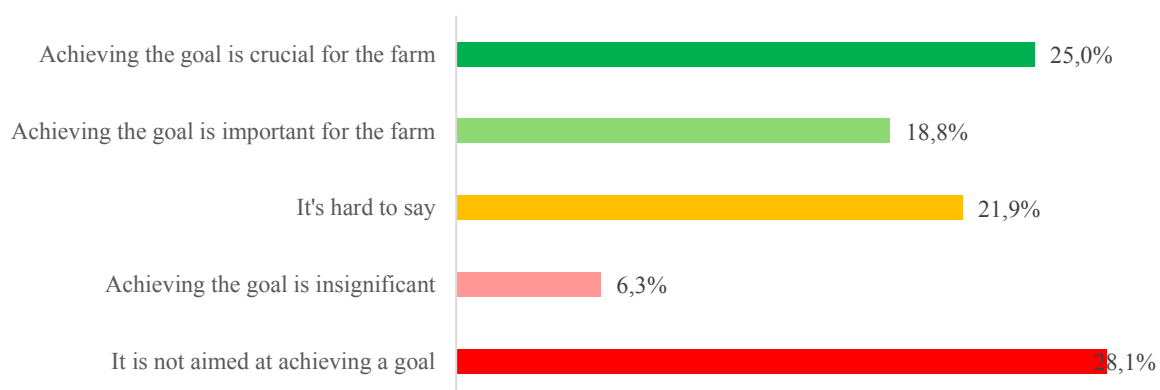


Figure 6. Implementation of the objective: “farm development with the intention of transferring it to the younger generation”.

Source: Own study based on survey research.

While the share of farms strongly oriented toward development (considering it a key or important objective) amounts to 43.8%, in the group of farms identified as “succession-oriented” (i.e., those with a potential successor), this indicator shows a clear upward trend, reaching 58%. Moreover, within this group, as many as 35% of farmers assign development

goals the status of a strategic priority. This relationship indicates that having a successor fosters the concretization of investment plans and extends the planning horizon. The successor thus acts as a motivating factor that stabilizes the owner's investment intentions.

These findings are further corroborated by the results of a correlation analysis. The calculated Pearson correlation coefficient demonstrated that, at a significance level of $\alpha = 0.01$, the null hypothesis of independence between the variables can be rejected, confirming the existence of a statistically significant stochastic relationship between the presence of a potential successor and the pro-development orientation of the farm owner. This result confirms that having an identified successor significantly increases the farmer's propensity to undertake investment activities and to pursue the objective of farm development with the intention of transferring it to the next generation. In other words, the successor acts as a motivating factor that concretises investment plans and extends the strategic planning horizon.

Farmers' decisions to undertake development activities in farms with limited land area are also justified by concern for the future of the next generation (Fig. 7).

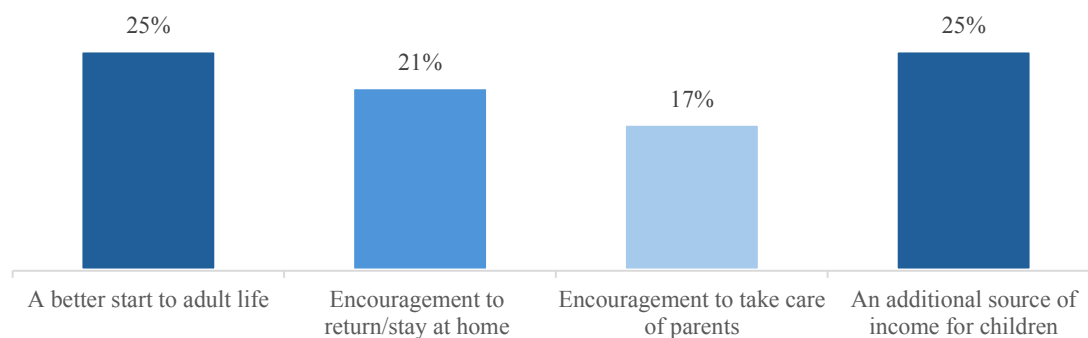


Figure 7. Factors motivating farmers to develop their farms with the intention of transferring them to the younger generation.

Source: Own study based on individual in-depth interviews.

The analysis of motivations indicates four complementary areas in which farmers perceive the rationale for modernization. The first is the desire to provide children with a better start in adult life (25%), which in practice means transferring a fully “equipped” working environment. An identical share of responses (25%) refers to the creation of the farm as a durable financial asset, constituting a significant form of capital security for children.

Modernization also serves a sociological function. Investment activities are aimed at creating conditions conducive to the return of children to their hometowns or encouraging them to remain on the farm, which is closely linked to the desire to maintain intergenerational continuity. An additional factor is the intention to secure future care from offspring by creating attractive living conditions for them in rural areas.

This suggests that investments in small farms are not driven solely by calculations of operational profit, but rather by a long-term strategy aimed at safeguarding family interests. Awareness of economic limitations resulting from small land areas leads farmers to adopt

measures focused on reducing labor intensity and simplifying production processes as much as possible. As a result, the farm adopts the model of a supplementary unit generating residual income, which serves as a useful addition to household budgets based on off-farm employment. Through this approach, farmers seek to minimize the risk of their children being excluded from the labor market and to provide them with a stable economic foundation in their home regions.

5. Discussion

This study provides empirical evidence on the determinants of succession in a specific and hitherto under-researched segment – small family organic farms. The hypotheses formulated were confirmed: H1 demonstrated that the absence of an identified successor significantly limits a growth-oriented outlook (58% vs. 43.8% for the full sample); H1a revealed a gap between the declared willingness to transfer the farm (79%) and the actual identification of a successor (only 34%); and H1b confirmed a positive relationship between the presence of a successor and the propensity to invest. A contribution relative to existing literature is the demonstration of these mechanisms specifically within the organic sector, which – contrary to intuition – does not act as a protective barrier against the succession crisis. The low share of young farmers in the sample (6% in the 25–35 age group) corresponds to data indicating that in the EU there are on average three farmers above 65 years of age for every one farmer below 40 (European Parliament, 2023). Dudek (2023) showed that in Poland one in three small farms reported having no successor – the present study suggests this tendency is even more pronounced within the organic sub-segment.

The low share of young farmers observed in the study sample (6% aged 25–35) is broadly consistent with the national demographic structure of Polish agriculture. According to data from the Central Statistical Office of Poland (GUS, 2023), farmers aged 25–34 account for approximately 10% of all individual farm holders employed on their own holdings, while those aged 35–44 represent around 22%. By contrast, the dominant age cohorts nationally are 45–54 and 55–64, together comprising over 55% of the farming population. The slight underrepresentation of the youngest cohort in the present sample relative to national averages may reflect the specific characteristics of the organic sub-sector and the geographic scope of the study, but the overall pattern — a strong concentration of farm holders in the 45–64 age range and a marginal presence of farmers under 35 — mirrors the broader national trend.

The relationship identified between successor identification and a development-oriented attitude is consistent with the findings of Bertolozzi-Caredio (2024), who, using a sample of 768 farms from nine European countries, found that successor identification leads to the adoption of on average two additional management strategies, while Borychowski, Grzelak and Stępień (2023) confirmed this mechanism using data from the Wielkopolska region. A degree

of divergence emerges, however, with regard to the short-term economic effects of succession. Dudek and Pawłowska (2022), analysing Polish FADN panel data, found no evidence that the mere transfer of a farm to a successor improves its economic situation in the short term, attributing this to the successor's prior influence on the farm's trajectory before the formal transfer takes place. The present study focuses precisely on this pre-transfer phase – the observed higher investment activity among farm owners who have identified a successor is therefore a manifestation of that earlier motivational effect, complementing the findings of Dudek and Pawłowska with an intentional and decision-making dimension.

An original and non-obvious finding is the absence of any protective 'organic effect' in the succession process. The literature indicates that newcomers to agriculture – people entering from outside farming families – are more inclined to adopt organic production models and innovative practices (Zagata and Sutherland, 2015). One might therefore expect the organic sector to attract the younger generation of environmentally conscious potential successors more strongly. Yet the results of this study – consistent with Borychowski et al. (2023) – point to the opposite relationship: the degree of ecological orientation in production is negatively correlated with the probability of finding a successor. This likely reflects the fundamentally different nature of the two groups: newcomers enter the organic sector driven by values, whereas farmers' children evaluate the inheritance through the lens of profitability and labour intensity. This is a key contribution of the article: the mechanisms of intra-family succession differ fundamentally from the patterns of entry into farming from outside the sector.

The dominance of sons as designated successors is fully consistent with the literature – Liu et al. (2023) demonstrated a sevenfold higher probability of a son being selected in US studies, while Sutherland (2023) described the cultural mechanisms that perpetuate the masculine succession pathway. The original contribution of the present work lies in situating this phenomenon within the organic sector context and capturing the subjective rationalisation offered by respondents, who cite the physical nature of farm work as a key argument – despite the fact that ongoing mechanisation renders this justification increasingly untenable. Rodriguez-Lizano et al. (2020), in their review of the determinants of succession, do not identify the specificity of the organic sector as a separate moderating variable, meaning that the present study fills this empirical gap.

The evolution of small farms towards a pluriactivity model is consistent with the observations of Chmielewska and Zegar (2022) and with the European trend of the most rapid liquidation occurring among precisely the smallest farm units (European Parliament, 2023). These findings have concrete practical implications: CAP 2023-2027 instruments – such as young farmer start-up grants – should be directed towards stimulating genuine succession planning rather than merely formal ownership transfer, since the observed fictitious succession (Wojewodzic, 2013) remains a structural phenomenon. Answering the question of the effectiveness of such interventions requires longitudinal studies tracking the same farms over time. Future research should also incorporate the perspective of potential successors – not only

farm owners – and verify whether the results obtained for central Poland are representative of regions with different agrarian structures.

Not all findings of this study, however, are consistent with the existing literature. First, the results suggest a dominant role of economic factors in succession decisions—the lack of profitability of small organic farms is identified as the main barrier to intergenerational transfer. Meanwhile, Czyżewski et al. (2024), examining small farms in Central and Eastern Europe (Romania, Moldova, Serbia), demonstrated that social embeddedness is a more important predictor of succession pathways than economic factors. This finding suggests that policies focused solely on improving profitability may not be sufficient to resolve the succession crisis, and that strengthening local support networks may be equally important.

6. Conclusion

The research conducted confirms that succession in small family organic farms constitutes a significant structural problem, the scale of which may be underestimated in the existing literature. The findings indicate that despite a high level of declared readiness to transfer the farm, the actual preparation of the succession process remains low, revealing a substantial gap between intentions and actions. At the same time, the study demonstrates that the presence of an identified successor acts as a key activating factor — reinforcing a growth -oriented outlook and the propensity to invest.

Against the backdrop of existing research, a particularly significant contribution of this article is the demonstration that the organic farming sector — despite its developmental character and institutional support — does not eliminate succession barriers. This implies that economic and demographic factors carry greater weight than the specific nature of the production model.

The findings have important implications for the development of agricultural management practice. They suggest the need to reorient agricultural policy instruments — in particular the Common Agricultural Policy — away from a focus on formal ownership transfer and towards support for genuine succession planning, encompassing the competency development of successors and the gradual handover of managerial responsibility.

The results obtained may serve as a starting point for further research, in particular of a longitudinal nature, which would allow for the analysis of changes occurring over time and the evaluation of the effectiveness of public interventions. It is also advisable to broaden the research perspective to include the viewpoint of potential successors and to account for regional variation in agrarian structure. In-depth analyses in this area may contribute to better design of tools supporting the sustainability and competitiveness of small family farms under conditions of advancing demographic and economic change.

References

1. Baer-Nawrocka, A., Kiryluk-Dryjska, E. (2023). Wspólna Polityka Rolna wobec kryzysu demograficznego w rolnictwie. In: P. Łysoń (Eds.), *Konsekwencje zmian demograficznych dla rozwoju rolnictwa* (pp. 74-83). Warszawa: Zakład Wydawnictw Statystycznych.
2. Bertolozzi-Caredio, D. (2024). The farm succession effect on farmers' management choices. *Land Use Policy*, vol. 137. <https://doi.org/10.1016/j.landusepol.2023.107014>
3. Borychowski, M., Grzelak, A., Stępień, S. (2023). Economic and environmental determinants of farm succession. The empirical evidence from Wielkopolska region (Poland). *Journal of Rural Studies*, vol. 101, doi.org/10.1016/j.jrurstud.2023.103063
4. Chmielewska, B., Zegar, J.S. (2022). Z czego żyje wieś? Źródła dochodów ludności wiejskiej, ich ewolucja i zróżnicowanie. In: J. Wilkin, A. Hałasiewicz (Eds.), *Polska wieś 2022. Raport o stanie wsi* (pp. 133-152). Warszawa: Scholar.
5. Czekaj, M. (2016). Wybrane problemy sukcesji gospodarstw rolnych w Polsce. *Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu Problemy ekonomii, polityki ekonomicznej i finansów publicznych*, No. 439, pp. 77-88, [doi:10.15611/pn.2016.439.07](https://doi.org/10.15611/pn.2016.439.07)
6. Czekaj, M. (2018). Plan sukcesji w gospodarstwie rolnym. *Więś i Rolnictwo*, Vol. 3, No. 180, pp. 211-227, [doi: 10.7366/wir032018/10](https://doi.org/10.7366/wir032018/10)
7. Czyżewski, B., Kryszak, Ł., Bajrami, E., Lucasenco, E., Muntean, A., Tošović-Stevanović, A. (2024). What determines small farms' succession patterns in Eastern European emerging markets? Exploring the role of embeddedness in social networks. *International Journal of Emerging Markets*, Vol. 20, Iss. 12, pp. 1-27, <https://doi.org/10.1108/IJOEM-03-2023-0445>
8. Dudek, M. (2023). Zmiany demograficzne a sukcesja gospodarstw rolnych w Polsce. In: P. Łysoń (Eds.), *Konsekwencje zmian demograficznych dla rozwoju rolnictwa* (pp. 116-130). Warszawa: Zakład Wydawnictw Statystycznych.
9. Dźwigoł-Barosz, M. (2018), Prerequisites for successful succession in family company according to its successor. *Managerial Economics*. Vol. 19, No. 2, pp. 169-185, <https://doi.org/10.7494/manage.2018.19.2.169>
10. Florek-Łuszczki, M. (2023). Psychospołeczne i zdrowotne konsekwencje starzenia się mieszkańców wsi. Zmiany demograficzne a sukcesja gospodarstw rolnych w Polsce. In: P. Łysoń (Eds.), *Konsekwencje zmian demograficznych dla rozwoju rolnictwa* (pp. 131-146). Warszawa: Zakład Wydawnictw Statystycznych.
11. Ginter, A., Kałuża, H., Niewęglowski, M. (2016). Sukcesja gospodarstw rolnych oparta na wiedzy. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu (SERiA)*. Vol XVIII, Iss. 4, pp. 62-66, DOI: 10.22004/ag.econ.257539
12. Główny Urząd Statystyczny (2017). *Charakterystyka gospodarstw rolnych w 2023 r.*, Warszawa: GUS, p. 90.

13. Ingram, T. (2023). *Odporność organizacyjna przedsiębiorstw rodzinnych*. Katowice: Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, p. 22.
14. Lewandowska, A. (2015). *Kody wartości, czyli jak skutecznie przejść sukcesję w firmie rodzinnej*. Poznań: Wydawnictwo Lewandowska i Partnerzy, p. 82.
15. Lewandowska, A., Andrzejczak, P., Stradomski, M. (2017). *Narodziny firmy rodzinnej. Jak mądrze zaplanować sukcesję i przekazać biznes następcy*. Poznań: Instytut Biznesu Rodzinnego, p. 35.
16. Lewandowska, A., Greser, J., Jakubowski, J. (2012). Sukcesja w firmie rodzinnej. In: M. Zawadka (ed.), *Firma w rodzinie czy rodzina w firmie. Metodologia wsparcia firm rodzinnych* (pp. 121-130). Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.
17. Market Research World (2025). *Polska wieś i rolnictwo*. Badanie realizowane na zlecenie Ministerstwa Rolnictwa i Rozwoju Wsi, Agencji Restrukturyzacji i Modernizacji Rolnictwa, Krajowego Ośrodka Wsparcia Rolnictwa i Kasy Rolniczego Ubezpieczenia Społecznego.
18. Maule, B., Zhang, W., Liu, Q. (2023). Of Women and Land: How Gender Affects Successions and Transfers of Iowa Farms. *Working Paper - Center for Agricultural and Rural Development, Iowa State University, No. 42*, p. 38, <https://doi.org/10.1002/aepp.13363>
19. Parlament Europejski (2023). *Rezolucja w sprawie odnowy pokoleniowej w gospodarstwach rolnych UE przyszłości (A9-0283/2023)*. Dz.U. UE C 402, 19.10.2023.
20. Polkowska, K., Dąbrowska, A., Grzybowska, W. (2024). Proces sukcesji przedsiębiorstwa rodzinnego na przykładzie Kotniz Sp. z o.o. *Akademia Zarządzania, Vol. 8, No. 3*, pp. 122-139, DOI: 10.24427/az-2024-0041
21. Rodriguez-Lizano, V., Montero-Vega, M., Sibelet, N. (2020). Which variables influence the succession process in family farms? A literature review. *Cahiers Agricultures. Vol. 29*, pp. 29-39, <https://doi.org/10.1051/cagri/2020040>
22. Roszko-Wójtowicz, E. (2016). Sukcesja w przedsiębiorstwach rodzinnych – od planowania po wybór sukcesora. *Edukacja Ekonomistów i Menedżerów, Vol. 40, No. 2*, pp. 45-64, <https://doi.org/10.5604/01.3001.0009.4571>
23. Rozporządzenie Rady (WE) Nr 834/2007 z dnia 28 czerwca 2007 r. w sprawie produkcji ekologicznej i znakowania produktów ekologicznych i uchylające rozporządzenie (EWG) Nr 2092/91 (DZ. U. L 189 z 20.07.2007 r).
24. Sass, R. (2021). Wielkość ekonomiczna gospodarstw rolnych w Polsce a ich efektywność w latach 2004-2018. *Zagadnienia Doradztwa Rolniczego, No. 2*, p. 32.
25. Soczewka, I., Kaluza, H., Ginter, A. (2014). Międzypokoleniowa współpraca w rodzinnych gospodarstwach rolnych na przykładzie wybranych gospodarstw powiatu siedleckiego. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, Vol. XVI, Iss. 6*, pp. 444-448.

26. Stępniewska, A. (2013). Elementy procesu sukcesji w wybranych polskich przedsiębiorstwach rodzinnych. *Przedsiębiorstwo we Współczesnej Gospodarcie: teoria i praktyka*, No. 1, pp. 40-49.
27. Sutherland, L.-A., McKee, A., Hopkins, J., Hasler, H. (2023). Breaking Patriarchal Succession Cycles: How Land Relations Influence Women's Roles in Farming. *Rural Sociology*, Vol. 88(2), pp. 512-545. <https://doi.org/10.1111/ruso.12484>
28. Szymczak, A. (2023). *5W, Czyli niezbędne aspekty dobrej sukcesji*, <https://familybusiness.ibrpolska.pl/5w-czyli-niezbedne-aspekty-dobrej-sukcesji/>, 07.04.2026.
29. Ślusarczyk, B., Sowa, B., Kalita, N. (2019). Kondycja Polskiego rolnictwa i czynniki warunkujące jego konkurencyjność. *Nobel Herald*, No. 1(12), pp. 105-118, DOI:10.32342/2616-3853-2019-2-12-11.
30. Ustawa z dnia 2 kwietnia 1997 r. Konstytucja Rzeczypospolitej Polski (DZ.U. Nr 78, poz. 483).
31. Ustawa z dnia 23 kwietnia 1964 r. Kodeks Cywilny (Dz.U. 2019, poz. 1145).
32. Wiktorowicz, J. (2020). Międzypokoleniowy transfer wiedzy: o instrumentach wspierania konkurencyjności przedsiębiorstw w warunkach starzejących się zasobów pracy. *Rynek Pracy*, Vol. 175, No. 4, pp. 28-42, GICID: 01.3001.0015.5398.
33. Wojewodzik, T. (2017). Procesy dywestycji i dezagraryzacji w rolnictwie o rozdrobnionej strukturze agrarnej. *Zeszyty Naukowe Uniwersytetu Rolniczego im. Hugona Kołłątaja w Krakowie. Rozprawy*, Vol. 535, No. 412, DOI:10.15576/978-83-66602-31-1
34. Wojewodzik, T. (2013). Pozorna sukcesja – zaburzenie cyklu życia gospodarstw rolniczych. *Ekonomika i Organizacja Gospodarki Żywnościowej*, No. 103, pp. 141-152, <https://doi.org/10.22630/EIOGZ.2013.103.35>
35. Zagata, L., Sutherland, L.-A. (2015). Deconstructing the 'young farmer problem in Europe': Towards a research agenda. *Journal of Rural Studies*, Vol. 38, pp. 39-51. <https://doi.org/10.1016/j.jrurstud.2014.10.003>
36. Zajkowski, R. (2018). *Transfery władzy, własności i wartości w przedsiębiorstwach rodzinnych. Efekt drugiego pokolenia*, Warszawa: C.H. Beck, p. 45.
37. Zegar, S.J. (2023). Transformacja rolnictwa rodzinnego w drugiej dekadzie XXI wieku. *Zagadnienia Ekonomiki Rolnej [Problems of Agricultural Economics]*, Vol. 374, Iss. 1, pp. 1-19, DOI: <https://doi.org/10.30858/zer/161785>
38. Zolotnytska, Y. (2021). Rola rodzinnych gospodarstw rolnych w rozwoju rolnictwa i obszarów wiejskich w Polsce: stan i perspektywy. *Kwartalnik Nauk o Przedsiębiorstwie*. Vol. 58, No. 1, pp. 43-58, DOI: <https://doi.org/10.33119/KNoP.2020.58.1.4>

CULTURAL DIVERSITY OF COOPERATION FORMS IN VIRTUAL COMMUNITIES OF PRACTICE. THE CASE OF WIKIMEDIA PROJECTS

Sebastian SKOLIK

Czestochowa University of Technology, Faculty of Management; sebastian.skolik@pcz.pl,
ORCID: 0000-0003-2364-4442

Purpose: The purpose of this paper was to present the diversity of forms of cooperation within Wikimedia projects in terms of creating high-quality content, mobilising users to take action, and building relationships with external institutions.

Design/methodology/approach: To achieve the research objective, a quantitative and qualitative analysis of data obtained from 50 language versions of Wikipedia was conducted. The first stage involved the statistical testing of three hypotheses concerning engagement in the creation of high-quality content; the second stage comprised a qualitative analysis of Wikipedia's website structures regarding the occurrence of cooperation initiatives with external institutions.

Findings: The research allowed for the acceptance of the hypothesis that cooperation effectiveness – in terms of the number of high-quality articles produced and the identification of low-quality articles – depends primarily on the size of the virtual communities of practice. Furthermore, the diversity of cooperation forms aimed at user engagement and relations with external institutions was greater in larger communities. However, it was observed that local socio-cultural factors may influence the nature and intensity of cooperation.

Research limitations/implications: Capturing the specifics of local determinants of cooperation would require an in-depth analysis of cooperation forms within individual Wikimedia projects.

Social implications: The research findings indicate that online projects oriented towards knowledge co-creation should consider the size of their own communities when replicating forms of cooperation from other projects.

Originality/value: Unlike previous studies, which focused on factors increasing the effectiveness of cooperation in Wikimedia, this paper presents a wide range of cooperation forms by comparing 50 language versions of Wikipedia.

Keywords: virtual communities of practice, knowledge sharing environment, forms of cooperation, Wikimedia projects.

Category of the paper: Research paper.

1. Introduction

Within the first few years of the 21st century, the user-generated encyclopaedia known as Wikipedia became one of the most frequently visited websites on the Internet. Among the research community, this triggered a need to define the phenomenon of cooperation that contributed to the success of this form of knowledge sharing and the mobilisation of intellectual capital resources on a global scale. A significant proportion of the encyclopaedia's early contributors originated from the free software movement, which subsequently led to the formation of the much broader free culture movement. Lessig, an advocate of free culture, described Wikipedia as a model example of the sharing economy (Lessig, 2008). For Benkler (2008), it represented a successful project in the field of peer production. Using Wikipedia as a case study, Tapscott and Williams defined a new format of global collaboration – *wikinomics* – which they argued must be adopted by global players if they are to remain competitive in the market (Tapscott, Williams, 2008). In turn, Levinson – drawing on Wikipedia and other services created by virtual communities of practice – identified a distinct category of media which he termed "new media" (Levinson, 2009).

Although the aforementioned authors were pioneers in describing online knowledge-sharing processes, they lacked extensive personal experience in the co-creation of Wikipedia. Over time, however, scholarly articles authored by Wikipedians themselves began to emerge. Certain initiatives aimed at fostering cooperation, particularly within the English-language version of Wikipedia, were supported by specific grants, including those from the Wikimedia Foundation, the organisation overseeing the project. This facilitated the diffusion of knowledge concerning modes of collaboration between the academic community and the community of Wikipedians. Nevertheless, the applicability of these research findings remained limited and was generally confined to technical solutions.

Researchers focusing on the communities developing both Wikipedia and its sister projects (collectively referred to as Wikimedia) have for years sought to identify factors that facilitate or constrain cooperation between users. In contrast to conventional organisations, where knowledge management is central to operational efficiency, Wikipedia lacks top-down directives regarding forms of collaboration. Studies suggest, however, that the strength of intra-group relations, evidenced by the intensity of interactions, leads to the creation of higher-quality content within that group. Efficiency is also impacted by the presence of a structure that enables direct communication while remaining linked to the global social network within a given language version of Wikipedia (see Rychwalska et al., 2025). The absence of formal guidelines and managerial roles is linked to the decentralised nature of collaboration. It is noted, however, that committed users who patrol the contributions of others are pivotal actors within the project's social structure and may play a significant role in mobilising other users for collaborative action. Typically, within individual language versions, the core is composed of

"first-generation" Wikipedians. These individuals also constitute the "elite" of Wikipedians, exhibiting a strong predisposition towards cooperative activities (Skolik, 2023; Pilati et al., 2025).

As Wikipedia is created in over 350 language versions and developed by communities from diverse cultural backgrounds, this results in the cultural differentiation of forms of cooperation. Previous research has demonstrated the significance of cultural influence on user engagement within internal Wikimedia structures and on the diversity of collectively produced knowledge resources (Nemoto, Gloor, 2011; Karczewska, 2023; Kukowska, 2023; Wang et al., 2025). The purpose of this article is to determine the diversity of areas of cooperation within Wikimedia, primarily among the largest language versions of Wikipedia. The author seeks to answer how cooperation is shaped in the following areas: (1) enhancing the quality of content; (2) identifying and eliminating low-quality content; (3) mobilising users for collaborative action; and (4) building relationships with external institutions to develop resources. The research conducted, which allowed for answering the above questions, was exploratory in nature. These studies employed a netnographic approach, using qualitative and quantitative methods.

2. Literature Review on Aspects of Collaboration in Wikipedia

The synchronisation of joint activities and the manner of their organisation are crucial for the quality of cooperation. In the initial stages of Wikipedia's development, efforts towards quantitative and qualitative growth were described in terms of the "wisdom of the crowd", and the term itself became a frequent subject of scholarly research (Surowiecki, 2005; Miller, Steyvers, 2011; Mannes et al., 2014). Subsequent studies pointed out that a term which better reflects the effectiveness of high-quality content creation, or more precisely the improved formulation of judgements, is sequential cooperation. The best results were achieved not when judgements were formulated independently, but when they were contingent upon the contributions of other users who had previously modified the content. Another factor conducive to quality was the option to refrain from expressing a judgement (Mayer, Heck, Kimmerle., 2025).

A large number of users representing different cultures and various specialisations can lead to a relatively comprehensive collection of knowledge resources. For this reason, cooperation is undertaken between Wikipedians and external institutions, including academic centres, to bridge knowledge gaps within Wikipedia's resources. One such initiative was the Wikipedia Diversity Observatory, supported by a grant from the Wikimedia Foundation. The aim of this initiative was, firstly, to create tools and visualisations of knowledge gaps within the project and, subsequently, to engage the community of Wikipedians and independent researchers in

collaboration. During the implementation of this project, it was possible to identify users' needs regarding the filling of knowledge gaps. Participants in the project were able to compare gaps across different language versions and determine priority tasks in this regard (Miquel-Ribé, Laniado, 2021). However, this project was short-lived. The websites where it was presented ceased to function, and awareness of it was not widespread across most language versions. Another solution was the creation of the WikiGap tool, which allowed Wikipedians to quickly familiarise themselves with the differences between article content in various languages. This is significant because non-Wikipedians are often convinced of the consistency of knowledge regardless of the language version (Wang et al., 2025). Ultimately, such a tool could also be used by readers. However, this would entail implementing a complex interface, which would be difficult to push through at a global level. Furthermore, individuals testing such tools too often abandon them after the initial phases of experiments, which are primarily conducted on the English-language Wikipedia.

The diversity of forms of cooperation arises from the fact that Wikipedia is created in over 350 language versions, which implies the influence of various socio-economic and cultural factors on negotiating rules, creating tools that facilitate editing, or accepting guidelines established at the Wikimedia Foundation level. Furthermore, within large language versions, distinct disparities in editing activity are also visible. A small percentage of Wikipedians is responsible for the majority of edits performed (see Shimada et al., 2023). In 2007, when Wikipedia was developing intensively in terms of both content volume and community size, it was noted that 0.1% of Wikipedians contributed over 40% of the encyclopaedia's value (Priedhorsky et al., 2007). The differentiation of projects is also affected by the fact that individual language versions were established at different times, and their creators had varying degrees of influence on formulating the rules of co-creation. Levels of engagement also vary, which can be attributed to cultural influences (Kukowska, 2022). Certain active minorities, such as the Catalans, strive more strongly to intensively develop the Wikipedia version in their own language. This is primarily accompanied by a focus on describing topics related to their own region and its culture (Massa, Scrinzi, 2012). Certain parameters of language versions may also result in different methods of identifying content quality. One such parameter is the number of existing articles. In large language versions, to detect content requiring improvement, it can be compared to the quintile of the best articles. In the case of smaller versions, there are too few high-quality articles for such a model to be useful. In studies concerning mid-sized language versions (Albanian, Basque, Catalan), articles were first compared in terms of length, number of citations, links to other articles, and illustrations, after which a corpus of the best articles was prepared. This approach enabled the relatively effective detection of content requiring verification through footnotes (Halitaj, Zubiaga, 2024).

The COVID-19 pandemic represented a particular situation that contributed to research into the diversity of factors influencing knowledge sharing. One study noted that the pandemic might have catalysed the diffusion of knowledge within the digital environment. Furthermore,

it was observed that socio-economic proximity could influence the intensity of interactions, consequently leading to a convergence of knowledge structures across different cultural regions (Yoon et al., 2023). Another study focused on diversity within a single language version (Japanese). In this instance, it was observed that users editing socio-political topics were more actively involved in developing articles related to the pandemic than those representing the natural and medical sciences. This phenomenon was particularly prevalent during the period of the pandemic's rapid progression. As it began to recede, individuals oriented towards the natural and medical sciences became more engaged with these topics. As noted, this resulted from the attitude of "scientists" who preferred to remain silent in the face of scientific uncertainty (Yang, Tanaka, 2023).

The diversity of cooperation forms also depends on individual user preferences regarding the type of activity. Only a small percentage of individuals who begin participating in the project remain active in the long term. Committed Wikipedians employ various methods to encourage further editing among those who produce reasonably correct contributions. Early experience can influence one's subsequent "career" on Wikipedia. Users may thus engage in article editing, building social relationships, supporting subsequent newcomers, patrolling other users' contributions, undertaking administrative tasks, focusing on team activities, or editing meta-pages (i.e. pages concerning Wikipedia and its community) (Antin, Cheshire, Nov, 2012).

To ensure the heterogeneity of the Wikipedian community, initiatives were undertaken to increase newcomer retention. One such initiative was the creation of a dedicated forum for newcomers called the Teahouse, where they could contact mentors and obtain answers to questions about the project. A tool was also implemented to allow new users to engage in article improvement immediately after creating an account (Warncke-Wang et al., 2023). In this way, newcomers become involved in activities before learning the rules. Consequently, a significant portion of their work is flawed and must be corrected or reverted. The problem also stems from the fact that those implementing this solution failed to mobilise the community in many language versions to conduct joint evaluations. Furthermore, based on past experiences, committed Wikipedians often do not expect newcomers to remain engaged and thus limit their activities as mentors. This also applies to experts wishing to fill knowledge gaps, who are frequently accustomed in their professional lives to being treated differently from amateurs. For the community, however, the extent to which experts adhere to established rules is more important than encouraging them to enhance the quality of resources. Moreover, Wikipedia is not a particularly attractive venue for experts relative to their professional work; therefore, they find it easier to abandon editing when differences of opinion arise (see Konieczny, 2021).

Hundreds of thousands of users collaborate on Wikimedia projects every month. In the case of the English-language version alone, this amounts to approximately 40,000 individuals (*Wikimedia Statistics*, 2026). Entering the rhythm of collaboration may, however, require a considerable amount of time. Nevertheless, to integrate new users, collaboration is undertaken

with educational institutions, among others. One such form of cooperation is edit-a-thons. Participation in these events allows for the development of critical thinking and provides participants with a sense of agency (Vetter, Sarraf, Woods, 2022). Activities performed by newcomers, if not supervised by committed Wikipedians, may nevertheless be perceived as harmful and the content removed, leading to frustration among participants. This is because the work performed may conflict with internal agreements, such as those regarding the scope of content that should be described in separate articles. Previous research has shown that the problems experienced by students included difficulties in finding instructions on article editing, an unintuitive interface, and a lack of feedback during the edit-a-thon (Gluza, Turaj, Meier, 2021). Some institutions or their employees do not even inform the Wikipedian community about the organisation of events related to editing Wikipedia.

The final significant aspect of cooperation is the identification and removal of flawed content, as well as the elimination of behaviours detrimental to the projects. To facilitate the identification of articles requiring improvement, Wikipedians place specific maintenance notices on their pages. The design of these notices results from spontaneous actions and they do not always influence the recipient appropriately, regardless of whether the recipient is another Wikipedian or a reader who has yet to become involved. Research indicates that the appropriate phrasing of the notice, as well as the colour scheme employed, can influence trust in the content presented in the article (Kuznetsov et al., 2022). However, this does not necessarily affect the recipient's motivation to resolve the reported issue. This applies primarily to content that is difficult to improve while simultaneously being free from obvious vandalism. Such "damage" to articles is typically reverted immediately. Yet, as early as 2007, it was noted that among edits performed in bad faith or other forms of article "damage", approximately 10% were accessible for 100 page views, while 0.06% remained for 10,000 views (Priedhorsky et al., 2007). This had the effect of weakening the project's credibility and undermining readers' trust in the content created. In certain language versions, including Polish, German, and Russian, a solution was introduced in the form of "flagged revisions"; this meant that edits performed by individuals without specific permissions were not visible to readers.

Alongside the identification of vandalism, users whose actions are judged to be intentionally detrimental to the project are detected and blocked. This also pertains to trolling behaviours and the creation of sockpuppets, that is, additional accounts established by "recidivists" (Skolik, 2017). Since many users may make mistakes or react emotionally during the initial stages of their activity, the detection of sockpuppets is non-trivial. Consequently, a specific type of cooperation occurs in this area. The general user base can identify behaviours resembling those of persistent offenders known to the community, while individuals with special permissions can compare the consistency of IP addresses, operating systems, or browsers used by the suspicious accounts. In large communities where hundreds or even thousands of edits are performed per hour, such detection requires support. In such cases, the use of machine learning models is advocated. One option being prepared for testing is meta-learning, where a model gains

experience across a set of tasks rather than just one, thereby improving performance in future tasks (Raszewski, Kock, 2025). Tools alone are insufficient for making decisions regarding the blocking of a specific user. However, the communication style of the most problematic users is relatively easily recognisable by community members. The more individuals participate in such detection and share knowledge of sockpuppet behaviours, the more rapidly they are identified.

3. Methods

To characterise the diversity of forms of cooperation within Wikimedia projects, both qualitative and quantitative data analyses were applied. The study was conducted in two stages. In the first stage, three hypotheses concerning cooperation in the creation of content defined by Wikipedians as either "good" or "problematic" were tested based on quantitative data. To this end, data were obtained from the 50 largest Wikipedias in terms of the number of active users, covering: the number of registered users, the number of featured articles (FA), the number of articles marked as having sourcing issues, and the length of articles from the list of 10,000 articles that every Wikipedia should have. The following research hypotheses were formulated at this stage:

- H1. Engagement in detecting problematic articles depends on the size of the overall user base. Articles marked as lacking sources were adopted as the indicator of problematic articles, while the number of registered accounts was taken as the indicator of the total number of users.
- H2. The effectiveness of cooperation in developing core encyclopaedic articles depends on the size of the community core. As an indicator of the effective development of core articles, the number of articles exceeding 16,000 characters from the list of 10,000 articles that every Wikipedia should have (top 10k) was adopted. The indicator for the size of the community core was the number of Wikipedians performing at least one edit in the last thirty days. The activity rate for the end of January 2026 was used; however, this value is relatively constant, as demonstrated in previous research (Skolik, 2025).
- H3. The higher the effectiveness of cooperation in developing core encyclopaedic articles, the more the volume of articles presented to readers as the best increases. In this case, the median size of articles from the top 10k list was adopted as the indicator of effective development of core articles. The indicator of articles presented to readers as the best is the number of articles evaluated by communities as "featured". While the increase in the size of articles from the top 10k list occurs independently of awareness of the list's existence, featured articles (FA) are submitted by authors for evaluation regarding compliance with established standards.

In the second stage of the study, the same language versions of Wikipedia were compared in terms of user mobilisation for collaborative action and cooperation with external institutions. A review of web pages concerning forms of cooperation was conducted, alongside an interpretation of the differences between language versions in this regard. A broader characterisation of the diversity was made possible by the netnographic approach (see Kozinets, 2015), particularly through the author's previous involvement in co-organising initiatives for content development across several Wikimedia projects.

4. Results

In the initial years of Wikipedia's development, users were primarily mobilised to create new articles, often only in stub form, assuming that they would be expanded by others at a later time. Simultaneously, it was assumed that the development of entries created en masse by thousands of Wikipedians would lead to an increase in their quality. Subsequently, attention began to be drawn to the fact that a significant proportion of the articles created in this manner were not being further developed. This, in turn, led to a need to identify such articles and eliminate flawed content through correction or deletion. One method of such identification involved the placement of specific templates within articles to provide information about their defects. Not all flawed articles were tagged in this way, and critical voices emerged within communities, asserting that tagging alone does not lead to content improvement. If, however, a larger number of users tagging defects did not directly lead to an increase in content quality, it could nonetheless contribute to the more frequent identification of problematic articles. For the purposes of this study, it was examined whether a higher number of registered users correlates with a larger number of articles tagged with a template indicating a lack of sources. Statistical testing revealed a statistically significant relationship between the two variables at $p < 0.05$. Spearman's rho correlation coefficient equals 0.5638. Consequently, H1 can be accepted. The results on logarithmic scales are presented in Figure 1.

The correlation between the intensity of tagging problematic articles and the number of users would likely be higher if a greater number of templates (notices) were taken into account. In the French version, there are over a dozen notices describing sourcing issues, while the one indicating a complete lack of sources was used significantly less frequently in relation to the number of users.

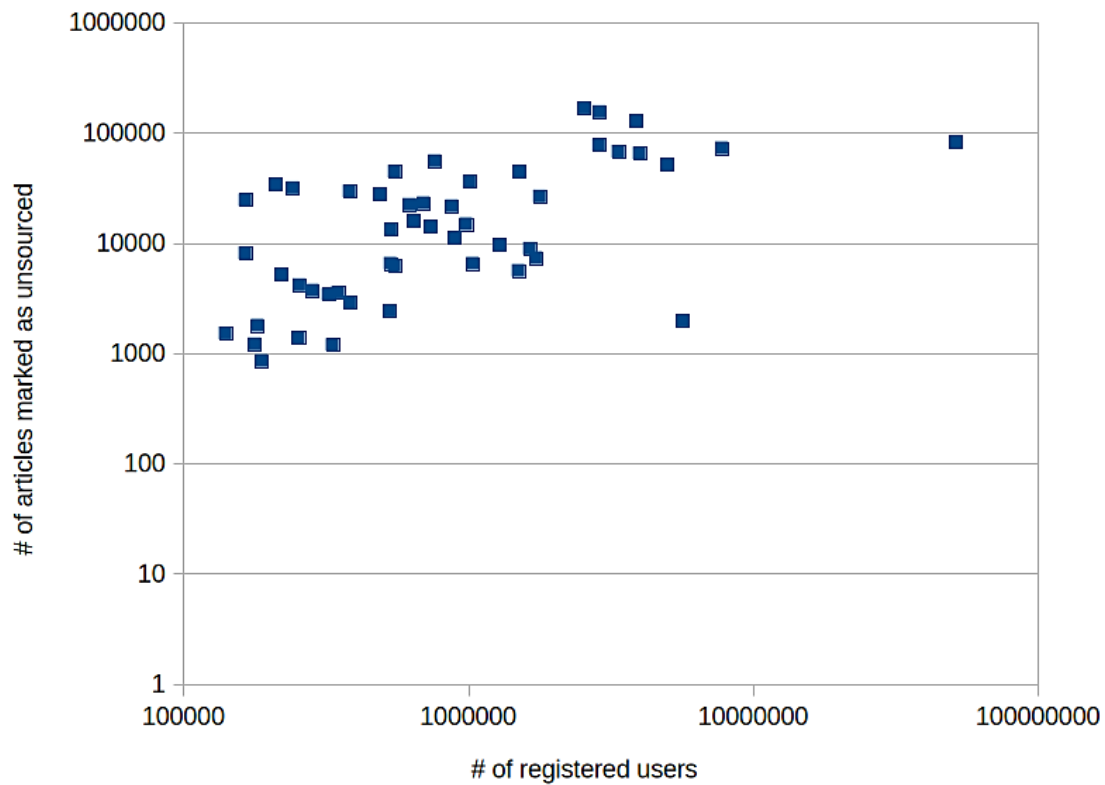


Figure 1. Correlation between the number of registered users and the number of articles marked as unsourced.

Source: own work.

The number of registered users does not imply that these individuals are active in the project. Only a fraction of those who create accounts perform edits on Wikipedia and become part of the community. Individuals engaged in editing and familiarising themselves with the operating principles can contribute to a greater extent to the increase in the quality of the accumulated knowledge. Therefore, it was assumed that the number of active users correlates with the development of articles recognised as core to the encyclopaedia. The list of 10,000 core articles (top 10k) was developed on a dedicated meta-page by the global community of Wikipedians. Specific metrics were also developed for these articles, including the number of articles containing at least 16,000 characters and the median article size (*List of Wikipedias by expanded sample of articles*, 2026). The study found that a statistically significant relationship exists between the number of active Wikipedians and the number of "huge articles" (> 16k characters) every Wikipedia should have. For $p < 0.05$. Spearman's rho correlation equals 0.7603 (Figure 2). Hypothesis 2 was also accepted.

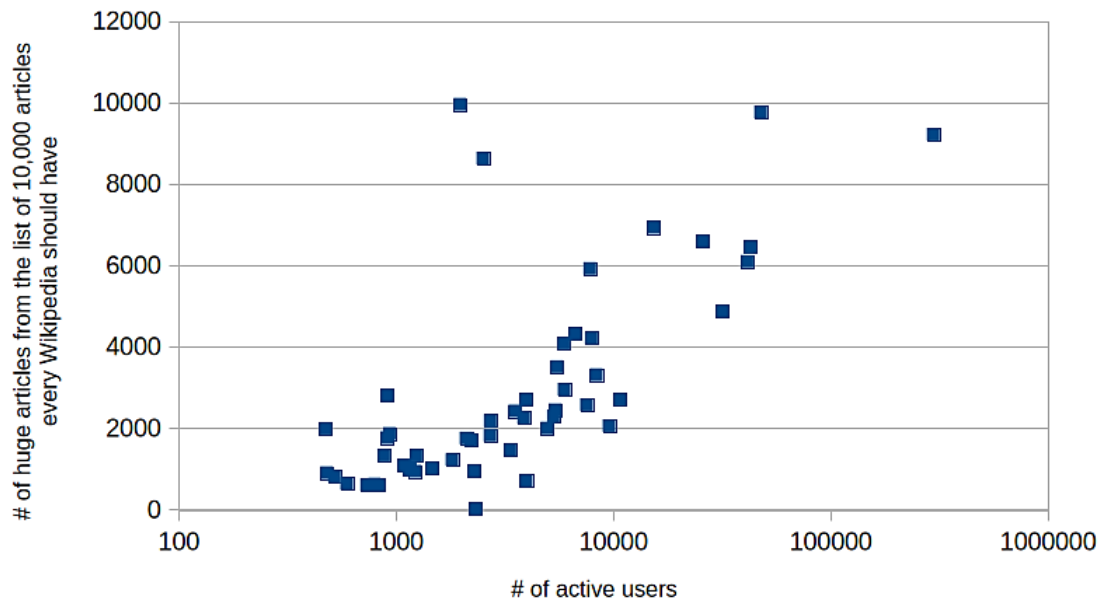


Figure 2. Correlation between the number of active users and the number of "huge articles" from the list of 10,000 articles every Wikipedia should have.

Source: own work.

Although the correlation strength in this case is greater than in the H1 test, more outliers from the trend are visible. In several cases, it can be said that communities exist which are more focused on developing these arbitrarily selected articles. These include Wikipedians from the Serbian, Catalan, and Spanish language versions, as well as the Basque and Galician versions among the smaller ones. It is noteworthy that, with the exception of the Serbian Wikipedia, the others are created by communities residing in a single country: Spain.

An increase in article size does not necessarily mean they are free from defects. It is possible that Wikipedians from the aforementioned versions compete with one another to achieve a higher position in the top 10k ranking. In large Wikipedia versions, communities attach significant importance to the projects' image and feature specially selected content on their main pages, most notably FAs. Such articles are often developed by individuals; however, they are subsequently peer-reviewed by active users, and any identified errors prevent them from being featured. It was assumed, nevertheless, that the increase in the volume of articles (median article size) from the top 10k list correlates with the number of FAs. A statistically significant relationship was demonstrated between these variables; for $p < 0.05$. Spearman's rho correlation equals 0.7702 (Figure 3.). Thus, H3 was also accepted.

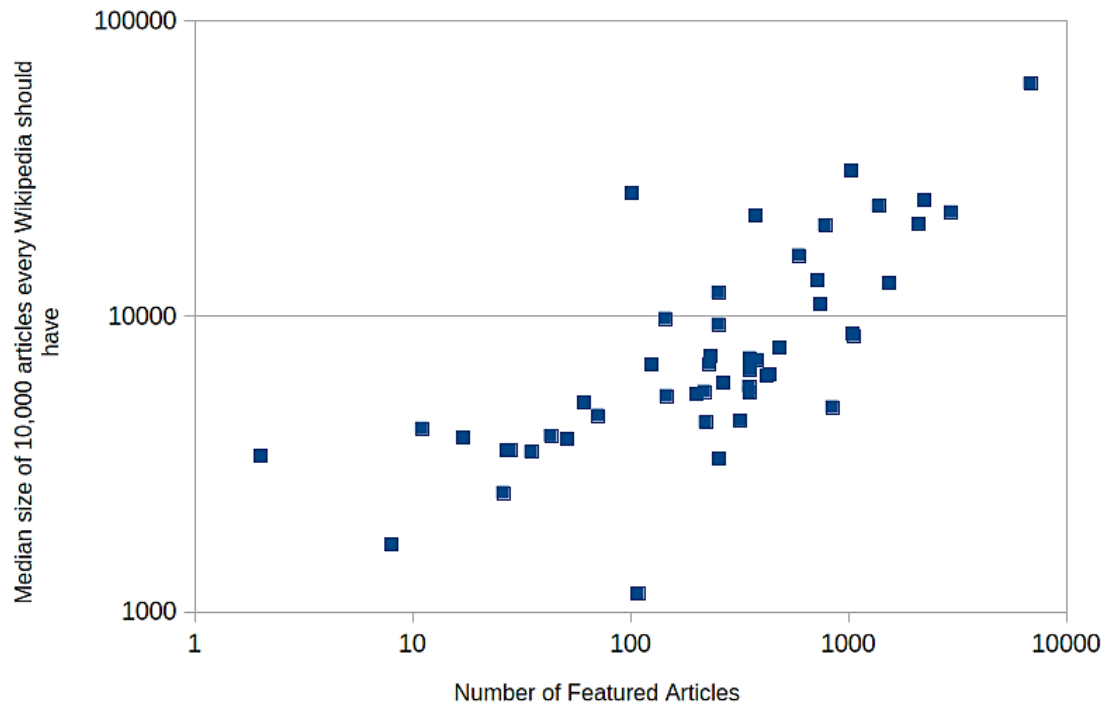


Figure 3. Correlation between the number of Featured Articles and the median size of the 10,000 articles every Wikipedia should have.

Source: own work.

In this case, certain deviations from the trend are also visible. The Japanese-language Wikipedia, despite its large community and highly developed articles from the top 10k list, has almost the same number of FAs as the Cantonese version, which is created by a small community. The median article size from the top 10k list is 25 times smaller in the Cantonese version compared to the Japanese version. This may result from less restrictive article evaluation in the Cantonese version due to a smaller number of mutually monitoring actors within the social network. Individual communities may also have priorities other than generating a large number of FAs. Additionally, it was examined whether and how strong the correlation is between the number of active users and the number of FAs. A statistically significant relationship was demonstrated between these variables; however, for $p < 0.05$, Spearman's rho correlation equals only 0.6285. The strength of this correlation is therefore weaker than the relationship between article size and quality.

In the second phase of the study, a qualitative analysis of cooperation in user mobilisation and building relationships with external institutions was conducted. Although the software used by Wikimedia was developed with collaborative content creation in mind, the communication method for novice users was unintuitive. Consequently, a range of external communication channels was launched, from mailing lists and chats to social media. However, offline meetings were more conducive to adopting a shared perspective, even though they typically gathered only a fraction of the most active users. Nonetheless, events of this type were popular enough to be documented in almost every major language version. Of the 50 versions studied, only five

(Simple English, Estonian, Galician, Tamil, and Cantonese) did not have established pages dedicated to community meetings (Table 1).

Table 1.

Selected types of pages documenting methods of mobilising Wikipedians for collaborative action in the studied language versions of Wikipedia

Language version	MEET	EDIT	COMP	COLL	Language version	MEET	EDIT	COMP	COLL
English	x	x	C	C	Greek	x			C
Spanish	x	x	C		Norwegian	x		p	
French	x		C	p	Catalan	x	x	C	
German	x	x	C		Bengali	x	x	C	C
Italian	x	x			Malay	x			C
Japanese	x		p		Romanian	x		p	C
Chinese	x		C	C	Bulgarian	x			
Polish	x	x		p	Serbian	x		C	
Dutch	x		p	C	Danish	x	x	p	
Hebrew	x				Slovak	x		p	
Portuguese	x		C	C	Croatian	x			
Russian	x	x			Estonian			C	
Persian	x	x		C	Hindi	x	x	C	C
Arabic	x	x	C	C	Azerbaijani	x			C
Czech	x	x	p		Slovenian	x	x	C	C
Ukrainian	x		C	C	Basque	x			
Korean	x	x		C	Armenian	x			
Turkish	x	x		C	Min Nan Chinese				
Indonesian	x			C	Lithuanian	x			
Swedish	x			C	Uzbek	x	x	C	
Simple English					Latvian	x		C	p
Vietnamese	x		C	C	Tamil				
Finnish	x				Albanian	x			
Hungarian	x				Georgian	x	x		
Thai	x			C	Galician			p	

Language versions are listed from largest to smallest. In the column headings, abbreviations denote documented forms of cooperation: MEET – meetups; COMP – competitions; EDIT – edit-a-thons; COLL – general category of collaboration. The letters denote: x – occurrence of a document; p – existence of a web page; C – existence of a broader category of documents.

Source: own work.

Specific forms of user mobilisation have been developed within Wikimedia projects. One such form involved various types of competitions, often involving rivalry between language versions regarding the number of articles. Spontaneously conceived ideas for subsequent contests attracted a considerable number of Wikipedians. Over time, however, a degree of routinisation occurred in their organisation, which rendered them less attractive. Furthermore, the emphasis on the quantity of content produced faced criticism, as a significant proportion of "competition" articles did not meet accepted standards. A similar situation was observed in the case of edit-a-thons. At times, it is difficult to distinguish between these two forms of mobilisation for collaborative action. In the Polish-language version, organised special actions involve internal competition, including the awarding of symbolic prizes; however,

they are associated with the edit-a-thons category rather than competitions. To improve the structuring of cooperation forms, larger language versions of Wikipedia often established general pages dedicated to collaboration or assigned individual initiatives to a general category of collaboration. A summary of the documentation types for mobilising users for collaborative action is presented in Table 1.

To present the diversity of cooperation with external educational and cultural institutions, three types of initiatives popular in large Wikimedia projects were selected. These included GLAM projects, which relate to cooperation with galleries, libraries, archives, and museums (from which they took their name); initiatives named the Wikipedia Education Program (WEP); and Wikipedia School and University Projects (WSUP). It was observed that this type of cooperation was primarily developed in the largest language versions (Table 2).

A page dedicated to the GLAM initiative was absent in only three out of the 25 largest language versions: Chinese, Vietnamese, and Simple English. The last of these languages is artificial, while the first two are associated with communities originating from countries where internet users lack access to Wikipedia websites. These versions are developed primarily by diasporas active in other countries. GLAM projects lack dedicated pages in languages representing certain Asian communities and those from Central and Eastern Europe. During the first decade of Wikipedia's development, communities reported significant difficulties in cooperating with cultural institutions in Central and Eastern European countries. Sometimes, however, such initiatives are described more broadly outside of Wikipedia's own pages. Within the Wikimedia Commons project, which serves as a global repository for multimedia files used by Wikipedia (among others), categories have been created for GLAM initiatives in individual countries. Although such a page was not established in the Wikipedias created in the Armenian, Azerbaijani, Bengali, and Bulgarian languages, GLAM initiatives developed in Armenia, Azerbaijan, Bangladesh, and Bulgaria can be found on Wikimedia Commons (*GLAM by Country*, 2026). Typically, this type of cooperation involves the photographic documentation of cultural heritage.

Table 2.

Documentation of major cooperation initiatives with external institutions in the studied language versions of Wikipedia

Language version	GLAM	WEP	WSUP	Language version	GLAM	WEP	WSUP
English	x	C	C	Greek			a
Spanish	x	C	a	Norwegian	x		a
French	x		C	Catalan	x	C	a
German	x	a	C	Bengali			
Italian	x		C	Malay			
Japanese	x	C		Romanian		a	
Chinese		C	a	Bulgarian			
Polish	x	a	C	Serbian	x		
Dutch	x	C		Danish	x		
Hebrew	x		a	Slovak			a
Portuguese	x	C	C	Croatian	x		

Cont. table 2.

Russian	x	a	a	Estonian	x		
Persian	x	C	a	Hindi	x	a	
Arabic	x	C	a	Azerbaijani			
Czech	x			Slovenian			C
Ukrainian	x	a	a	Basque		C	
Korean	x	C	a	Armenian			
Turkish	x	C	C	Min Nan Chinese			
Indonesian	x		C	Lithuanian			
Swedish	x	C		Uzbek		a	
Simple English			C	Latvian	x	C	
Vietnamese		a		Tamil			
Finnish	x			Albanian			
Hungarian	x		C	Georgian			
Thai	x	a	C	Galician			C

Language versions are listed from largest to smallest. In the column headings, abbreviations denote documented forms of cooperation: GLAM – pages dedicated to cooperation with galleries, libraries, archives, and museums; WEP – Wikipedia Education Program; WSUP – Wikipedia School and University Projects. The letters denote: x – occurrence of a document; p – existence of a web page; C – existence of a broader category of documents.

Source: own work.

Educational programmes, in turn, do not always entail formal cooperation with educational institutions and may be implemented independently by teachers or lecturers. The lack of formal cooperation, however, results in Wikipedians having no control over how new users adapt to established rules. This frequently leads to the reverting of contributions made by students as part of their coursework. If WEP and WSUP projects are considered complementary, they were absent from only the Czech and Finnish language versions among the 25 largest Wikipedias. Nevertheless, Czech Wikipedians undertake educational initiatives supported by the Wikimedia Česká republika association, aimed at developing region-related knowledge (*Czechoslovakia 2025*, 2026). Similar actions were taken by the Wikimedia Suomi association, which oversees the Finnish-language Wikipedia (Perhiö, 2017). Unlike GLAM, under which global competitions such as Wiki Loves Monuments are continually organised, educational programmes tend to have a shorter lifespan. WSUP were relatively popular in the Polish-language Wikipedia prior to 2010, but were only rarely implemented in the following decade.

5. Discussion

Regardless of the various factors influencing the effectiveness of cooperation, the number of users contributes to the growth of qualitative resources within Wikimedia projects. Previous studies have noted the existence of a specific mechanism of sequential content supplementation and correction (Mayer, Heck, Kimmerle, 2025). However, the creation of top-tier content (FA) is often the result of actions by individual users who conduct source research and expand

articles based on their findings. Similarly, the identification of problematic articles is frequently carried out by a small number of users who specialise in reviewing content and posting notices regarding identified defects. If, therefore, one can speak of a sequentiality of actions, it is often not a synchronised team effort, but rather an "assembly-line" process of content creation, development, and modification. Over time, the most committed users specialise in a very narrow range of activities, and the choice of "career paths" may begin as early as the initial stage of editing Wikipedia (Antin, Cheshire, Nov, 2012). This applies to both the thematic scope and the type of edits performed. On a macro scale, this sequentiality of action may also be linked to the mobilisation to edit or the decision to withdraw from activity, depending on a sense of uncertainty regarding one's knowledge, as pointed out by Yang and Tanaka (2023).

The size of the Wikipedian community may also influence the heterogeneity of the structure of documented forms of cooperation within the project. Small communities operating in smaller teams do not require a large number of pages and categories reflecting the spontaneously emerging division of labour. For any initiative to be effective, it requires the involvement of at least several or a dozen individuals. Launching too many initiatives in small communities may lead to cannibalisation or result in the atrophy of initiatives as the number of users decreases. In very large projects, such as the English-language Wikipedia, it is possible to determine the properties of social networks within its structures (e.g. in the WikiProjects workspace). Such research allows for the identification of conditions for group efficiency (Rychwalska et al., 2025). In smaller communities, however, internal structures are less permanent and tend to disappear. In the Polish-language Wikipedia, dozens of WikiProjects were established before 2010; however, by the third decade of the 21st century, high activity was observed in only a few of them, and many had been abandoned. The decline in efficiency and the subsequent dying out of some WikiProjects could also have been influenced by fluctuations resulting in a mismatch with the optimal team size (Kukowska, 2023).

Large communities also possess greater capacity to mobilise users for cooperation with external institutions. Greater experience results in more frequent engagement of cultural and academic institutions in the collaboration on knowledge resource creation within Wikimedia. Despite this, situations are still observed where newcomers joining through such collaborations encounter significant difficulties in expanding Wikipedia's content (Gluza, Turaj, Meier, 2021; Konieczny, 2021). This primarily concerns communication problems between Wikipedians and representatives of external institutions. Newcomers typically do not know at least some of the most important rules; sometimes, even event organisers are themselves unfamiliar with the guidelines. Furthermore, the later institutions joined the cooperation, the more difficult it was to convey knowledge of internal rules, the number of which has increased over time.

6. Summary

The research findings presented in the article indicate that achieving a substantial "critical mass" is a vital factor in the development of cooperation on Wikipedia. A larger user base leads to the creation of a higher number of articles evaluated as featured and enables the identification of flawed articles, while also fostering a diversity of cooperation forms in terms of both user mobilisation and collaboration with external institutions. However, in certain communities, a significantly greater focus on activities aimed at improving the quality of core articles can be observed. This may be linked to local cultural determinants. In other cases, political factors may restrict Wikipedians' ability to cooperate with cultural institutions.

A better understanding of the specifics of individual language versions of Wikipedia would require a more detailed examination of the collaboration processes in the projects. Numerous articles highlighted for quality or marked as defective may be the result of short-term community initiatives. In this regard, two forms of collaboration can be distinguished: on the one hand, routine efforts to improve the project's quantity and quality; on the other, initiating initiatives and mobilizing many active users. However, the mobilization activities themselves lose momentum over time and turn into routine activities involving a small part of the Wikipedia community.

Selecting the 50 largest language versions for the study made it possible to illustrate certain disparities between them. However, this did not constitute an exhaustive review of all forms of cooperation within individual language versions. Further research in this area would allow for a more in-depth analysis of local conditions and help to capture how specific forms of cooperation emerge within virtual communities of practice.

References

1. Antin, J., Cheshire, C., Nov, O. (2012). Technology-mediated contributions: Editing behaviors among new wikipedians. *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work, CSCW '12*, pp. 373-382. doi: 10.1145/2145204.2145264
2. Benkler, Y. (2008). *Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven/London: Yale University Press.
3. *Czechoslovakia 2025: Seniors and Students Bring History to Life on Wikipedia – Wikimedia ČR* (2026). Retrieved from: <https://www.wikimedia.cz/en/2026/02/02/czechoslovakia-2025-seniors-and-students-bring-history-to-life-on-wikipedia/>
4. *GLAM by country—Wikimedia Commons* (2006). Retrieved from: https://commons.wikimedia.org/wiki/Category:GLAM_by_country

5. Gluza, W., Turaj, I., Meier, F. (2021). Wikipedia Edit-a-thons and Editor Experience: Lessons from a Participatory Observation. *Proceedings of the 17th International Symposium on Open Collaboration, OpenSym '21*, pp. 1-9. doi: 10.1145/3479986.3479994
6. Halitaj, A., Zubiaga, A. (2024). Providing Citations to Support Fact-Checking: Contextualizing Detection of Sentences Needing Citation on Small Wikipedias. *Natural Language Processing Journal, Vol. 8*, doi: 10.1016/j.nlp.2024.100093
7. Karczewska, A. (2023). GLAM Wikiprojects as a Form of Organization of Cooperation Between Wikipedia and Cultural Institutions. *European Conference on Knowledge Management, Vol. 24*, pp. 619-627. doi: 10.34190/eckm.24.1.1374
8. Konieczny, P. (2021). The Case for Institutional Support: It's High Time for Governments and University Administration to Actively Support Wikipedia. *She Ji: The Journal of Design, Economics, and Innovation, Vol. 7, Iss. 2*, pp. 187-196. doi: 10.1016/j.sheji.2021.05.002
9. Kozinets, R.V. (2015). *Netnography: Redefined* (2nd edition). SAGE Publications Ltd. Retrieved from: http://whel-primo.hosted.exlibrisgroup.com/openurl/44WHELF_NLW/44WHELF_NLW_services_page?u.ignore_date_coverage=true&rft.mms_id=99828644702419
10. Kukowska, K. (2022). Knowledge Sharing Co-operative Structures: The Case of WikiProjects. *European Conference on Knowledge Management, Vol. 23*, pp. 696-704. doi: 10.34190/eckm.23.1.570
11. Kukowska, K. (2023). Collaborative Structures in WikiProjects. Wikipedia Users' Activity Case Study. *European Conference on Knowledge Management, Vol. 24*, pp. 760-768. doi: 10.34190/eckm.24.1.1377
12. Kuznetsov, A., Novotny, M., Klein, J., Saez-Trumper, D., Kittur, A. (2022). Templates and Trust-o-meters: Towards a widely deployable indicator of trust in Wikipedia. *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems, CHI '22*, 1-17. doi: 10.1145/3491102.3517523
13. Lessig, L. (2008). *Remix: Making Art and Commerce Thrive in the Hybrid Economy*. East Rutherford: Penguin Publishing Group.
14. Levinson, P. (2009). *New new media*. Boston: Allyn & Bacon.
15. *List of Wikipedias by expanded sample of articles – Meta-Wiki* (2006). Retrieved from: https://meta.wikimedia.org/wiki/List_of_Wikipedias_by_expanded_sample_of_articles
16. Mannes, A.E., Soll, J.B., Larrick, R.P. (2014). The wisdom of select crowds. *Journal of Personality and Social Psychology, Vol. 107, Iss. 2*, pp. 276-299. doi: 10.1037/a0036677
17. Massa, P., Scrinzi, F. (2012). Manypedia: Comparing language points of view of Wikipedia communities. *Proceedings of the Eighth Annual International Symposium on Wikis and Open Collaboration*, pp. 1-9. WikiSym '12: The 8th International Symposium on Wikis. doi: 10.1145/2462932.2462960

18. Mayer, M., Heck, D.W., Kimmerle, J. (2025). Opting out in computer-supported sequential collaboration. *Computers in Human Behavior*, Vol. 165, doi: 10.1016/j.chb.2024.108527
19. Miller, B., Steyvers, M. (2011). The Wisdom of Crowds with Communication. *Proceedings of the Annual Meeting of the Cognitive Science Society*, Vol. 33, Iss. 33.
20. Miquel-Ribé, M., Laniado, D. (2021). The Wikipedia Diversity Observatory: Helping communities to bridge content gaps through interactive interfaces. *Journal of Internet Services and Applications*, Vol. 12, Iss. 1, doi: 10.1186/s13174-021-00141-y
21. Nemoto, K., Gloor, P.A. (2011). Analyzing Cultural Differences in Collaborative Innovation Networks by Analyzing Editing Behavior in Different-Language Wikipedias. *Procedia - Social and Behavioral Sciences, The 2nd Collaborative Innovation Networks Conference - COINs2010*, Vol. 26, pp. 180-190. doi: 10.1016/j.sbspro.2011.10.574
22. Perhiö, T. (2017, May 12). Kylmä sota, kuuma tietosanakirja: 136 lähdeviitettä ja 10 artikkelia kurssityönä Wikipediaan. *Wikimedia Suomi*. <https://wikimedia.fi/2017/05/12/kylma-sota-ja-wikipedia-koulutuksessa/>
23. Pilati, F., Sacco, P.L., Artime, O. (2025). Mass collaboration or curatorship? The functioning of Wikipedia needs both. *Online Information Review*, Vol. 49, Iss. 8, 122-133. doi: 10.1108/OIR-10-2023-0515
24. Priedhorsky, R., Chen, J., Lam, S. (Tony) K., Panciera, K., Terveen, L., Riedl, J. (2007). Creating, destroying, and restoring value in wikipedia. *Proceedings of the 2007 International ACM Conference on Conference on Supporting Group Work - GROUP '07*.
25. Raszewski, L., Kock, C.D. (2025). Detecting Sockpuppetry on Wikipedia Using Meta-Learning. *Proceedings of the 63rd Annual Meeting of the Association for Computational Linguistics, Vol. 1: Long Papers*, pp. 22252-22264. doi: 10.18653/v1/2025.acl-long.1083
26. Rychwalska, A., Talaga, S., Ziembowicz, K., Jemielniak, D. (2025). Quality teamwork on Wikipedia: Interpersonal communication networks as a social capital booster. *Journal of the Association for Information Science and Technology*, Vol. 76, Iss. 11, pp. 1553-1569. doi: 10.1002/asi.70014
27. Shimada, T., Ogushi, F., Török, J., Kertész, J., Kaski, K. (2023). A simple model of edit activity in Wikipedia. *Physica A: Statistical Mechanics and Its Applications*, Vol. 630, 129253. doi: 10.1016/j.physa.2023.129253
28. Skolik, S. (2017). Pacynki, trolle, spam, hoaxy i wandalizmy. Mechanizmy wykrywania oszustów w przestrzeni Wikipedii. *Teksty z Ulicy. Zeszyt Memetyczny*, Vol. 18, pp. 129-143.
29. Skolik, S. (2023). Meaning of the Power Users in the Wikipedia Working Environment. *European Conference on Knowledge Management*, Vol. 24, pp. 1228-1236. doi: 10.34190/eckm.24.2.1376
30. Skolik, S. (2025). The Dynamics of Knowledge Social Sharing in the Major Wikipedia Language Versions. *European Conference on Knowledge Management*, Vol. 26, Iss. 2, pp. 921-928. doi: 10.34190/eckm.26.2.3723

31. Surowiecki, J. (2005). *The Wisdom of Crowds*. Westminster: Knopf Doubleday Publishing Group.
32. Tapscott, D., Williams, A.D. (2008). *Wikinomia: O globalnej współpracy, która zmienia wszystko*. Warszawa: Wydawnictwa Akademickie i Profesjonalne.
33. Vetter, M.A., Sarraf, K.S., Woods, E. (2022). Assessing the Art + feminism Edit-a-thon for Wikipedia literacy, learning outcomes, and critical thinking. *Interactive Learning Environments*, Vol. 30, Iss. 6, pp. 1155-1167. doi: 10.1080/10494820.2020.1805772
34. Wang, Z., Zhang, Y., Yoon, D., Vincent, N., Samir, F., Shwartz, V. (2025). *WikiGap: Promoting Epistemic Equity by Surfacing Knowledge Gaps Between English Wikipedia and other Language Editions* (arXiv:2505.24195). arXiv. doi: 10.48550/arXiv.2505.24195
35. Warncke-Wang, M., Ho, R., Miller, M., Johnson, I. (2023). Increasing Participation in Peer Production Communities with the Newcomer Homepage. *Proceedings of the ACM on Human-Computer Interaction*, Vol. 7, Iss. CSCW2, pp. 280:1-280:26. doi: 10.1145/3610071
36. *Wikimedia Statistics* (2006). Retrieved from: [https://stats.wikimedia.org/#/en.wikipedia.org/contributing/active-editors/normal|line|2-year|\(page_type\)~content*non-content|monthly](https://stats.wikimedia.org/#/en.wikipedia.org/contributing/active-editors/normal|line|2-year|(page_type)~content*non-content|monthly)
37. Yang, K., Tanaka, M. (2023). Crowdsourcing Knowledge Production of COVID-19 Information on Japanese Wikipedia in the Face of Uncertainty: Empirical Analysis. *Journal of Medical Internet Research*, Vol. 25, Iss. 1, e45024. doi: 10.2196/45024
38. Yoon, J., Park, J., Yun, J., Jung, W.-S. (2023). Quantifying knowledge synchronization with the network-driven approach. *Journal of Informetrics*, Vol. 17, Iss. 4, 101455. doi: 10.1016/j.joi.2023.101455

DEVELOPMENT OF MODERN LEADERS AS A FUNDAMENTAL FUNCTION OF THE LEADERSHIP TRAINING SYSTEM IN THE ARMY

Jan STACHOWICZ^{1*}, Bartosz SYLWESTRZAK²

¹ General Tadeusz Kościuszko Military University of Land Forces in Wrocław; jan.stachowicz@awl.edu.pl,
ORCID: 0000-0002-2838-7142

² General Tadeusz Kościuszko Military University of Land Forces in Wrocław; bartosz.sylwestrzak@awl.edu.pl,
ORCID: 0000-0002-1649-1436

*Correspondence author

Purpose: The main objective of the research presented in this paper is an attempt to present a modern leadership in command personnel armed forces training systems, with particular focus on the tactical level.

Design/methodology/approach: The research process involved document research, critical analysis of literature and logical deduction in order to formulate conclusions.

Findings: The popularization of the modern leadership model in management and command systems requires the proper definition of a leader model with a high level of professional, moral and social reliability, functioning within a network of leaders of contemporary organisations, providing a high level of interpersonal trust in leadership systems and following the rules for shaping the organizational structure of leadership in management and command systems.

Practical implications: The changing nature of challenges in the areas of security, social norms and trends, as well as in the structure of societies, gives rise to new expectations and needs in terms of effective training for command authorities. This determines the need to continue research on developing the leadership skills of commanders at all levels. Fortunately, the significance of the problem seems to have been correctly identified, and training centers and research centers are effectively developing their capabilities to fulfill their tasks.

Originality/value: The article contains recommendations concerning the conditions necessary for the popularisation of the proposed leadership model in the context of threats identified in the research process. It is addressed to managers of organisations and institutions of the security agencies and researchers involved in the issue of leadership in the modern economy and the rebuilding of the security architecture.

Keywords: leadership, reliability, management.

Category of the paper: Research paper.

1. Introduction

The pressure of management practice and its specific variant, i.e., command, as well as the crisis of the principles and concepts of leadership used in these processes to date, are the reasons for the formulation of new concepts and models of management and command, including new models of leadership. In these areas of management activity, practically every manager and commander takes on a leadership role. There are relatively few publications in the literature that focus on the role of cognitive technologies in developing leadership skills and theory of modern shared leadership (Zbierowski, 2024; Łydka, 2024; Majewski, 2020; Matthews, Lester, Hannah, Reed, 2022). The pressure of crisis conditions and the pressure to implement solutions based on modern information technologies and artificial intelligence (AI) determine the legitimacy of significant changes in the education of management and command personnel, as well as changes in the structure and functions of leadership systems in the management and command process at various levels and stages of the organizational structure. This article presents concepts of leadership systems in command based on contemporary organizational conditions. Particular attention is paid to sociological and psychological conditions and barriers to the use of information technology and artificial intelligence in the process of shaping and applying a new leadership model. The aim of this publication is to attempt to develop a model of modern leadership in command training systems, with particular emphasis on the tactical level. Based on a review of the available literature on the subject, using document research, critical analysis of the literature, and logical deduction, conclusions were formulated and presented in the final part of the article.

2. Methods

The research was conducted using such research methods and techniques as critical analysis of literature, review of legal acts and normative documents concerning program assumptions in the process of training and improving sub-unit commanders, secondary research and logical deduction. As part of the literature review, an analysis was carried out of the available databases using keywords such as leadership, cognitive technologies, management and command. The results of the study on the identification of sociological, psychological, and axiological determinants of leadership, the importance of information and cognitive technologies, and the building of leadership credibility as the basis for effective management processes are presented below.

3. Results

Cognitive crises and breakthroughs show up as an impossibility to understand and explain what's going on in social, economic and political reality. This is caused by the weakness of cognitive paradigms for constructing scientific theories and formulating a methodological basis for instruments, i.e., principles, procedures, and methods of practice in the processes of organizing contemporary reality. Important reasons for cognitive breakthroughs and the formulation of new cognitive dogmas and new theories and tools for rationalizing management include the discovery of the essence of the role and importance of human psychology and the sociology of communities and organizations, as well as related phenomena and processes. But perhaps above all, despite many crises, it is the realization of the truth about the principles and necessity of ethical and moral values that dominate the development of societies, and the recognition of the rights and obligations of managers in this area. Among those identified as important for shaping management and command processes is awareness of the influence of emotions on human behavior. The discovery in the human brain of organs responsible for the flow and transformation of emotional states, including empathy, is justified, among other things, by the theory of shared circuits (Keysers, 2017). The author argues that we are all connected by invisible bonds of mutual influence. The invisible bonds of shared circuits explain the impact of leaders, among others, on the behavior and attitudes of members of organizations and societies in which they lead due to their functions. Emotions, as practice teaches us, also significantly influence the behavior of managed and commanded members of an organization, which is further emphasized by the impact of social media today. Unfortunately, today's sophisticated social media systems too often lead to targeted disinformation to manipulate attitudes and emotions, and thus to control the behavior of members of organizations and societies. In this context, emotional intelligence is one of the determinants that plays an important role in an individual's life, influences the proper management of one's own emotions and coping with the emotions of others, builds social relationships, and supports human cognitive development. Researchers believe that emotional intelligence has a significant role in achieving positive results at work, in almost every position and in every profession. They point out two positive aspects of emotional intelligence that help people function in a professional environment:

- the cognitive aspect, which allows for the efficient processing of information that influences thought processes, which also supports creativity and ingenuity as important leadership skills,
- the social aspect, which ensures the efficient adaptation of individuals to functioning in difficult social conditions.

Emotional competence is a practical skill resulting from emotional intelligence. The skills that make up emotional competence contribute to success at work (in service). These include the following elements:

- self-awareness – knowledge of one's own internal states, preferences, capabilities, and intuitive judgments, realistic assessment of one's own abilities, and justified belief in one's own capabilities,
- self-regulation – control over one's own internal states, impulses, and capabilities,
- motivation – emotional tendencies that lead to new goals or facilitate their achievement,
- empathy – awareness of other people's feelings, needs, and concerns, the ability to see things from another person's point of view,
- social skills – eliciting desired responses from others and the ability to control one's own emotions in interpersonal interactions (Goleman, 1999).

Modern organizations try to develop their emotional intelligence at all levels. Modern organizations strive to develop their emotional intelligence at all levels. Emotional intelligence in an organization means a way of managing the organization in which communication and interpersonal relationships contribute to its smooth and effective operation and problem solving. The team emotional intelligence of a given organization defines the level to which it utilizes the intellectual capital of its employees.

In this context, the results of research involving Ukrainian commanders who took part in operations during the Russian-Ukrainian conflict seem interesting. They draw attention to selected determinants of specific behaviors and characteristics of commanders. These include new technologies and previously unknown methods of influence, decision-making in extremely difficult situations, the attitudes and expectations of subordinates towards their commanders, and periods of oppressive physical and psychological influence by the enemy, disrupting the process of team management. As a result, the respondents identified the following behaviors and attitudes useful in the specific conditions of human team functioning described above, which are presented below.

Table 1.
Behavior and attitudes of leaders based on research

No.	Attitude, feature, behavior	Description
1.	Emotional intelligence	• interpersonal sensitivity, i.e., the ability to understand subordinates' problems, empathy, • positive impact in an extremely difficult situation, • self-awareness of one's own feelings, ability to manage them.
2.	Power delegation	• trusting subordinates, inspiring them to create their own solutions and take responsibility for them.
3.	Motivating	• precisely defining goals, influencing the team in their joint implementation.
4.	Creativity and business skills	• the ability to identify and generate new, non-standard solutions depending on current needs.

Cont. table 1.

5.	Self-regulation	• ability to take responsibility for non-standard solutions and ideas, adjusting one's own temptations in favor of a common goal.
6.	Adaptation	• the ability to adapt, adjust one's own ways of thinking and practical actions to the requirements of the combat environment imposed by the enemy and the surroundings.

Source: Sylwestrzak, 2023, pp. 531-549.

At the level of organization and command processes, sociological and psychological phenomena and processes significantly influence the rationality of decision-making processes. Examples of this can be found in the practice of decision-makers using called heuristics. Psychological heuristics are a kind of mental shortcut that our brain uses to simplify decision-making processes, allowing us to make quick decisions in the face of complexity and limited time. The human brain uses certain simplifications based on previous experiences, stereotypes, and emotions. In the literature on the subject, we can find such types as, for example:

- availability heuristic, which involves assigning a higher probability to collisions that are easier to remember,
- representativeness heuristic, which involves assessing probability based on similarity to a certain pattern or stereotype,
- anchoring heuristic, which involves relying on an initial reference point (anchor) when making decisions, even if it is irrelevant.

Koźmiński's collaborations are particularly inspiring for practicing management and leadership in contemporary organizations. As a result of research into the behavior and opinions (including results) of a group of leading figures in the economic and political spheres, he justifies the thesis that the strength of leadership manifests itself in their ability to overcome subjective and objective limitations—limitations that are influenced by sociological processes and are of particular importance to which leaders are subject. He formulated the theory of limited leadership, which provides practical recommendations for shaping the behavior of leaders to overcome barriers and limitations and act rationally. According to this concept, leadership is a constant struggle for autonomy and overcoming limitations (Koźmiński, 2013). The leadership process begins with the formulation of a goal, referred to by researchers as a vision, which is a description of the future that is attractive not only to its author but also to other members of the team (organization). In military terms, it is the intention of a specific action that includes a goal to be achieved and the way in which the leader (commander) intends to achieve it. When the vision finds receptive ground, the leadership process begins to develop. As early as the last century, many leadership theorists and researchers began to distinguish between assigned leaders and emerged leaders. The former play leadership roles as a result of assuming a formal position in an organization (public or private), without always having something to offer to the organizations and people they lead. Therefore, they do not always become true leaders. The latter, on the other hand, regardless of their title and position in the organization, begin to play an influential role in the group, thanks to their ideas, behavior, and identification with the team.

The work continued in this area by M. Bojar, defining the principles and recommendations for rational leadership in various types of communities, is valuable for contemporary management. A leader is a person who inspires, convince, motivates, and has an impact on others, and above all, points out and creates conditions for change. Contemporary conditions for the functioning of organizations and teams and their environment are characterized by constant change. In the context of leadership, the author refers to the concept of servant leadership. It is based on the idea that management is a process of serving others. A servant leader serves those he or she leads, which means that his or her followers are an end in themselves rather than a means to an end. His or her actions focus on meeting the needs of team members, ensuring their development, and building a sense of community. Servant leadership reminds us of the purpose of a public benefit organization (PBO) – to serve the people (but not only) who are associated with it and on whom the organization has an impact. What distinguishes it from other concepts is primarily the fact that it takes into account the individual motives of the leader, which seems to be of particular importance for the organization.

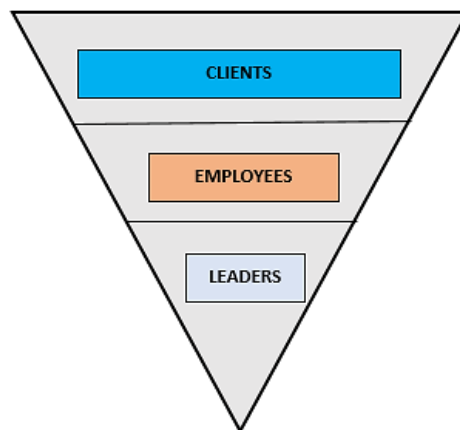


Figure 1. The role of leaders in the concept of servant leadership.

Source: own studies.

The methods of shaping these competencies in contemporary leaders should be a particularly important distinguishing feature and component of the system for selecting and training managers and commanders. A commander (leader) who does not develop their skills in an optimal way exposes their team to the loss of potential benefits and themselves to a quick end to their career. Management education should therefore be a carefully designed strategy. Various strategies are used to develop management personnel. There are managers who prefer to learn over the years by experimenting on their subordinates. This strategy has its advantages and disadvantages. The advantage is that learning takes place without leaving the workplace. The fact that you can come to conclusions on your own can be very satisfying. It should be remembered that this can be painful for the team on which the experiments are conducted. Learning in this way also avoids confrontation with other managers. This can significantly increase self-esteem, but it can also lead to overly optimistic conclusions and contribute to

a narrow view of one's potential. Moreover, it may take several years before constructive conclusions can be reached. Another strategy is ambitious self-development, combined with a passion for exploring the world, meeting new people, and studying literature. This is a very ambitious, talented, usually lonely manager who, in a heroic struggle, reaches the highest peak of their career. This is an interesting and ambitious strategy, but it requires a lot of determination. Its downside is that it leads to the periodic use of less active development methods. The third strategy is development based on egalitarian training and coaching, as well as the advice of experienced mentors and coaches. This strategy works well when a highly motivated manager encounters a very experienced mentor and has the opportunity to take advantage of various forms of development. Unfortunately, in practice, this happens rather rarely.

The meaning of IT and cognitive technologies in shaping a new leadership model. IT and cognitive technologies, including artificial intelligence (AI), which have shaped cyberspace, have a significant impact on the psychosocial processes of interaction between team members. These influences are revealed through the use of these technologies in the processes of shaping the behaviors, attitudes, and emotions of members of organizations and societies. There are many recent examples of this, including all kinds of cyberattacks, hybrid wars, propaganda campaigns using disinformation, and the like. The nature of these influences of information technology and AI on human behavior and attitudes is attempted to be explained by theories based on quantum physics. The effective use of artificial intelligence, data analysis, process automation, and other advanced tools allows for the optimization of resources, reduction of costs, more accurate decision-making, and increased competitiveness and effectiveness of organizations, including, of course, military structures. The technologies mentioned above have been put to very effective use in many modern functional areas. These innovative process organization solutions, designed to promote these solutions, are intended to lead to the organization of processes in an organization where all other processes are integrated. These technologies are used to deepen process automation and increase efficiency. Recently, a report entitled Industry 5.0. Towards a sustainable human-centric and resilient European industry was developed in the European Union. According to this concept, solutions are sought that enable a harmonious and synergistic combination of people and machines. It assumes the use of renewable energy sources and recycling, but above all, it is based on the assumption that the human employee is at the center of production, which can be done to improve their comfort at work while respecting people's rights to privacy and dignity. In this context, the question arises: does this concept find its reference in the armed forces environment? The answer seems obvious: the external ties of any structure, including the military, directly and indirectly imply external conditions and applications. It is interesting that this concept assumes the development of a shared leadership model within the organization. In these cases, the models focus on specific types of interaction, such as mutual learning, greater shared understanding, and ultimately effective action. The transition towards collective learning

is particularly important because it emphasizes the need to expand individual skills and characteristics related to learning (such as self-awareness) to include more team-focused practices and skills, such as authenticity, openness, sensitivity, and the ability to anticipate the reactions and needs of other team members.

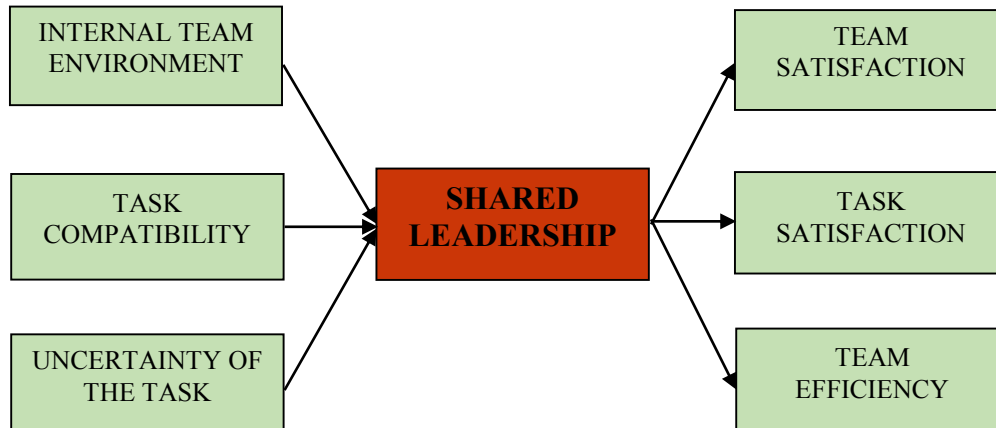


Figure 2. Shared leadership model.

Source: Sangeetha, Kumaran, 2018, p. 47.

The dynamic development of artificial intelligence-based technology is increasingly highlighting the limitations of this technology and the threats it poses today, such as: control of people's behavior in authoritarian societies (China) the use of algorithms that imitate human behavior (bots) to make autonomous decisions by machines, which is particularly dangerous in security systems, the widespread use of AI can lead to the destruction of learning processes and creativity (AI has no moral responsibility because it functions outside of human feelings and emotions). Recently, we have witnessed many attempts to regulate the development of these technologies, but above all, we are experiencing common-sense limitations on their development.

In cognitive warfare, the battlefield is the human mind. The goal is to change not only what the opponent thinks, but also how they think and how they plan and conduct combat. Effectively conducted cognitive warfare shapes and influences individual and group beliefs and behaviors, promoting the tactical or strategic goals of the opponent. In this type of activity, which operates both in the cyber domain and within the framework of subliminal activities, cybernetic, informational, psychological, and social engineering tools are used in combination to achieve specific goals. Due to the dynamic development of modern digital technologies, researchers accept the emergence of another domain for conducting operations, namely the sphere of the human mind. There is a correlation between activities conducted in the areas of hybrid, information, and cognitive warfare and other types of warfare. When organizing the functioning of a networked command and control system, it is reasonable to emphasize the limitations and barriers to the rational functioning of commanders resulting from the shortcomings and limitations of the widespread use of these technologies. In addition, when shaping the professionalism of command and management leaders, special attention should be paid to

building the professional resilience of managers and commanders to the effects of irresponsible use of AI and other technologies.

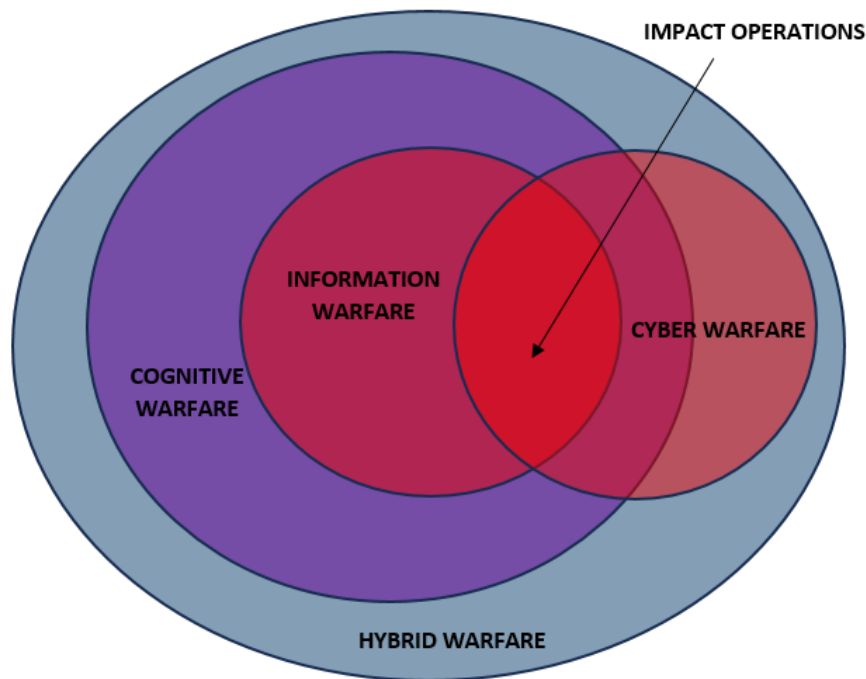


Figure 3. The relationship between cognitive and hybrid warfare and other types of activities.

Source: Jawor, [https:// infosecurity24.pl/...](https://infosecurity24.pl/...), 30.08.2025.

In the practice of organizing the management and command process, qualitatively new management functions are emerging in organizations, institutions, and military structures. These functions, as strategic systems inspiring the activities of managers and commanders, organize distinctive leadership systems within management systems. These contemporary leadership systems not only rationalize command processes, but also organize these systems as autopoietic systems. The autopoietic nature is a feature of living systems, as well as social systems, which, through systems of self-organization and mutual interaction, relationships of trust, causes the reproduction of states and organizational culture. On this basis, among others, the following principles of contemporary leadership can be identified:

- raising awareness of the qualitatively new leadership role of leaders in management activities in the economy, uniformed services, administration, and governance;
- the decentralisation of the functions and roles of leaders. Bringing this charismatic and strategic role and function of leaders down to the operational levels of command management and project/task management;
- the relevance of shaping and developing the specific talents and competencies of contemporary leaders, such as the ability to formulate strategic, innovative ideas, concepts, and decisions; the ability to transform and communicate decisions to partners and motivate them to act and behave in accordance with the concepts and decisions of leaders, the ability to formulate knowledge about the methods and instruments for

implementing the leader's concepts and decisions, and the ability to reliably convey this knowledge to partners and subordinates. We assess these abilities as the level of intellectual capital, including the emotional intelligence of the leader, the ability of leaders to build relationships of trust in executive teams and motivation for cooperation and innovative task solving;

- popularising awareness of the particular importance and role of moral values and virtues of leaders, which have come to be known as attributes of a leader's personality, referred to as humanity in general. Personality is a set of relatively stable traits that we consider moral; it is an internal system of regulating attitudes and behaviours. The humanity of managers and leaders is characterized by a dominant system of values and moral norms in their behavior, characterized by empathy, social sensitivity, and ecological sensitivity. This leads to the justification of ethical assessments of one's own behavior and the behavior of others through the prism of ethical criteria, which consist of the virtues of kindness, righteousness, courage, bravery, and composure, and the counteraction of behaviors characterized by wickedness, cowardice, and indolence;
- distinguishing feature of contemporary leadership is the unique ethos of the modern leader, which determines, for example, the recommended course of action in complex, conflictual situations (such as combat). A contemporary leader is not only a person with very high competences and moral virtues, but also someone who shapes the ethical behavior and attitudes of subordinates and partners;
- structure of the leadership system is shaped by networks of interactions and mutual influences between members of the organization and partners in projects. Each mutual interaction becomes and occurs as an intertwining, an organization of three elements: creative power potential, knowledge potential, and the potential of social and moral values;
- special leadership skills of managers are manifested in decision-making processes, communicating decisions to others, and inspiring and motivating them to act in accordance with the leaders' wishes. The processes and phenomena of transferring creative power, knowledge, and values to partners and subordinates shape specific social relationships in organizations, i.e., interpersonal behavior and subordination relationships. It should be emphasized that these processes occur in accordance with the mechanisms of the so-called trust spirals. This concept describes a mechanism in which trust in society is built and strengthened through mutual interactions. According to the author, trust is not something that is given once and for all; it is a process that can develop or disappear depending on the behavior of individuals and institutions. Mutual, positive interactions lead to an increase in trust, which in turn encourages further trust-based actions. A positive spiral is created, which strengthens social bonds.

According to the findings of the research and in particular the review of the relevant literature and empirical studies, there are no clear references to the identified research gap. In this context, the area under investigation appears to be significant, and this study fills the identified research gap.

4. Discussion

The research carried out confirms that there is a justified need to develop the concept of a modern leadership model in the process of training command personnel for the Polish armed forces. They indicate that emotional intelligence and the reliability of the leader or commander are particularly important qualities that have a significant impact on the management of military personnel in difficult conditions, in the conditions of war and kinetic, hybrid and cognitive operations. This shows that there is a need for further research in this area.

Building the credibility of leaders as the basis for effective management processes. Modern management and leadership are particularly important in new types of leadership processes. The main features of this new leadership system are:

- a) mutual interaction within a network of leaders, executives, and subordinates participating in leadership processes,
- b) particularly high management competence potential focused on information and cognitive technologies, including AI,
- c) the great importance of a proper understanding of emotional intelligence in team leadership and the moral virtues of leaders operating in networks.

The attributes and competencies of modern leaders are well represented by leadership models and patterns:

- a) transactional leader – who relies on the exchange relationship between the leader and group members – in exchange for meeting the leader's expectations, subordinates receive rewards that satisfy their diverse, but mainly basic, needs,
- b) wise leader – characterized by the ability to build a vision, inspire a team, make decisions based on ethics and empathy, and be flexible in adapting to changing circumstances.

The characteristics of contemporary leaders do not cover all the competencies necessary to ensure the high efficiency of the contemporary leadership process. Efficiency is assessed using praxeological criteria (effectiveness, efficiency) as well as moral efficiency criteria, taking into account the criteria of a high level of so-called social well-being.

The network structure of mutual interactions and influences in contemporary leadership systems determines not so much the attributes as the credibility of leaders in networks of mutual influences that shape the behavior of partners and performers, including their emotions and

mutual relationships of trust. Credibility means meeting expectations and fulfilling obligations towards others who have placed their trust in us (Sztompka, 2007). The functioning of contemporary leaders in leadership system networks is determined by three streams that shape their activity – namely, the streams of their creative power, knowledge, and values. Therefore, in order to assess the value of leadership, it was decided to define the effectiveness of leaders in the following three aspects:

- causal and strategic credibility manifests itself in the potential of creative leaders to generate ideas and strategies for organizing and developing the organization, as well as in their ability to influence and transform these ideas and strategies to partners in the leadership network in accordance and harmony with their decisions, and in the ability of leaders to motivate partners to cooperate,
- professional credibility demonstrates a high level of professional knowledge for strategic leadership, but also the potential to transfer skills to partners and subordinates; little motivation to use this knowledge in task implementation processes and to develop this knowledge as organizational knowledge ensuring innovative task performance,
- moral credibility, decency, and kindness are manifested in harmony between the systems of professed values and moral virtues, the declared motives for their actions, and in accordance and harmony with the instruments used by leaders to motivate task performers.

Leadership effectiveness is determined by the level of dynamic harmony achieved by integrating these three types of credibility. The driving force behind the integration of these three levels of leadership credibility is moral credibility. The higher the level of credibility of leaders in leadership networks, the higher the level of mutual trust in organizations and executive teams; the higher the potential for shaping an innovative culture, the higher the potential for self-poeticism of organizations and teams.

Experiences from history and the present day provide many examples of the particular importance and role of dominant leaders in governance and command processes. They shape and direct decision-making processes, particularly influencing executors and partners, and they shape and formulate the development of societies and organizations. The role of leaders with personalities shaped by high moral credibility in these processes is obvious. As experience teaches us, history shows that there are often cases of managers with psychopathic tendencies. The strategic importance of such leaders in political, social, and economic systems usually leads to the formation of a culture of cynicism in these communities and organizations, and consequently to their decline.

Understanding the importance of emotional intelligence is one of the determinants that plays a significant role in the life of a leader, influencing the proper management of their emotions and dealing with the emotions of others. In addition, it builds social relationships within the team and supports the mutual cognitive development of its members. The turbulences of the modern world, new challenges, and interpersonal relationships based on the digital world

require special attention to be paid to emotional and social competencies, communication skills, and coping with work in an isolated, one-person environment. Researchers are increasingly focusing their attention on verifying the importance of emotional intelligence and its impact on professional effectiveness (Sylwestrzak, 2023). A review of research in this area shows that a certain level of emotional intelligence has a positive impact on a person's functioning in their professional life. A measurable skill derived from emotional intelligence is emotional competence, which broadens the discussion on employee or professional competence. These could include the following five components:

- self-awareness – knowledge of one's own internal states, preferences, capabilities, and intuitive judgments; realistic assessment of one's abilities and justified belief in one's own capabilities,
- self-regulation – control over one's own internal states, impulses, and capabilities,
- motivation – emotional tendencies that lead to new goals or facilitate their achievement,
- empathy – awareness of other people's feelings, needs, and concerns, the ability to see things from another person's point of view,
- the reliability of the leader, which manifests itself in a high potential for professional knowledge for strategic leadership,
- social skills – eliciting desired responses from others and the ability to control one's own emotions in interpersonal interactions.

Building up a number of leadership skills for commanders should be seen as an interdisciplinary process, involving training at educational centers, self-development centers, participating in training at the company (military unit), and gaining professional (combat) experience. It is important to emphasize a proactive approach to the self-development of commanders. Formal (command) competencies acquired after taking up a position should not be treated as the only and most important attribute for effective leadership. Throughout their military service, they should seek ways to improve their leadership competencies. By taking on successive positions in national and allied structures, commanders, chiefs, and managers become more professional in the areas of management and leadership.

5. Summary

The research carried out indicate that emotional intelligence and the operational reliability of the leader (commander) are particularly important qualities that have a significant impact on the management of military personnel in conditions of war. This requires a whole new attitude towards the training of command and leadership personnel working in structures and organizations operating in conditions of instability, under kinetic enemy fire, and in the face of destructive factors such as natural disasters, etc. This confirms that there is a need for further

research in this area. Dissemination of the modern leadership model in management and command systems requires a series of measures to address the challenges faced by commanders, including:

- defining the ideal model of a leader who is highly integrated in terms of professional, moral, and social trustworthiness, operating within the network of leaders in modern organizations. This model should take into account leaders' high level of emotional intelligence, as well as their strength and resilience in the face of the risks posed by modern information technology, cognitive technology, and artificial intelligence,
- compliance with the principles governing the organizational structure of leadership, management systems, and command structures that foster a high degree of self-reliance within these systems and a strong culture of innovation,
- ensuring a high level of interpersonal trust in leadership systems, in line with the contemporary definition of trust processes as the shaping of awareness—among both those who receive and those who grant trust—regarding the significant role of axiological factors,
- the continued development of leadership skills among commanders at all levels, in response to changes in the operating environment, workplace conditions, implemented technologies, and methods of conducting combat operations.

The changing nature of challenges in the areas of security, social norms, and trends as well as shifts in the structure of societies—give rise to new expectations and needs regarding the effective training of command personnel. This necessitates continued research into the development of leadership skills among commanders at all levels. Fortunately, the significance of the issue appears to have been properly identified, and training and research institutions are effectively developing their capacity to fulfil training tasks.

References

1. Basińska, M., Jaskólska, J., Piórowski, K. (2007). *Inteligencja emocjonalna a typy zachowań i przeżyć w pracy w grupie żołnierzy zawodowych*. Bydgoszcz: Polskie Forum Psychologiczne.
2. Bojar, E., Rakowska, A., Zarębska, A., Bojar, M. (2010). *Przywództwo w zarządzaniu rozwojem lokalnym*. Białystok: Białostocka Fundacja Kształcenia Kadr.
3. DuBrin, A.J. (2000). *Przywództwo*. Poznań: Dom Wydawniczy REBIS.
4. Goleman, D. (1999). *Inteligencja emocjonalna w praktyce*. Poznań: Media Rodzina.
5. Kołodziejczyk, A. (2015). O kształtowaniu kompetencji społecznych w wojsku. Perspektywa socjologiczna. *Bezpieczeństwo, obronność, socjologia*, nr 1(3), Warszawa: Wojskowe Centrum Edukacji Obywatelskiej.

6. Koźmiński, A. (2013). *Ograniczone przywództwo. Studium empiryczne*. Warszawa: Poltext.
7. Łydka, W. (2024). *Przywództwo wojskowe*. Warszawa: Wojskowe Centrum Edukacji Obywatelskiej.
8. Majewski, T., Kurek, D., Szulc, B.M. (2020). *Przywództwo konteksty reminiscencje odniesienia*. Warszawa: Akademia Sztuki Wojennej.
9. Matthews, M., Lester, P., Hannah, S., Reed, B. (2022). *Leadership in dangerous situations: a handbook for the Armed Forces, Emergency Service, and First Responders*, Annapolis: Naval Institute Press.
10. Skrabacz, A., Pajka, A., Więckowski, B. (2025). Wojna kognitywna jako nowy wymiar operacji wielodomenowych – mapowanie i profilowanie obszaru badań za pomocą metod bibliometrycznych. *Journal Of Modern Science*. Józefów.
11. Stachowicz, J., Olko, S., (2025). Rozważania na temat współczesnego paradygmatu poznawczego i zasad teorii organizacji i zarządzania (z prac Komisji Nauk Organizacji i Zarządzania Polskiej Akademii Nauk, Oddział Katowice). *Zeszyty Naukowe Akademii Górnośląskiej*. Katowice.
12. Sylwestrzak, B. (2023). Managing selected areas of preparation military personel for their assigned roles in the state. *Scientific Papers of Silesian University of Technology – Organization and Management Series*, nr 170. Gliwice.
13. Sztompka, P. (2007). *Zaufanie – fundament społeczeństwa*. Kraków: Znak.
14. Szulc, B., Mazurek, Z. (2011). *Determinanty implementacji perspektywicznych metod kształcenia w zastosowaniach wojskowych*. Warszawa: Akademia Obrony Narodowej.
15. Zbierowski, P. (2024). *Przywództwo pozytywne*. Warszawa: Difin.

THE PROSUMER-CENTERED APPROACH TO ENERGY MICROGRIDS IN POLAND

Tomasz WAŁEK

Silesian University of Technology, Faculty of Organization and Management, Department of Production
Engineering; tomasz.walek@polsl.pl, ORCID: 0000-0003-1772-5289

Purpose: This paper presents the application potential of an innovative, prosumer-centered concept of energy microgrids, aimed at increasing benefits for prosumers under the technical and legal conditions of the Polish energy system.

Design/methodology/approach: The concept is implemented through a novel metering and billing system tailored for prosumer microgrids in Poland. It uses a new type of multi-source energy meter, which allowed for maximizing the benefits for prosumers.

Findings: This paper proposes a more prosumer-centered interpretation of the “smart” concept in the context of microgrids operating within the Polish smart grid systems. Traditional smart grid solutions in Poland have focused mainly on balancing and stabilizing energy generation and transmission infrastructure. Existing grid management systems can partially control the prosumer energy use level to enhance balance and stability of utility-scale energy sources and distribution networks -while treating prosumers as secondary, controllable actors. In contrast, the proposed approach directly integrates smart functionalities on the prosumer side, enabling them to gain direct benefits from participating in energy clusters that include renewable energy sources, energy storage systems, and other energy-efficient sources - allowing for lower-cost electricity use. The introduction of multi-source energy meters, which enable the real-time distinction of what portion of the electricity measured comes from specific sources present in the microgrid (e.g., grid, solar, wind, hydro, battery), forms the basis for a new billing method aligned with Polish regulations and technical standards. This enhances the financial viability of microgrids for prosumers and shifts the operational benefits of microgrid participation toward them.

Social implications: The proposed solution supports the development and broader adoption of energy microgrids, especially in prosumer clusters, contributing to energy transition and local sustainability.

Originality/value: The study introduces an original approach using multi-source energy meters as a component of a billing framework designed specifically for Polish prosumer microgrids. This enables a shift in value creation from the utility side to the prosumer side. The concept is relevant to energy cluster and microgrid designers and operators, as well as prosumers engaged in local energy systems.

Keywords: Polish smart microgrids, energy clusters, multi-source energy metering, smart billing system, energy management.

Category of the paper: Technical paper, conceptual paper.

1. Introduction

The escalating requirement to mitigate pollutant emissions is propelling the evolution of power generation systems toward an increased integration of renewable and high-efficiency energy sources within microgrid architectures, complemented by the deployment of advanced measurement and control systems. Energy microgrids in Poland are only beginning to develop, and currently, there are just a few such installations (Adamek, Kordas, 2022; Pyk, 2023; Wasilewski, Kaleta, Baczyński, 2015), which remain largely in pilot or experimental stages. They have not yet reached a level of technological maturity that would enable their broader integration with national power networks and widespread availability for interested consumers or prosumers. Prior studies and analyses aimed at optimizing the operational strategies of electricity generation sources in conjunction with diverse consumer categories (residential, commercial, etc., including clusters of such objects) characterized by distinct load profiles have primarily focused on achieving optimal alignment between the aggregate consumption profile of supplied objects and the overall energy generation profile of interconnected microgrid resources (Shuai et al., 2016; Deng et al., 2023; Attia, 2020). Common approaches include flattening the energy consumption profile within consumer facilities (Chapaloglou et al., 2019; Arcos-Vargas, Lugo, Núñez, 2018), peak-shifting techniques to synchronize consumption peaks with renewable generation peaks (Martinez-Pabon, Eveleigh, Tanju, 2018; Vigna et al., 2018), and predictive load forecasting with a certain lead time to enable adaptive generation scheduling (Li, Wen, Malkawi, 2016; Zheng et al., 2022). All these measures are applied - either individually or in combination - within Polish power networks in general, as well as in smart grids and in the initial implementations of microgrids (Parol, 2024).

A closer examination of these enhancement strategies reveals that their primary advantages are realized from the standpoint of energy generation sources and transmission/distribution networks (Mbungu et al., 2019; Babayomi et al., 2023). It is predominantly the generation facilities and transmission networks that acquire “smart” capabilities, because with the use of dedicated energy management systems they can partially control energy load operations, thereby improving system-wide balancing and operational stability across energy generation, transmission, and distribution systems. Although such improvements can be monetized and theoretically redistributed among participating prosumers (e.g., through reduced unit energy costs), this rarely occurs in practice; end-users typically incur tariffs comparable to those prior to the implementation of microgrid or grid-side enhancements (Charoen et al., 2018; Fridgen et al., 2018; Vergados et al., 2016; Cai et al., 2022).

This study proposes the integration of the smart functionalities on the prosumer side, enabling direct economic and operational benefits resulting from participation in clusters that combine renewable generation units, energy storage systems, and other high-efficiency sources delivering electricity at a lower cost compared to standard grid supply. These benefits are

facilitated through the deployment of multi-source energy metering solution, which makes it possible to distinguish what portion of the energy flowing through an individual meter at any given time is supplied from the grid, what from renewable sources, and what from other sources present in the microgrid.

2. Standard metering and billing in prosumer microgrids

Currently, only a few installations in Poland operate as energy microgrids (Adamek, Kordas, 2022; Pyk, 2023; Wasilewski, Kaleta, Baczyński, 2015). These include:

- the Tauron microgrid in Bytom, Poland,
- the PKP Energetyka railway microgrid,
- an industrial microgrid at the WAGO facility near Wrocław, Poland,
- the FOGO microgrid by Generpol,
- the ZKlaster energy cluster microgrid in Zgorzelec, Poland,
- the academic microgrid at Kielce University of Technology, Poland.

None of these networks function as prosumer-based microgrids, which means that the area of prosumer engagement in microgrid investments remains undeveloped in Poland. Similarly, metering and billing systems tailored for prosumer microgrids - specialized and profiled differently from general EMS solutions - have not yet been designed, adapted, or implemented. In traditional microgrid configurations, the operation of individual energy sources is typically governed by the current or forecasted total energy load profile across all consumption nodes. Figure 1 illustrates a representative topology of a prosumer-based microgrid, highlighting the spatial distribution of generation assets and loads, as well as the metering points used for consumer-level billing. Energy delivered to end-users consists of a dynamic mix of energy streams originating from multiple sources, with their respective contributions varying over time according to source availability and current operational status of every source. Conventional meters, measuring the energy consumption by individual consumers at any given moment, however, do not provide differentiation regarding the composition of these flows; they record only the total consumption at a given interval. Consequently, all energy consumed within a billing period is aggregated under a single measurement, and charges are computed based on this undifferentiated total value.

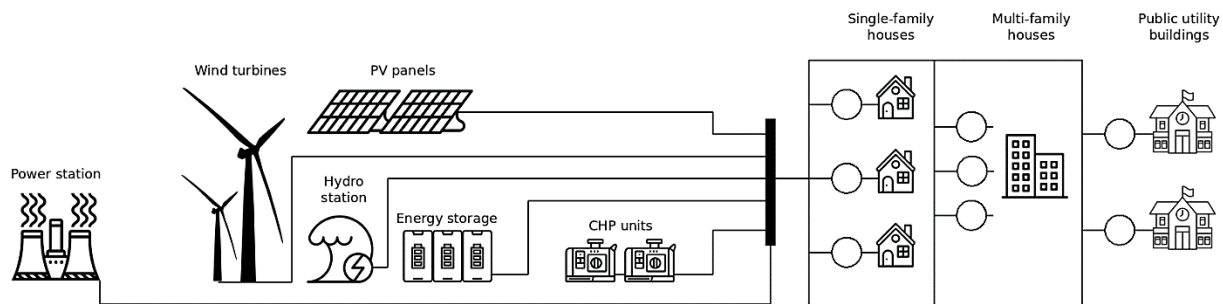


Figure 1. A schematic representation of energy sources and consumption loads within a prosumer-oriented microgrid. The circles indicate individual consumption metering points (with use of standard meters), which serve as the basis for calculating electricity charges for each cluster participant.

The unit energy price within a microgrid cluster is typically set uniformly for all participants, with possible differentiation based on standard tariff structures such as peak and off-peak periods. In practice, this price is established for the current billing cycle or a longer contractual term and remains independent of the proportional contribution of individual energy sources to the total energy consumed. Consequently, scenarios may arise where the cluster's entire demand at a given moment is met exclusively by renewable sources, yet consumer meters still record undifferentiated consumption, which is billed at the general cluster rate per kilowatt-hour. From a consumer perspective, billing should ideally distinguish between energy supplied from the main grid - charged according to the supplier agreement - and energy delivered from renewable sources, which should reflect a lower cost. In clusters incorporating cogeneration units, metering should additionally segregate the share originating from cogeneration systems, applying the corresponding tariff. Current metering and billing systems in prosumer-based microgrids lack this capability, limiting the practical realization of the “smart” concept on the consumer/prosumer side.

3. Multi-Source energy metering

To realize direct cost savings for end-users based on the efficiency of installed energy sources assets within a microgrid, it is essential to implement an advanced metering and billing system capable of recording consumption over defined intervals (e.g., monthly) while disaggregating the energy mix by source - renewable generation, grid supply, cogeneration (where applicable), and other sources. Such the functionality is enabled through multi-source electricity meters, whose architecture and operational principles are detailed in Walek (2023).

As shown in Figure 2a, a conventional meter registers the total aggregate energy flow, representing the sum of all streams from sources connected upstream of the device. In contrast, a multi-source metering configuration (Figure 2b) incorporates additional measurement circuits on each feeder branch corresponding to individual sources. Data from these circuits is transmitted to a central controller, which computes the proportional contribution of each source

to the total flow. The controller then relays this information to multi-source meters installed at consumer nodes, enabling separate counters to record consumption by source category. In the example shown, two feeder branches are present - one for grid supply and another aggregating all renewable sources into a single line, based on the assumption that renewable generation uniformly offers a lower energy cost for end-users. The construction of meters supports more than two feeders; for instance, if cogeneration units are integrated, an additional branch with its own power transformer and dedicated counter would be required, as cogeneration typically incurs a cost higher than renewables but lower than grid-supplied electricity.

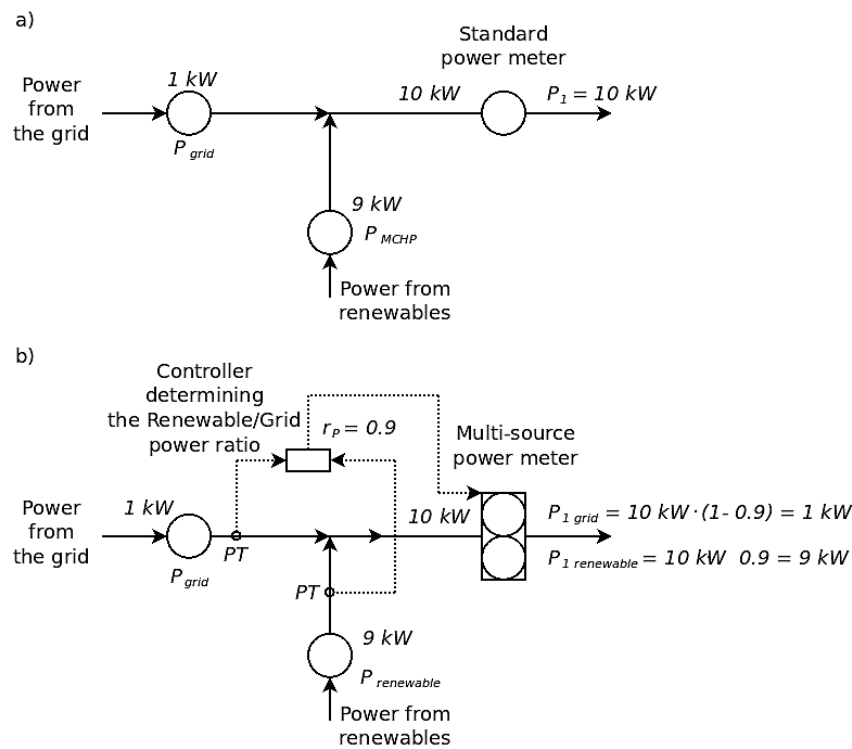


Figure 2. Comparison of energy measurement using a conventional (a) and a multi-source metering system (b). A standard meter records only the aggregate energy flow without distinguishing the origin of supply (grid vs. renewables). In contrast, the multi-source system employs power transformers (PT) on each feeder branch to capture real-time signals from individual sources. These signals are processed by a controller that computes the renewable-to-grid ratio (r_p) and transmits this data to the multi-source meter equipped with separate counters for grid and renewable energy consumed. This enables source-specific energy registration. Displayed power values represent instantaneous readings in kW, while final billing data is expressed in kWh. Solid lines indicate power supply paths; dotted lines denote signal transmission.

For the configuration illustrated in Figure 2b, featuring two feeder lines and two counters within the meter, the control signal generated by the controller and transmitted to the meter would take the form “0.9;0.1” (or, alternatively, a single value such as “0.9,” with the second value derived by subtraction). This indicates, for example:

- $r_p = 0.0;1.0$ all power at that instant originates from the grid,
- $r_p = 0.5;0.5$ power supply is evenly split between renewable sources and the grid,
- $r_p = 1.0;0.0$ all power at that instant is supplied by renewable sources.

For systems incorporating three or more feeders (sources) and corresponding counters, the structure of the control signal would follow the same principle respectively.

4. Multi-Source metering and billing in prosumer microgrids

Figure 3 shows a schematic layout of energy sources and consumption loads within a prosumer microgrid equipped with a multi-source electricity metering system.

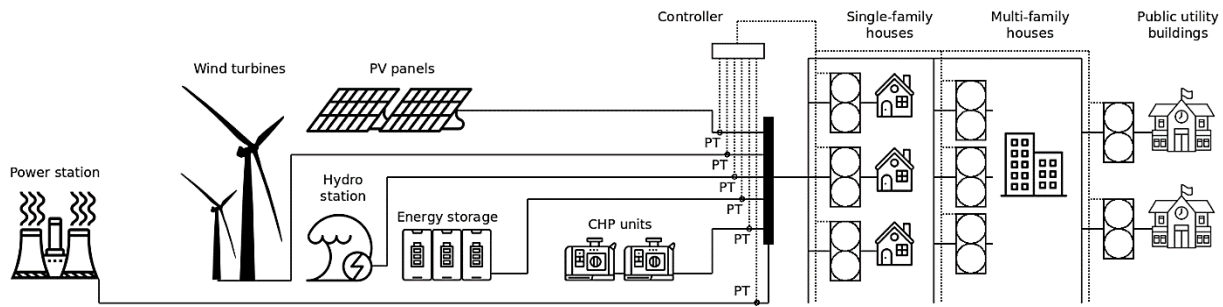


Figure 3. Schematic layout of power sources and consumption loads within a prosumer microgrid implementing a multi-source metering system. This configuration enables source-specific billing for individual cluster members by distinguishing the origin of consumed energy. “PT” denotes power transformers; double circles represent multi-source meters; solid lines indicate power supply paths, while dotted lines correspond to signal transmission.

Each counter within the multi-source meter continuously and separately collects and aggregates real-time consumption data for each of the energy sources. The accumulated values over the billing interval serve as the basis for cost calculation, ensuring that charges reflect the actual amount of energy consumed from each source operating within the cluster.

The unit cost of electricity for each source (or source group) is defined by the cluster operator. For renewable generation, this tariff will be lower than the grid price and reflects associated capital expenditures, operational costs, maintenance, repairs, and lifecycle renovations. The grid energy price corresponds to the contractual rate agreed upon between the cluster and the utility provider. For cogeneration systems, the electricity specific cost can be determined using methodologies such as those outlined in Walek (2023). Any additional service or administrative expenses may be proportionally allocated and incorporated into the source-specific energy cost.

In summary, under a conventional metering and billing framework, prosumer electricity charges for a given billing cycle are calculated according to the relationship:

$$C_{P1} = P_1 \cdot SC_P, \quad (1)$$

where:

C_{P1} - total electricity cost for prosumer No. 1 during a given billing period,

P_1 - total energy consumed by prosumer No. 1 during a given billing period,

SC_P - unit cost of electricity supplied from the microgrid.

The costs for subsequent prosumers are calculated analogously.

In the proposed metering and billing system utilizing multi-source meters, the calculation is expressed as:

$$C_{P1} = P_{1r} \cdot SC_{Pr} + P_{1CHP} \cdot SC_{PCHP} + P_{1grid} \cdot SC_{Pgrid} + \dots, \quad (2)$$

where:

P_{1r} - energy from renewable sources consumed by prosumer No. 1 during a given billing period,

P_{1CHP} - energy from cogeneration consumed by prosumer No. 1 during a given billing period,

P_{1grid} - energy from the grid consumed by prosumer No. 1 during a given billing period,

SC_{Pr} - unit cost of electricity from renewable sources,

SC_{PCHP} - unit cost of electricity from cogeneration,

SC_{Pgrid} - unit cost of electricity purchased from the grid.

The same approach applies to all other prosumers in the cluster.

In a conventional multi-source setup using standard energy meters, billing is limited to applying an averaged unit energy cost across all sources. By contrast, the implementation of multi-source metering enables precise billing based on real-time consumption data, allowing cost allocation that reflects actual source contributions and benefits individual end-users. Both solutions can be implemented under Polish legal and technical conditions. For the variant involving multi-source meters, obtaining appropriate certification and regulatory approvals is required.

5. Discussion

To comprehensively assess the applicability and impact of the proposed metering and billing system in prosumer microgrids, it is necessary to analyze all potential scenarios of energy distribution among sources within the cluster:

- complete coverage of cluster demand by renewable generation, with surplus energy charging storage units,
- partial coverage by renewables and/or storage, supplemented by cogeneration or other systems (if present),
- mixed supply from renewables, storage, and/or cogeneration, with any shortfall met by the grid,
- full coverage of cluster demand by grid supply.

It should be noted that under this model, temporary disparities may occur in the extent to which individual consumers benefit from lower-cost energy.

The proposed solution serves as a mechanism to incentivize investment in renewable and high-efficiency energy technologies within Polish legal and technical frameworks, promoting faster return on investment and reducing electricity costs for prosumers. Furthermore, this approach creates new opportunities for advancing renewable-powered microgrids and accelerating their adoption across diverse consumer clusters. Barriers to the development of such solutions in Poland may include legislative risks that discourage investment, resistance from large energy companies due to their diminishing role in the context of intensive prosumer energy growth, as well as the absence of incentive mechanisms for citizen energy initiatives (legal and tax-related). Additionally, the prevailing focus on individual installations - which do not leverage economies of scale - further limits the expansion of these systems (Wasilewski, Kaleta, Baczyński, 2015).

6. Conclusion

Current enhancements in power grids and microgrids primarily deliver benefits from the perspective of power generation sources and transmission/distribution networks. These infrastructures become “smart” by subsuming (at least partially) consumer-side operations, improving system balancing and stability. This paper extends the smart concept to the prosumer level, enabling direct economic benefits through participation in microgrids integrating renewable sources, energy storage, and other high-efficiency sources that provide electricity at lower costs than grid supply.

This can be achieved by implementing an advanced metering and billing system capable of disaggregating consumption over defined intervals (e.g., monthly) by source - renewables, grid, cogeneration (if present), and others. Existing metering solutions lack this functionality, limiting consumer-side smart capabilities. The proposed multi-source metering system addresses this gap.

Its architecture supports multiple feeder lines from diverse sources, including renewables, storage, grid supply, cogeneration/micro-cogeneration, emergency generators, fuel cells, and additional technologies. The concept can also be adapted for thermal energy (heating/cooling) distribution, subject to further analysis.

This metering and billing approach represents an evolution of the smart grid paradigm for prosumer microgrids, fostering broader adoption of high-efficiency and renewable technologies. It creates new opportunities for the development and scalability of renewable-powered microgrids across heterogeneous consumer clusters. Considering that energy microgrids are only beginning to develop in Poland, it is feasible to implement metering and billing solutions that support prosumer-oriented microgrid configurations, such as those described in this paper. This, in turn, can increase the role of microgrids as a component of

distributed and smart energy systems cooperating with conventional generation and transmission networks.

References

1. Adamek, A., Kordas Ł. (2022). Doświadczenia z realizacji pierwszej w Polsce mikrosieci energetycznej [Experiences from implementation of first Polish microgrid]. *Rynek Energii*, Vol. 5, Iss. 162, pp. 16-20. Retrieved from: [https://www.cire.pl/filemanager/Materia%C5%82y%20Problemowe%20\(Wies%C5%82aw%20Drozdowski\)%20/7cc20f5a8311b04e777a8747946bdcdf29eda985247c13349a60d3675c3dc128.pdf](https://www.cire.pl/filemanager/Materia%C5%82y%20Problemowe%20(Wies%C5%82aw%20Drozdowski)%20/7cc20f5a8311b04e777a8747946bdcdf29eda985247c13349a60d3675c3dc128.pdf), 30.11.2025.
2. Arcos-Vargas, A., Lugo, D., Núñez, F. (2018). Residential peak electricity management. A storage and control systems application taking advantages of smart meters. *International Journal of Electrical Power & Energy Systems*, Vol. 102, pp. 110-121, doi: 10.1016/j.ijepes.2018.04.016
3. Attia, A.M. (12-14.08.2020). *Simulation and analytical comparison between load management techniques*. 2020 IEEE 8th International Conference on Smart Energy Grid Engineering (SEGE), Place: Oshawa, ON, Canada, pp. 128-132, doi: 10.1109/SEGE49949.2020.9182010
4. Babayomi, O., Zhang, Z., Dragicevic, T., Hu, J., Rodriguez, J. (2023). Smart grid evolution: Predictive control of distributed energy resources - a review. *International Journal of Electrical Power & Energy Systems*, Vol. 147, pp. 108812, doi: 10.1016/j.ijepes.2022.108812
5. Cai, Q., Xu, Q., Qing, J., Shi, G., Liang, Q.M. (2022). Promoting wind and photovoltaics renewable energy integration through demand response: Dynamic pricing mechanism design and economic analysis for smart residential communities. *Energy*, Vol. 261, Part B, p. 125293, doi: 10.1016/j.energy.2022.125293
6. Chapaloglou, S., Nesiadis, A., Iliadis, P., Atsonios, K., Nikolopoulos, N., Grammelis, P., Yiakopoulos, C., Antoniadis, I., Kakaras, E. (2019). Smart energy management algorithm for load smoothing and peak shaving based on load forecasting of an island's power system. *Applied Energy*, Vol. 238, pp. 627-642, doi: 10.1016/J.APENERGY.2019.01.102
7. Charoen, P., Sioutis, M., Javaid, S., Lim, Y., Tan, Y. (12-15.08.2018). *Fair billing mechanism for energy consumption scheduling with user deviation in the smart grid*. IEEE International Conference on Smart Energy Grid Engineering (SEGE). Place: Oshawa, ON, Canada, pp. 84-88, doi: 10.1109/SEGE.2018.8499487
8. Deng, Y., Luo, F., Zhang, Y., Mu, Y. (2023). An efficient energy management framework for residential communities based on demand pattern clustering. *Applied Energy*, Vol. 347, p. 121408, doi: 10.1016/j.apenergy.2023.121408

9. Fridgen, G., Kahlen, M., Ketter, W., Rieger, A., Thimmel, M. (2018). One rate does not fit all: An empirical analysis of electricity tariffs for residential microgrids. *Applied Energy*, Vol. 210, pp. 800-814, doi: 10.1016/j.apenergy.2017.08.138
10. Li, X., Wen, J., Malkawi, A. (2016). An operation optimization and decision framework for a building cluster with distributed energy systems. *Applied Energy*, Vol. 178, pp. 98-109, doi: 10.1016/j.apenergy.2016.06.030
11. Martinez-Pabon, M., Eveleigh, T., Tanju, B. (2018). Optimizing residential energy management using an autonomous scheduler system. *Expert Systems with Applications*, Vol. 96, pp. 373-387, doi: 10.1016/j.eswa.2017.12.017
12. Mbungu, N.T., Naidoo, R.M., Bansal, R.C., Vahidinasab, V. (2019). Overview of the optimal smart energy coordination for microgrid applications. *IEEE Access*, Vol. 7, pp. 163063-163084, doi: 10.1109/ACCESS.2019.2951459
13. Parol, M. (2024). Mikrosieci - mikrosystemy energetyczne zasilające odbiorców energii. Stan aktualny i perspektywy rozwoju. [Microgrids - energy micro-systems supplying energy receivers. Current state and development perspectives]. *Przegląd Elektrotechniczny*, Vol. 100, Iss. 2, pp. 44-49, doi: 10.15199/48.2024.02.08
14. Pyk, A. (2023). Mikrosieci jako wzorcowe rozwiązania zarządzające odnawialnymi zasobami energii [Microgrids as exemplary solutions for managing renewable energy resources]. *Zeszyty Naukowe Akademii Górnośląskiej*, Iss. 6, pp. 116-123, doi: 10.53259/2023.6.11
15. Shuai, Z., Sun, Y., Shen, Z.J., Tian, W., Tu, C., Li, Y., Yin, X. (2016). Microgrid stability: Classification and a review. *Renewable and Sustainable Energy Reviews*, Vol. 58, pp. 167-179, doi: 10.1016/j.rser.2015.12.201
16. Vergados, D.J., Mamounakis, I., Makris, P., Varvarigos, E. (2016). Prosumer clustering into virtual microgrids for cost reduction in renewable energy trading markets. *Sustainable Energy, Grids and Networks*, Vol. 7, pp. 90-103, doi: 10.1016/j.segan.2016.06.002
17. Vigna, I., Perneti, R., Pasut, W., Lollini, R. (2018). New domain for promoting energy efficiency: Energy Flexible Building Cluster. *Sustainable Cities and Society*, Vol. 38, pp. 526-533, doi: 10.1016/j.scs.2018.01.038
18. Walek, T. (2023). New model of cost allocation for micro-cogeneration systems applied in multi-family buildings - with standard and new-type multi-source energy meters. *Energy*, Vol. 262, p. 125480, doi: 10.1016/j.energy.2022.125480
19. Wasilewski, J., Kaleta, M., Baczyński, D. (2015). Wybrane zagadnienia rozwoju mikrosieci energetycznych w Polsce [Selected Issues of Energy Microgrid Development in Poland]. *Energy Policy Journal*, Vol. 18, Iss. 1, pp. 45-58. Retrieved from: <https://repo.pw.edu.pl/info/article/WUTe329dc5c417446e7bdefcd0069f47b2f/>, 30.11.2025.
20. Zheng, L., Zhou, B., Cao, Y., Or, S.W., Li, Y., Chan, K.W. (2022). Hierarchical distributed multi-energy demand response for coordinated operation of building clusters. *Applied Energy*, Vol. 308, p. 118362, doi: 10.1016/j.apenergy.2021.118362

THE IMPACT OF AUDIT ON THE EFFECTIVENESS OF BUSINESS MANAGEMENT

Elżbieta WAŻNA^{1*}, Irena MALINOWSKA², Marta PIETRZYKOWSKA³

¹ Pomorska Szkoła Wyższa w Starogardzie Gdańskim; elzbieta.wazna@twojestudia.pl,
ORCID: 0000-0002-9174-4376

² Wyższa Szkoła Kształcenia Zawodowego we Wrocławiu; galindia@wp.pl, ORCID: 0000-0002-9194-3121

³ Wyższa Szkoła Kształcenia Zawodowego we Wrocławiu; marta.pietrzykowska@gmail.com,
ORCID: 0009-0000-7758-7354

* Correspondence author

Purpose: The purpose of this article is to analyse the role and importance of audit in business management, with particular emphasis on its impact on decision-making effectiveness, process optimisation and organisational transparency. The aim of the study is to determine whether systematic and reliable auditing can improve management effectiveness and support the achievement of strategic objectives.

Methodology: The study includes a descriptive section presenting the function of audit in management systems and internal control, as well as an empirical section based on surveys conducted among managers and employees, aimed at assessing the perceived impact of audit on organisational processes.

Results: Audit serves as an independent tool for evaluating organisational effectiveness and identifying areas requiring improvement. It contributes to operational transparency, supports effective management and enables the optimisation of internal processes, thereby increasing overall efficiency and organisational stability.

Practical implications: The implementation of systematic auditing provides management with objective information, supports risk identification and strengthens internal control systems, which contributes to more informed strategic and operational decision-making.

Originality/value: The originality and value of this study lie in the evaluation of audit as a management tool, highlighting its role not only in detecting errors but also in improving processes, optimising resources and enhancing organisational transparency. The study also provides practical guidance for managers.

Keywords: audit, business management, decision-making, process optimisation, transparency of operations.

Category of the paper: research paper.

1. Introduction

Modern enterprises operate in conditions of increasing competition, economic volatility and pressure to achieve ever-better financial and organisational results. In such circumstances, tools that enable the assessment of management effectiveness and the degree of strategic objective attainment gain particular significance. One of the most important instruments supporting the management process is auditing, which provides management with objective and independent information about the functioning of the organisation, the internal control system and risk management. Internal auditing constitutes a systematic and structured evaluation of processes within an organisation, particularly in the areas of risk management, control and corporate governance, and its results can form the basis for process improvement and the making of sound managerial decisions (Ucieszyńska, 2017).

The importance of auditing in enterprise management derives primarily from its objective nature and advisory function. Audit not only identifies irregularities, but also supports management in achieving strategic goals, mitigating risk and improving organisational processes. The literature emphasises that auditing is a vital tool in supporting risk management and internal control systems and can contribute to increased enterprise value and improved organisational effectiveness (Przybylska, Kańduła, Bogucka, 2024).

A review of existing research indicates that the issue of audit effectiveness and its impact on management has been the subject of numerous scholarly studies. For example, internal audit effectiveness has been systematically reviewed in the literature, with emphasis on factors influencing its performance and role in organisational success. Other studies have critically examined internal audit effectiveness in various organisational contexts, identifying gaps and directions for further research. Despite these contributions, there remains a need for empirical research into the impact of auditing on managerial effectiveness, particularly with respect to its use as a tool that supports decision-making and process optimisation.

The aim of this article is to analyse the role and significance of auditing in business management, with particular emphasis on its impact on the quality of decision-making, process optimisation and the transparency of organisational activities. This issue is of considerable importance both from a theoretical perspective within the field of management studies and from a practical perspective in the modern business environment.

In developing this article, the following research hypothesis was adopted: systematic and rigorous auditing contributes to the improvement of enterprise management effectiveness by enabling early detection of irregularities, supporting process optimisation, and providing greater transparency in organisational operations.

To verify the research hypothesis, the study employs both literature review and empirical research conducted using a questionnaire survey administered to employees and managers of enterprises. This mixed methodology allows for a comprehensive assessment of the

significance of auditing in management and its impact on organisational performance (Bednarek, Ciak, 2022).

The novelty of this article lies in its approach to auditing not only as a control mechanism, but also as a strategic management instrument that supports decision-making and continuous process improvement. The findings contribute to the development of research on audit effectiveness and have practical implications for managers seeking to enhance organisational performance. Given the topicality and importance of the subject, dissemination of the research results in scientific publications in the fields of management and finance is recommended.

Internal audit constitutes an important element of modern organisational management systems and one of the key mechanisms supporting the achievement of organisational objectives. The origins of internal audit lie in accounting, from which it gradually evolved into a specialised function supporting management processes (Sawyer, Dittenhofer, Scheiner, 2005). In its early stages, internal audit focused primarily on verifying the accuracy of financial data and reviewing accounting documentation. At that time, audit performed mainly a control function, and its primary objective was the detection of errors and financial irregularities. Along with the development of organisations and the increasing complexity of management processes, the scope of internal audit gradually expanded. Currently, it includes the assessment and analysis of internal control systems, risk management and corporate governance in both the private and public sectors.

The development of internal audit worldwide is primarily associated with the growing complexity of organisational structures and the separation of ownership from management, which resulted in the need for an independent function evaluating organisational activities. A significant milestone in the development of internal audit was the establishment of The Institute of Internal Auditors in 1941 in the United States, which developed professional standards and a code of ethics for internal auditors. Since then, internal audit has been perceived not only as a control function but also as an advisory activity supporting management and contributing to the improvement of organisational performance.

The literature indicates that internal audit has evolved from a financial control function into a managerial and strategic function. Contemporary internal audit focuses mainly on risk assessment, the effectiveness of management control systems and the efficiency of organisational processes. Increasing attention is also paid to its role in creating added value for the organisation through identifying opportunities for process improvement, risk reduction and enhanced operational effectiveness (Lenz, Hahn, 2015).

Internal audit was introduced in Poland relatively late, only at the beginning of the 21st century, despite its much longer tradition in other countries. It was formally introduced in 2002 through an amendment to the 1998 Public Finance Act (Bartosiewicz, 2015). The first years of its operation were transitional and were associated with the modernisation of public administration, largely based on benchmarking and the implementation of solutions used in European Union countries. This process involved the training of qualified audit staff,

the establishment of internal audit units in public finance sector entities and the development of procedures and standards for conducting internal audits.

Currently, internal audit constitutes one of the key elements of corporate governance. It is an independent and objective activity focused on the analysis of risk management mechanisms, internal control systems and the effectiveness of organisational operations (Piaszczyk, 2013; Tatoj, 2017). Its purpose is to support management in achieving organisational objectives through the evaluation of processes and the formulation of recommendations aimed at improving organisational performance. Audit activities include the review of procedures, systems, internal regulations and operational processes, and the results are presented in the form of reports containing conclusions and recommendations for management.

Unlike internal audit, internal control is an element of ongoing organisational management and involves monitoring compliance with applicable procedures, legal regulations and internal policies (Winiarska, 2014). It focuses primarily on detecting and correcting irregularities and ensuring the proper achievement of operational objectives. Internal control is performed by the organisation's employees and has a continuous character. Internal audit, in contrast, is independent and periodic, and its purpose is to assess the effectiveness of the entire internal control system as well as risk management processes, which gives it a more strategic character.

According to Article 272 of the Public Finance Act, internal audit is an independent and objective activity aimed at supporting organisational management through the systematic evaluation of management control and advisory activities. Similarly, The Institute of Internal Auditors defines internal audit as an assurance and consulting activity designed to add value and improve an organisation's operations through the systematic evaluation of risk management, control and governance processes.

An important element of the contemporary approach to internal audit is the COSO model, which provides a framework for internal control systems within organisations. This model assumes that the internal control system consists of five interrelated components: the control environment, risk assessment, control activities, information and communication, and monitoring. Internal audit plays an evaluative role in this system by assessing the effectiveness of these components and the overall risk management processes.

The literature provides various interpretations of internal audit. Saunders emphasises its role in the independent assessment of the effectiveness of control and risk management systems. Jagielski highlights its supervisory and advisory functions, particularly in the public finance sector. Paczuła treats audit as a management tool that identifies system weaknesses and indicates areas requiring improvement. Kuc focuses on financial and accounting aspects as well as the use of statistical methods in auditing. Winiarska underlines the importance of audit in creating added value and enhancing organisational efficiency. Kałużny points out that the purpose of audit is not to criticise employees but to identify areas requiring improvement.

Nowicki and Kafel define audit as a structured process of collecting and evaluating evidence in order to verify compliance with specific criteria.

In contemporary terms, internal audit is defined as an independent and objective assurance and consulting activity aimed at adding value and improving organisational operations (Nowicki, Kafel, 2020). This reflects a shift away from a narrow, retrospective perception of audit as a tool for detecting errors towards recognising it as a strategic element of the management system. Modern internal audit therefore performs not only a control function but also advisory, analytical and improvement-oriented roles, contributing to enhanced organisational performance and risk reduction.

2. Literature review and methodology

The role of auditing in corporate management has significantly increased in recent years due to the need to raise management standards in a rapidly changing economic environment. Both internal and external auditing perform verification, advisory, and preventive functions, supporting decision-making processes, strengthening internal control structures, and enhancing an organisation's ability to respond to risks and uncertainty (Eulerich, 2020). Contemporary enterprises operate under conditions of high uncertainty, global disruptions, intense competition, and rapid technological change, which requires effective tools to support decision-making and the efficiency of operational processes (Winiarska, 2014).

A review of literature from 2020-2024 indicates that auditing is a key component of modern corporate governance. Studies emphasise that internal and external auditing support risk identification, improve decision quality, and ensure compliance with legal regulations and industry standards (Przybylska, Kańduła, Bogucka, 2024). Auditing can also serve an advisory and preventive role, allowing managers to make more informed decisions based on reliable data. Contemporary research further highlights that the application of appropriate auditing standards and the implementation of audit recommendations contributes to higher management effectiveness and the improvement of internal processes (Emerling, 2015).

Despite the extensive literature, a clear research gap exists. Existing studies do not sufficiently integrate internal and external auditing in assessing management effectiveness. Empirical research analysing the impact of auditing on specific managerial aspects, such as decision-making quality, internal control structures, organisational responsiveness to risks, or operational security, is lacking. Additionally, the Polish enterprise context is under-researched, despite the increasing use of auditing and ongoing updates to auditing standards between 2020-2024. This study addresses these gaps by providing empirical data and practical insights to improve management practices in enterprises.

Based on the literature analysis, two main areas of focus were identified. The first concerns management effectiveness, understood as the quality of decision-making processes, operational efficiency, and an organisation's capacity to respond to risks and uncertainty. Measurement variables include indicators of decision quality improvement, minimisation of errors, and evaluation of operational process efficiency. The second area concerns auditing practices, encompassing the scope and type of auditing (internal and external), auditor independence, applied standards, and the implementation of audit recommendations. Measurement variables include the number and type of audits conducted, auditor competencies, and the extent to which recommendations are utilised in management practice. The selection of these variables is directly based on the literature and existing research gaps, ensuring a coherent analysis of auditing's impact on management (Winiarska, 2014).

Empirical data were collected using a survey method, which allowed the views of employees and management regarding auditing's influence on enterprise functioning to be obtained. The survey included questions on the structure and scope of the audit department, auditor independence, standards applied, and the use of audit recommendations in decision-making processes (The Institute of Internal Auditors, 2024). Analysis of the survey data enabled the identification of auditing practices that genuinely contribute to improving process quality, reducing risks, and streamlining the decision-making system.

The findings indicate that auditing is not merely a control tool but also an essential support for decision-making processes, enhancing management effectiveness. The implementation of audit recommendations positively affects decision quality, operational security, and organisational responsiveness to risks. The study also highlights effective audit models and practices that enterprises can adopt to improve internal process efficiency. These results confirm that auditing plays a crucial role in contemporary corporate management and should be systematically integrated into strategic organisational processes (Emerling, 2015).

In conclusion, auditing serves a control, advisory, and preventive function, supporting managers in decision-making and increasing management effectiveness. This study addresses a research gap by providing empirical evidence on the impact of auditing on enterprise functioning and offering practical solutions for organisations seeking to enhance decision-making quality, reduce risks, and raise management standards.

3. Results

To properly understand the impact of auditing on management, one must first determine its place within the organisation's structure. Auditing forms part of the oversight system, which influences all key areas of the organisation's operations, ranging from operational processes through finance to strategy. Its role is not limited to checking compliance with procedures,

but also involves assessing the efficiency and effectiveness of the actions taken. To clarify the relationship between auditing and the management system, a simplified diagram of these interdependencies is presented below.

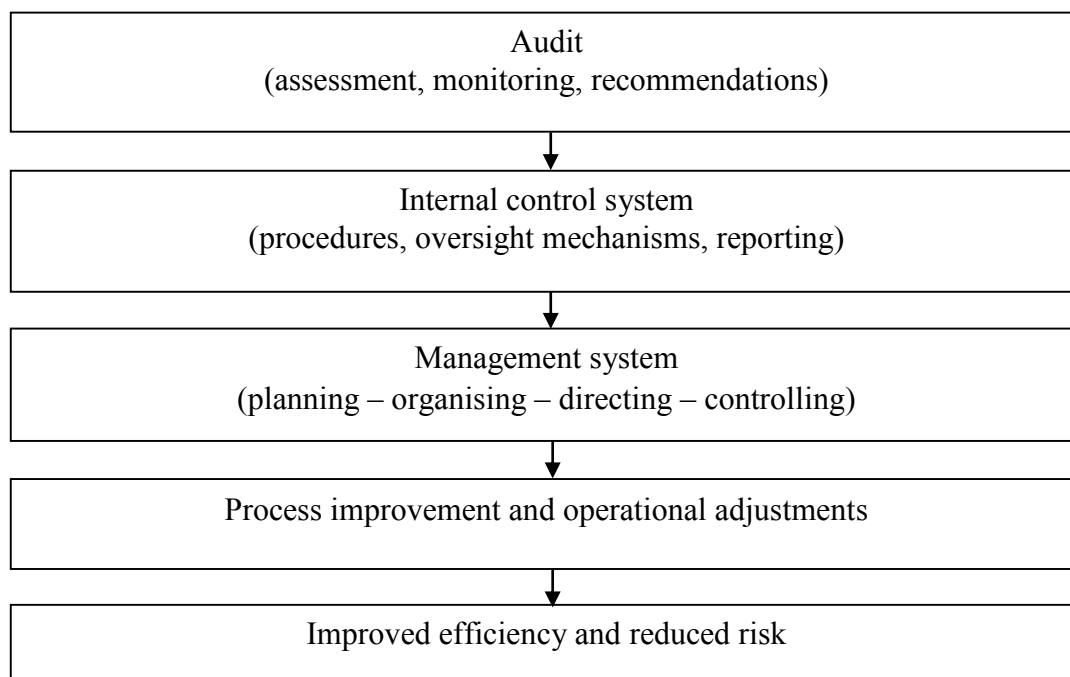


Figure 1. The role of auditing in a company's management system.

Source: Waściński, Sławińska, 2021, pp. 57-71.

As shown in the diagram above, an audit forms part of the feedback loop within a management system. Its purpose is to provide information that enables the correction of actions and the improvement of control mechanisms. In this way, an audit enhances the rationality of decision-making processes and the organisational stability of the enterprise (Emerling, 2015). This is of particular significance in the context of its impact on the internal control system, which is the fundamental mechanism ensuring the proper functioning of the organisation. One of the key areas of audit influence is the internal control system. Internal control comprises a set of rules, procedures and mechanisms designed to ensure compliance with established standards, the protection of assets, and the reliability of financial and operational information (Ampuła, 2014). In practice, the effectiveness of internal control depends on the level of formalisation of procedures, the quality of the reporting system and the extent to which staff are aware of the applicable rules. To deepen the analysis, it is useful to compare the key elements of the internal control system with the role of audit in the process of their improvement (Table 1).

Table 1.*The impact of the audit on elements of the internal control system*

Control system component	Characteristics	The role of auditing in improvement
Control environment	Organisational culture, ethics, accountability structure	Assessment of compliance with ethical principles and the appropriateness of the division of responsibilities
Risk assessment	Risk identification and analysis	Verification of the completeness of risk identification and the effectiveness of responses
Control mechanisms	Approval procedures, authorisations, segregation of duties	Testing the effectiveness of procedures and identifying control gaps
Information and communication	Reporting and data flow systems	Assessment of the quality, timeliness and reliability of information
Monitoring	Ongoing monitoring and internal audits	Independent assessment of the functioning of the entire system

Source: Winiarska, 2012, pp. 23-40.

This overview shows that an audit affects all components of internal control, serving an integrating and coordinating function. It is not limited to detecting irregularities, but systematically assesses the adequacy of the organisational arrangements in place.

In the context of the owner–management relationship, reducing information asymmetry takes on particular importance, as this asymmetry, in the principal–agent relationship, gives rise to the risk of conflicts of interest and a lack of transparency in managers’ actions. In accordance with the principles of Agency Theory, supervisory mechanisms are essential for monitoring management effectiveness and minimising potential conflicts of interest. Internal audit, acting as an independent control instrument, provides objective and reliable information on the organisation’s operations, enabling owners and the supervisory board to assess the effectiveness of managerial decisions, increase the transparency of activities, and make informed supervisory decisions that support the achievement of the company’s strategic objectives (American Accounting Association, 2021).

The impact of an audit on the quality of decision-making processes is equally significant. Strategic and operational decisions require access to reliable data. By analysing reporting systems and information flows, an audit identifies areas where distortions or delays in information may occur. Implementing recommendations to streamline the reporting system leads to improved accuracy of analyses and forecasts. To better illustrate this mechanism, the relationship between the quality of information and the effectiveness of decisions can be shown (Figure 2).

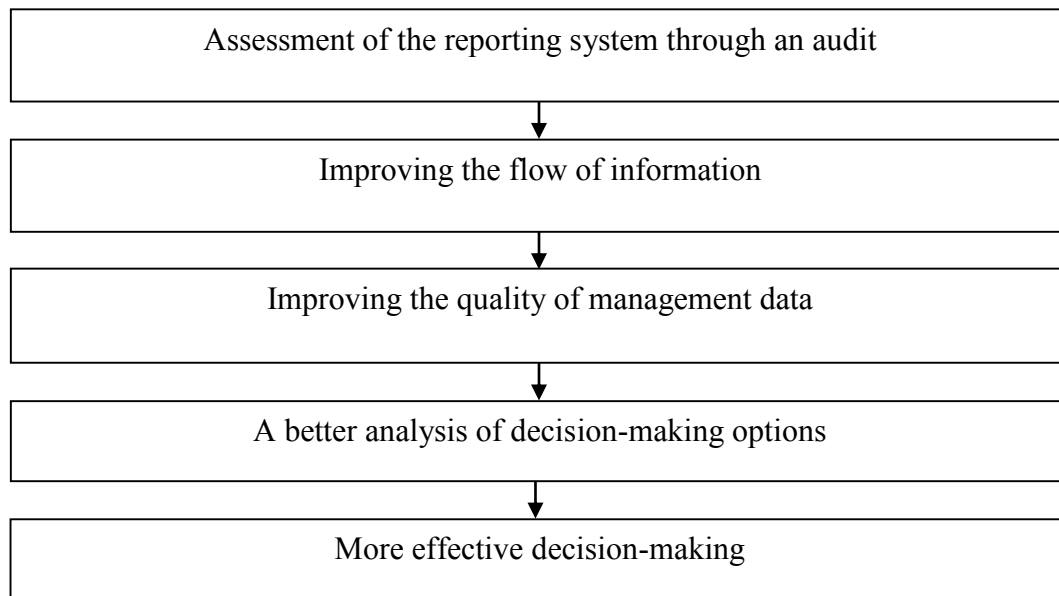


Figure 2. The impact of an audit on the decision-making process.

Source: Emerling, 2015, pp. 90-110.

The diagram shows that auditing has an indirect impact on a company's performance by improving the quality of the information on which decisions are based. In this way, it helps to reduce strategic and operational errors. Risk management is also a key area where auditing has an impact. Modern companies are exposed to numerous financial, operational, legal, technological and reputational risks. Auditing analyses the process of identifying and monitoring risks, assessing the adequacy of the safeguards in place. This enables the organisation to systematically reduce the likelihood of losses occurring and minimise their impact.

The role of auditing in improving the management system is also evident in ensuring that operations comply with legal regulations and corporate governance principles. Standards promoted by, amongst others, the Organisation for Economic Co-operation and Development (OECD) emphasise the importance of transparency, accountability and effective oversight of corporate activities. In this context, auditing serves as a practical tool for implementing these principles, enabling an assessment of the extent to which they have been implemented within the organisation and the identification of areas requiring improvement. This is confirmed by research indicating that internal auditing supports risk management and the achievement of the company's strategic objectives (Wojtysiak-Kotlarski, 2019)

Despite the growing importance of internal audit in enterprise management, there remains a significant research gap in the literature regarding the empirical assessment of its impact on specific areas of organisational functioning, such as the detection of irregularities, process optimisation, and the enhancement of transparency. Existing studies primarily focus on theoretical approaches or case study analyses (Wojtysiak-Kotlarski, 2019; Szydłowski, 2019),

which do not allow for a comprehensive evaluation of the practical significance of internal audit for the effectiveness of enterprise management.

In order to address this gap and to verify the research hypothesis, the author conducted a survey study among 100 respondents using the Internet, including social media and other widely accessible communication platforms. The survey was carried out among employees of manufacturing, service, and commercial enterprises, as well as among individuals holding various positions, which enabled the collection of reliable data from respondents possessing experience and knowledge of the functioning of internal audit within organisations.

The questionnaire was deliberately limited to four questions, each corresponding to one of the key aspects of the research hypothesis. This approach allowed respondents to provide thoughtful and precise answers, while minimising the risk of survey fatigue and a decline in data quality. The limited number of questions made it possible to obtain specific, clear, and reliable information, which systematically contributes to filling the research gap identified in the literature and provides empirical evidence of the importance of internal audit in improving the effectiveness of enterprise management.

The obtained results clearly indicate that the majority of respondents recognise the significant role of auditing in identifying errors and irregularities at an early stage. The predominance of the responses “definitely yes” and “rather yes” confirms that auditing is perceived as an effective tool of both a control and preventive nature. This implies that its function extends beyond the passive detection of deficiencies, encompassing the active reduction of the risk of their occurrence in the future. In practice, this translates into the ability to respond more rapidly to emerging problems and to limit their potential consequences, which directly improves managerial efficiency. In light of the findings, auditing can therefore be regarded as a key component of an organisation’s early warning system (Figure 3).

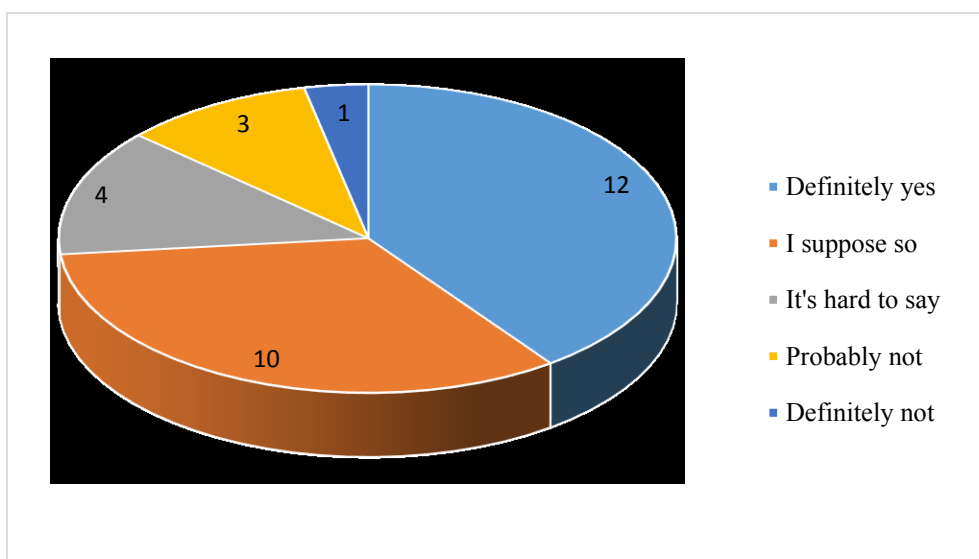


Figure 3. The Role of Auditing in the Early Detection of Irregularities.

Source: own analysis based on a survey.

The next area of analysis concerned the impact of auditing on the optimisation of processes within the organisation. In this case as well, the majority of respondents indicated a positive influence, emphasising the importance of auditing in streamlining processes and improving work organisation. These results suggest that auditing is not limited solely to identifying irregularities but also performs an advisory function, enabling the identification of areas requiring improvement and a more efficient allocation of resources. Importantly, the role of auditing as a tool supporting managerial decision-making, both at the operational and strategic levels, becomes evident. Moreover, the regular conduct of audits fosters the development of an organisational culture based on continuous improvement, which in the long term contributes to increased competitiveness and adaptability to a dynamic market environment (Figure 4).

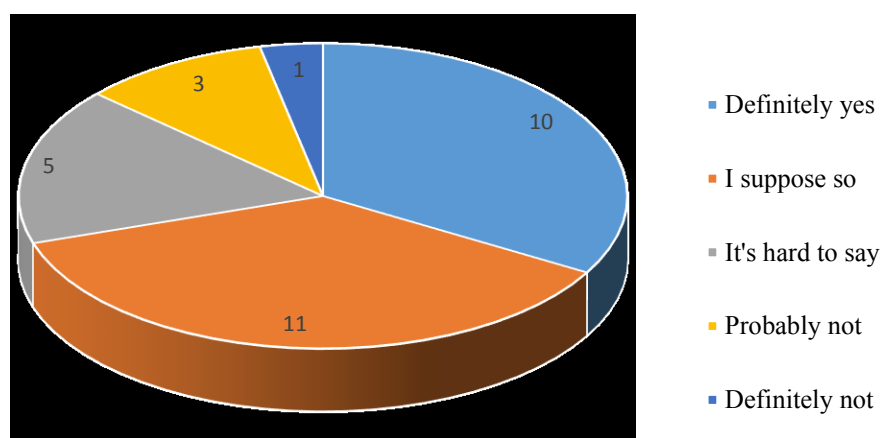


Figure 4. The Role of Auditing in the Optimisation of Company Processes.

Source: own analysis based on a survey.

The subsequent part of the study focused on the impact of auditing on the transparency of organisational operations. The collected data indicate that auditing significantly contributes to enhancing transparency, particularly in terms of documentation control and information flow. The predominance of positive responses suggests that the implementation of audit procedures supports the structuring of information processes and strengthens oversight of their proper functioning. Increased transparency not only facilitates more accurate managerial decision-making but also enhances employees' sense of responsibility for their duties. Furthermore, transparency constitutes a crucial factor in building trust both within the organisation and in relations with external stakeholders. Auditing also enables the identification of areas requiring improvement in internal communication and control mechanisms, leading to greater organisational coherence and compliance with established procedures (Figure 5).

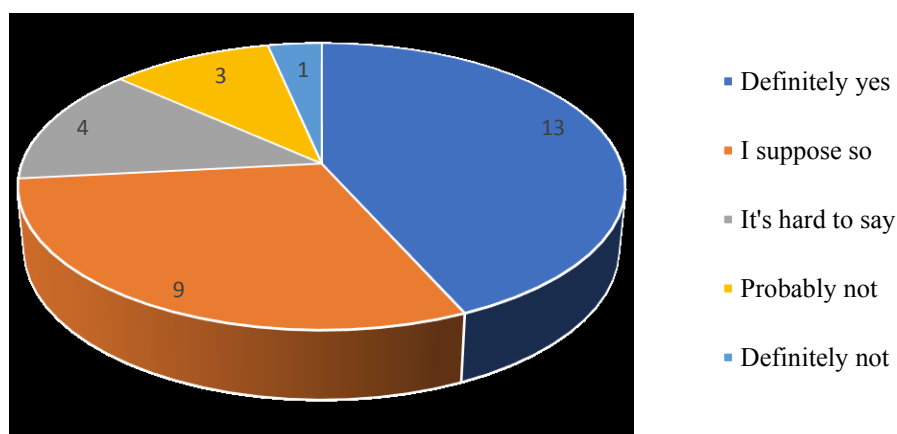


Figure 5. The Role of Auditing in Enhancing Transparency Within a Company.

Source: own analysis based on a survey.

The final aspect examined was the overall impact of auditing on the effectiveness of business management. The results indicate that the vast majority of respondents assess this impact as high or very high, confirming the strategic importance of auditing in management processes. The responses demonstrate that auditing provides substantial support to management by enabling more informed and data-driven decision-making. Through systematic analysis of organisational processes, it becomes possible not only to detect irregularities promptly but also to implement appropriate corrective actions. Consequently, this leads to more efficient resource utilisation and an improvement in operational performance. Importantly, auditing also contributes to greater organisational stability and improved economic outcomes, further highlighting its role as a key instrument supporting modern management (Figure 6).

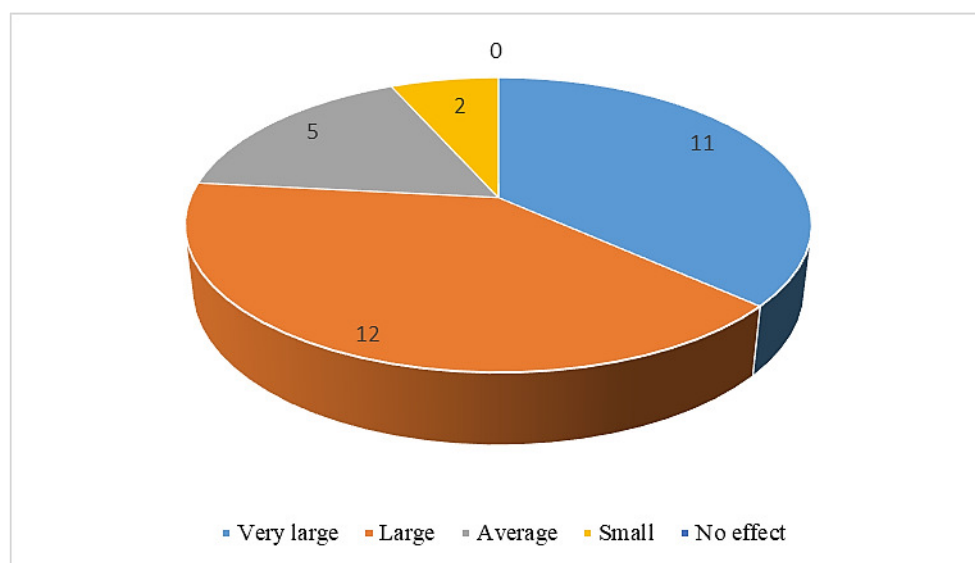


Figure 6. The Impact of Auditing on the Effectiveness of Company Management.

Source: own analysis based on a survey.

In conclusion, the conducted analysis clearly demonstrates that auditing plays a fundamental role in improving organisational performance. Its impact encompasses both operational and strategic dimensions, contributing to the early detection of irregularities, process optimisation, and increased transparency of activities. The findings confirm the high effectiveness of auditing as a tool supporting management and reducing operational and financial risks. Consequently, its systematic implementation should be considered an essential element of a modern management system, determining organisational stability, efficiency, and long-term development.

Furthermore, the consistency of positive responses across all analysed areas strengthens the validity of the conclusions and indicates that auditing delivers measurable and multidimensional benefits to organisations. It not only enhances control mechanisms but also actively supports the development of more resilient and adaptable organisational structures. From a managerial perspective, this underscores the need to treat auditing not as a formal or regulatory obligation, but as a value-creating process integrated into strategic management practices. In addition, the results suggest that organisations which invest in the continuous development of audit functions are better equipped to respond to uncertainty and dynamic market conditions. Therefore, auditing should be recognised as a critical driver of organisational excellence, innovation, and sustainable competitive advantage in the contemporary business environment.

4. Discussion and conclusions

In summary, the analysis highlights the crucial importance of internal audit in business management, particularly in terms of its impact on the quality of decision-making, process optimisation and the transparency of an organisation's operations. Both theoretical considerations and the results of empirical research confirm that internal audit is an essential element of modern management systems, going beyond the traditionally understood control function and playing a significant role in shaping organisational effectiveness.

The results obtained provide positive confirmation of the research hypothesis, according to which a systematically and reliably conducted audit contributes to improving the effectiveness of business management by detecting irregularities at an early stage, supporting process optimisation, and increasing the transparency of organisational activities. The consistency of respondents' answers across all analysed areas further confirms the practical significance of auditing and its tangible impact on the functioning of enterprises.

Research findings also indicate that internal audit should be viewed not merely as a compliance control tool, but above all as a strategic instrument that supports decision-making processes and organisational development. Its advisory, analytical and monitoring functions

contribute to the rationalisation of management decisions, the improvement of risk management and the continuous improvement of processes. The speed with which audit recommendations are implemented is also of particular importance, as it directly influences the improvement of the company's operational and financial performance.

From a practical perspective, it seems reasonable to formulate the following recommendations for companies:

1. The systematic implementation of audit recommendations as a prerequisite for improving process efficiency and reducing the number of irregularities.
2. Reducing the response time to audit findings, thereby minimising the risk of losses and improving operational efficiency.
3. Strengthening the independence of the audit function and raising staff awareness of its importance, which promotes a reliable assessment of risk and increases the transparency of operations.
4. Integrating audit with the organisation's strategic processes so that it acts in an advisory capacity and actively supports long-term decision-making.

It should be emphasised that the issues discussed are of particular importance in the context of growing competition, a volatile economic environment and increased demands for organisational efficiency. In this context, internal audit is becoming one of the key tools supporting the stability and development of enterprises.

At the same time, this issue requires further, in-depth research. In particular, it is appropriate to conduct analyses across various sectors of the economy, taking into account differences in the size of enterprises and the maturity of management systems. Another important direction for future research could be the assessment of the long-term impact of auditing on financial performance and its role in shaping an organisation's resilience to crises. Developing research in this area will contribute to a better understanding of the mechanisms through which auditing exerts its influence and its significance in modern business management.

References

1. Abbott, L.J., Parker, S, Peters, G.F. (2010). Serving Two Masters: The Association Between Audit Committee Internal Audit Oversight and Internal Audit Activities. *Accounting Horizons*, 24(1). <https://doi.org/10.2308/acch.2010.24.1.1>
2. Ampuła, D. (2014). Kontrola i audyt wewnętrzny w jednostce organizacyjnej. *Problemy Techniki Uzbrojenia*, vol. 132, no. 4.
3. Alzeban, A., Gwilliam, D. (2014). Factors Affecting the Internal Audit Effectiveness: A Survey of the Saudi Public Sector. *Journal of International Accounting, Auditing and Taxation*, 23(2). <https://doi.org/10.1016/j.intaccudtax.2014.06.003>

4. Arena, M., Azzone, G. (2009). Identifying Organizational Drivers of Internal Audit Effectiveness. *International Journal of Auditing*, 13(1). <https://doi.org/10.1111/j.1099-1123.2008.00392>.
5. Bartosiewicz, A. (2015). Transformacja audytu wewnętrznego w Polsce – audyt zgodności do audytu efektywnościowego. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, nr 390. DOI: 10.15611/pn.2015.390.03
6. Bednarek, Z., Ciak, R. (2022). Efektywność audytu wewnętrznego w przedsiębiorstwach – ujęcie teoretyczno-empiryczne. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*.
7. Cohen, A., Sayag, G. (2010). The Effectiveness of Internal Auditing: An Empirical Examination. *Managerial Auditing Journal*, 25(4). <https://doi.org/10.1108/02686901011034184>
8. Committee of Sponsoring Organizations of the Treadway Commission (COSO) (2013). *Internal Control – Integrated Framework*. 2nd edition. Durham, NC: COSO.
9. Committee of Sponsoring Organizations of the Treadway Commission (2020).
10. Dasek, T. (2017). Ewolucja audytu wewnętrznego na świecie. *Studenckie Prace Prawnicze, Administratywistyczne i Ekonomiczne*, no. 22. DOI: 10.19195/1733-5779.22.3
11. D'Onza, G., Sarens, G., De Simone, S. (2015). The influence of internal audit quality on financial reporting quality. *Managerial Auditing Journal*, 30(3), 247-271. <https://doi.org/10.1108/MAJ-10-2014-1109>
12. Emerling, I. (2015). Rola audytu w zarządzaniu jednostką – aspekt praktyczny. *Studia Ekonomiczne w Katowicach. Współczesne Finanse*, nr 240.
13. International Professional Practices Framework (IPPF).
14. Iwanowicz, B., Borowy, T. (2019). Wskaźniki efektywności audytu wewnętrznego w sektorze bankowym. *Kwartalnik Nauk o Przedsiębiorstwie*, nr 4. Szkoła Główna Handlowa w Warszawie.
15. Lenz, R, Hahn, U. (2015). A Synthesis of Empirical Internal Audit Effectiveness Literature Pointing to New Research Opportunities. *Managerial Auditing Journal*, 30(1). <https://doi.org/10.1108/MAJ-08-2014-1072>
16. Moeller, R.R. (2016). *Internal Auditing: Assurance and Consulting Services*. 6th edition. Hoboken, NJ: Wiley.
17. Nowicki, P., Kafel, P. (2020). *Wybrane zagadnienia zarządzania jakością. Dokumentacja i audyt systemów zarządzania jakością*. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie.
18. Piaszczyk, A. (2013). Audyt wewnętrzny jako narzędzie zarządzania ryzykiem w organizacji. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, nr 902. Kraków: Wydawnictwo UEK.
19. Pickett, K.H.S. (2010). *The Internal Auditing Handbook*. 3rd edition. Chichester: John Wiley & Sons.

20. Przybylska, J., Kańduła, S., Bogucka, I. (eds.). (2024). *Audyt wewnętrzny narzędziem ułatwiającym zarządzanie organizacją*. Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
21. Sarens, G., De Beelde, I. (2006). 'Internal auditors' perception about their role in risk management. *Managerial Auditing Journal*, 21(1). <https://doi.org/10.1108/02686900610634766>
22. Sawyer, L.B., Dittethofer, M.A., Scheiner, J.H., (2005). *Sawyer's Internal Auditing. The Practice of Modern Internal Auditing*. Institute of Internal Auditors.
23. Sawyer, L.B., Dittethofer, M.A., Scheiner, J.H. (2005). *Sawyer's Internal Auditing*. 5th edition. Altamonte Springs, FL: The Institute of Internal Auditors.
24. Skoczylas-Tworek, J. (2022). Rola audytu w ograniczaniu ryzyka i nadużyć. *Management and Business Administration*.
25. Szydłowski, C. (2019). Rola audytu wewnętrznego w ocenie wydatków samorządów miejskich. *Problemy Ekonomiki i Finansów*, nr 2. Szkoła Główna Gospodarstwa Wiejskiego w Warszawie.
26. Tatoj, M. (2017). *Polityka w zakresie audytu wewnętrznego jednostek sektora polskich finansów publicznych a wspomaganie zarządzania w kształtowaniu wyników jednostek*. Uniwersytet Ekonomiczny w Kielcach.
27. Tatoj, D. (2017). *Audyt wewnętrzny jako element ładu korporacyjnego*. Warszawa: Difin.
28. The Institute of Internal Auditors (IIA) (2017). *International Professional Practices Framework (IPPF)*. Altamonte Springs, FL: The Institute of Internal Auditors.
29. The Institute of Internal Auditors (IIA) (2024). *Globalne Standardy Audytu Wewnętrznego*.
30. Ucieszyńska, M. (2017). Skuteczność i efektywność audytu wewnętrznego w jednostkach sektora finansów publicznych. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 471.
31. Ustawa z dnia 29 listopada 1998 r. o finansach publicznych, t.j. Dz.U. z 1998, nr 155, poz. 1014.
32. Ustawa z dnia 29 listopada 1998r. o finansach publicznych, t.j. Dz.U. z 1998, nr 155, poz. 1014, uchylona.
33. Winiarska, E. Audyt wewnętrzny 2004-2014 – kierunki rozwoju i wyzwania. *Finanse, Rynki Finansowe, Ubezpieczenia*, nr 71. Szczecin: Wydawnictwo Naukowe Uniwersytetu Szczecińskiego.
34. Wojtysiak-Kotlarski, M. (2019). Audyt wewnętrzny a proces zarządzania ryzykiem. *Kwartalnik Nauk o Przedsiębiorstwie*, nr 3. Szkoła Główna Handlowa w Warszawie.

DIGITAL COMPETENCES AS A DETERMINANT OF INFORMATION PROCESS PERFORMANCE IN MUNICIPAL ADMINISTRATION

Angelika WODECKA-HYJEK^{1*}, Hubert OBORA², Michał TECZKE³

¹ Krakow University of Economics; wodeckaa@uek.krakow.pl, ORCID: 0000-0002-6930-4438

² Krakow University of Economics; oborah@uek.krakow.pl, ORCID: 0000-0003-2744-726X

³ Krakow University of Economics; teczke@uek.krakow.pl, ORCID: 0000-0001-9617-1936

*Correspondence author

Purpose: The aim of the study is to identify and analyse the role of employees' digital competences in shaping the performance of information processes in a municipal administration, using the Krakow City Hall as a case study. Achieving this objective required assessing the level of employees' digital competences, identifying available forms of development support, and examining the scale and nature of errors occurring in information processes.

Design/methodology/approach: The theoretical part of the article discusses the determinants of information processes in the digital age and the role of digital competences in the development of e-government. The empirical part presents the results of an online CAWI survey conducted among 245 employees from nine organisational units of the Krakow City Hall that most frequently reported problems related to the functioning of information processes. The collected data were analysed using descriptive statistics.

Findings: The results indicate that the level of employees' digital competences, according to their self-assessment, is only moderate (mean score of 2.93 on a five-point scale), accompanied by a moderate level of errors in information processes. The study identified, among others, situations related to information overload and information scarcity, difficulties in interpreting information, and the retention of information by employees. The findings suggest that insufficient digital competences constitute one of the factors contributing to the occurrence of information inefficiencies.

Research limitations/implications: The limitations of the study relate primarily to its scope, which covered selected organisational units of the Krakow City Hall, and to the fact that the measurement of competences was based on respondents' self-assessment. Future research should extend the analysis to all organisational units of the office as well as to other municipal administrations, and should employ additional research methods, including objective competence tests and qualitative approaches.

Practical implications: The results highlight the need for a systemic strengthening of employees' digital competences through the development of training programmes, greater managerial involvement in motivating employees to improve their skills, and the promotion of an organisational culture supportive of digital transformation. Such measures may contribute to reducing errors in information processes and improving the quality of public services.

Social implications: Enhancing the level of digital competences in public administration is a key element of the digital transformation of the public sector and directly affects the quality of life of citizens and their access to public services. Reducing information inefficiencies through the development of employees' competences may foster trust in digital administration, help reduce digital exclusion, and increase civic participation in public life.

Originality/value: The article combines the perspective of digital competences with the analysis of specific information inefficiencies within a local government administration office, thereby addressing a gap in national research on the digital transformation of the public sector.

Keywords: digital competences, information processes, information inefficiencies, e-administration, e-government, local government administration.

Category of the paper: Research paper.

1. Introduction

Although the concept of digital transformation is widely used, it is rarely defined unambiguously in the literature (Alvarenga et al., 2020). D.M. Mazzone (2014) defines digital transformation as “the intentional and continuous digital evolution of an organisation, its business model and processes, implemented at both strategic and tactical levels”. M. Fitzgerald et al. (2013), in turn, describe it as the use of new digital technologies, such as social media, mobile devices, analytical tools or embedded technologies, to achieve significant business improvements, including improved customer service quality, optimisation of operational processes and the creation of new business models. Digital transformation is also understood as a process of change leading to a certain level of technological advancement or, more broadly, as a set of trends and consequences resulting from the increasingly intensive use of digital technologies (Dufva, Dufva, 2019). In this perspective, it refers to organisational transformation resulting in the integration of digital technologies with business processes and leading to the development of a new operating model based on these technologies (Liu et al., 2011). In practice, the terms digitisation, digitalisation and digital transformation are sometimes used interchangeably in the literature (Mergel et al., 2019, p. 1).

The rapid development of markets based on information and communication technologies (ICT) has been an important driver of economic growth in recent years. The dynamic advancement of digital technologies has led to the transfer of many areas of social life into the virtual environment. This process is associated with the need to develop appropriate competences enabling the conscious, effective and safe use of ICT, thereby enabling full participation in social life. The development of information and communication technologies has also enabled a key innovation in service delivery in the form of electronic services. In the most general sense, electronic services (e-services) are defined in the literature as services provided via a network (Rust, Kannan, 2003, pp. 37-42).

Digital transformation in the public sector involves new ways of collaborating with stakeholders, creating innovative service delivery frameworks and building new forms of relationships (Mergel et al., 2019, p. 1). The digitalisation of public administration is one of the key transformation processes of the modern state, which must adapt its legal and organisational structures to a rapidly changing technological environment. The introduction of modern technologies into public administration is intended to increase the efficiency of public offices and improve the accessibility of services for citizens. A modern administration should therefore not only perform its tasks effectively but also respond to the expectations and needs of citizens. An important prerequisite for well-designed digital public services and a high level of service delivery is the continuous development of digital competences among public administration employees, particularly those working in local government administration. In the public sector, digitalisation has primarily affected the way public services are delivered, enabling institutions to better adapt to the changing expectations of citizens. In this context, the concept of e-government becomes particularly important. It can be interpreted broadly as the use of ICT to provide access to public information and, more narrowly, as the use of these technologies directly in the process of delivering public services (Mergel et al., 2019).

A study conducted by Miazga et al. (2022) on the digitalisation of municipal offices in Poland revealed a limited systemic approach to digital transformation in Polish city administrations, strongly differentiated by the size of the city. Most municipalities lack strategic documents or organisational structures dedicated to digitalisation, which results in the uncoordinated and fragmented implementation of ICT solutions. Although the experience of the COVID-19 pandemic contributed to accelerating digitalisation processes, particularly in larger cities, solutions with limited functionality still dominate and are largely based on central government administrative platforms. E-services are typically dispersed, allow only partial completion of administrative procedures online, and are rarely designed from a user-centred perspective. The main barriers to digital transformation include financial and competence-related shortages, organisational resistance, and siloed administrative structures. In the long term, these factors may deepen digital disparities between small and large cities.

This study aims to identify and analyse the role of employees' digital competences in shaping the efficiency of information processes in a local government administration office, using the Krakow City Hall as a case study.

The theoretical part of the article discusses the determinants of information processes in the digital age and examines the concept of digital competences in the context of the development of e-government. The empirical part is based on a CAWI survey conducted among 245 employees from nine organisational units of the Krakow City Hall. The analysis focused on employees' assessments of their level of digital competences, the availability of development support, and the scale and nature of errors occurring in information processes. The study was designed to verify two hypotheses concerning the need to further strengthen digital competences and their influence on the occurrence of information inefficiencies.

The final part of the article presents a discussion of the results in relation to both Polish and international research, highlighting similarities and differences in the role of digital competences in the functioning of public administration and their importance for reducing errors in information processes.

2. Determinants of information processes in the digital age

The digitalisation of the public sector reshapes the conditions under which information processes operate, increasing the scale, intensity and complexity of information flows within the sector under analysis. The literature emphasises that digital transformation is not limited to the implementation of IT tools but involves the integration of technological infrastructure, e-services and human capital development (Valaskova et al., 2025; Jafari et al., 2025). In this perspective, information becomes part of a broader organisational system in which technology, procedures and employees' competences remain interrelated. The issue of information inefficiencies under conditions of digitalisation has also been examined in empirical studies conducted within local government administration. A case study of the Municipality of Krakow indicates the multidimensional nature of disruptions in information circulation, encompassing quantitative, temporal and competence-related aspects (Obora, Teczke, 2024). This perspective confirms the relevance of analysing information processes in the public sector from an integrated standpoint that combines both structural and cognitive dimensions.

Studies concerning the public sector indicate that the process of digital transformation is regionally and institutionally differentiated (Valaskova et al., 2025). This implies that the level of digital maturity may vary between organisations and countries, which may also affect the organisation and performance of information processes. At the same time, longitudinal studies show that as digital organisations mature, the focus shifts from IT infrastructure alone towards a broader integration of technological resources with organisational processes and human capital (Jafari et al., 2025). This, in turn, indicates the need to analyse information processes from a multidimensional manner.

The first dimension considered in the analysis is the quantitative dimension, in which information overload is a frequently examined phenomenon. Model-based studies on team decision-making demonstrate that as the level of information overload increases, the effectiveness of information-sharing strategies may change depending on the priority adopted (speed versus accuracy of decisions) (van Veen et al., 2020). Although the authors do not refer directly to the public sector, their findings suggest that an increase in the volume of processed information may require adjustments in the ways information is shared and selected. Research on digital environments has also shown that information overload may be associated

with information avoidance behaviours. An analysis of social media user behaviour indicates that system design may influence the level of information overload, which in turn may be related to behaviours involving the limitation of exposure to information content (Kumalasari, Priharsari, 2023). Although the study was conducted in the context of social networking services (SNS) and pandemic-related information, the mechanism identified may also occur in other contexts, highlighting the importance of the structure and intensity of communication in digital environments.

In the literature addressing information overload, attention is also drawn to its potential links with the cognitive characteristics of individuals in managerial positions (Vieira, Razzolini Filho, 2019). These studies focus in particular on the validation of instruments used to measure information overload and the construct of need for cognition. The authors analyse the relationship between the perceived amount of information and the cognitive characteristics of the individual. Their findings suggest that the quantitative dimension of information processes may be interpreted both in terms of the objective volume of information and the subjective perception of information excess.

Another dimension examined in a multidimensional perspective is the temporal dimension. Digital communication systems enable a substantial reduction in the time required to transmit information and increase the frequency of data updates. The literature on digital transformation emphasises that technology may support the reorganisation of work and the integration of organisational processes (Jafari et al., 2025). However, this does not automatically lead to improvements in all parameters of organisational functioning. Results of model-based studies (van Veen et al., 2020) suggest that under certain levels of information overload, communication strategies may differ in effectiveness depending on whether the priority is the speed or the accuracy of decisions. Although the authors do not refer directly to public administration, their findings indicate that the pace of information flows remains related to the quality of information processing. For this reason, the temporal dimension of information processes can be understood as encompassing not only the speed of information transmission but also the synchronisation, timeliness and appropriateness of the moment at which information is delivered.

From a broader perspective, analyses of the digitalisation of the public sector indicate gradual changes in the level of digital inequality among EU member states (Valaskova et al., 2025). It should be noted, however, that these studies do not directly address the speed of information circulation within organisations. Therefore, their conclusions concerning the temporal dimension should be interpreted primarily within the broader context of the development of digital infrastructure and e-services.

The third dimension considered in the multidimensional analysis is the qualitative dimension of information. Information quality in digital environments includes such characteristics as relevance, clarity and consistency of content. Studies on the design of SNS-based systems indicate that features of information systems may be related to users'

perceptions of information quality (e.g., information relevance and information equivocality) as well as to the level of information overload (Kumalasari, Priharsari, 2023). This suggests that the design of digital tools may significantly influence the reception and processing of information. In the context of public sector transformation, digital maturity is understood to include, among other elements, the development of e-services, the strengthening of digital competences and the integration of data resources (Valaskova et al., 2025). The cited authors analyse these elements from a comparative perspective across EU member states. Their findings clearly emphasise the importance of structural conditions for the functioning of information systems. The literature addressing information overload also highlights that the perception of information excess may be related to the cognitive processes of decision-makers (Vieira, Razzolini Filho, 2019). This indicates that information quality can be considered not only in objective terms but also in subjective terms related to the ability of individuals to process information.

The final dimension of the analysis is the competence dimension. Numerous studies on the public sector emphasise the importance of digital competences in transformation processes. An analysis of employees in the Portuguese public sector indicates that digital transformation may be hindered by insufficient levels of digital competences, while participation in digital training programmes remains limited (Lopes et al., 2023). The authors report a relatively low level of self-assessed digital knowledge and a high proportion of employees who have not participated in training activities in recent years. These findings highlight the importance of investment in human capital. From an organisational perspective, the literature also emphasises the role of digital leadership and intellectual capital management in the public sector (Firmansyah et al., 2025). The cited authors suggest that improvements in intellectual capital management and digital leadership may be associated with higher quality of public services and increased stakeholder trust. Longitudinal studies on the transformation of public organisations indicate that effective integration of digital technologies requires adjustments in organisational culture and institutional structures (Jafari et al., 2025). In this sense, digital competences can be understood as part of a broader institutional framework encompassing both human resources and organisational arrangements.

3. Digital competences in the context of the development of e-government

The primary document defining digital competences is the Council Recommendation of 22 May 2018 on key competences for lifelong learning (Council Recommendation of 22 May 2018, 2018). According to this document, digital competences refer to the confident, critical and responsible use of digital technologies in education, work and participation in society. They include, among others, the ability to work with information and data, communication and

collaboration, media literacy, digital content creation (including programming), security (including cybersecurity and digital well-being), issues related to intellectual property, problem-solving and critical thinking.

A more detailed elaboration of the concept of digital competences is presented in the same document (Council Recommendation of 22 May 2018 on key competences for lifelong learning, p. 9), where digital competences are defined as the confident, critical and responsible use of, and engagement with, digital technologies for the purposes of learning, working and participation in society. They encompass the ability to work with information and data, communication and collaboration, media literacy, digital content creation (including programming), security (including digital well-being and cybersecurity competences), issues related to intellectual property, problem-solving and critical thinking. The use of digital technologies and digital content requires a reflective and critical, yet also curious, open and forward-looking attitude towards their development. It also requires an ethical, safe and responsible approach to their use.

The European Commission Communication on the Digital Education Action Plan 2021-2027 identifies two strategic priorities: the development of a high-performing digital education ecosystem and the strengthening of digital competences for the purposes of digital transformation. The implementation of the first priority requires appropriate infrastructure, access to connectivity and digital equipment, effective planning of organisational capacity development, as well as competent educational staff and high-quality digital content and tools that comply with safety and ethical standards. The second priority focuses on the development of both basic and advanced digital competences (Digital Education Action Plan..., 2021).

Digital competences constitute a broad set of skills enabling the effective use of digital technologies. Their key importance for active participation in the information society is widely emphasised, as is their integrated and multidimensional character in the process of their development (Rozkrut, 2018, p. 349). Digital competences refer to the ability to understand and use information available in various formats and electronic sources. In this context, the crucial factor is not merely technical proficiency but the ability to think critically, evaluate the quality of information and use it in a conscious and responsible manner. These competences also include attitudes and skills enabling the search, analysis, integration and creation of digital resources, as well as communication and cooperation in various areas of social life (Tarkowski et al., 2015, p. 30).

According to the definition adopted by the Polish Ministry of Digital Affairs, digital competences consist of several interrelated components. The first category includes IT competences, which involve the ability to use computers and other electronic devices, safely use the internet, applications and software, as well as emerging intelligent digital technologies. This category also includes the ability to apply methods derived from computer science when programming and developing digital solutions to problems in various domains (computational thinking). The second category comprises information and communication competences,

understood as the ability to search for information, comprehend it, critically evaluate and select relevant content, and communicate remotely using digital technologies. The third category includes functional competences, understood as the practical application of the above skills in different areas of everyday life, such as finance, work and professional development, maintaining social relationships, health, hobbies, civic engagement or spiritual life, while respecting the principles of safe use of digital technologies (Digital Competences, 2020). The ability to use digital technologies significantly affects quality of life, labour market position, access to information, educational and health services, and a wide range of products that facilitate everyday functioning and improve work performance. The benefits associated with possessing digital skills are therefore substantial, whereas their absence not only limits the ability to benefit from digital transformation but may also contribute to the deepening of social inequalities. Digital competences should therefore be understood not only as the ability to operate tools and technologies, but also as a set of soft skills, including critical thinking, effective communication and the ability to adapt to a dynamically changing digital environment. These capabilities enable individuals to fully exploit the potential of digital technologies while simultaneously reducing the risk of digital exclusion. At the level of the European Union Member States, digital competences are commonly assessed using five categories of digital skills related to: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Definition and Levels of Digital Competence, 2024).

It therefore appears justified to advance the argument that the development of digital competences—both among employees of public institutions and within society more broadly—constitutes a necessary condition for the effective implementation of modern information and communication technologies in the public sector. At the same time, a significant challenge is the shortage of highly qualified ICT specialists in public administration. It should also be emphasised that digital competences in public administration should not be limited solely to technical aspects. Technology constitutes a tool for the implementation of public tasks, and the continuous development of the digital skills of local government employees contributes to the wider use of digital solutions supporting the delivery of public services.

A multidimensional analysis of information processes clearly indicates that technology, although it provides an essential infrastructural foundation, does not in itself determine the overall performance of information flows within an organisation. The previously identified dimensions—quantitative, temporal and qualitative—ultimately converge in the competence dimension, which in everyday managerial practice may function either as a catalyst or as a bottleneck of the entire transformation process. While general research models often emphasise the architecture of information systems, in the highly formalised and institutionally specific environment of public administration it is human capital that becomes the primary driver of change. Consequently, shifting the analytical focus from purely technical solutions to their users necessitates a more in-depth examination of the role of the human factor within the

digital ecosystem. From this perspective, a detailed analysis of the digital skills of public administration staff appears justified as a necessary step towards understanding the mechanisms shaping the effectiveness of information flows within local government structures. These employees constitute the practical foundation of the dynamically developing system of e-government.

The introduction of modern information and communication technologies into public administration constitutes an important element of activities aimed at improving the functioning of administrative institutions, rationalising administrative processes and enhancing the accessibility and quality of services provided to citizens. In this context, the concept of modern administration refers not only to the ability to perform public tasks efficiently and in compliance with legal requirements, but also to the capacity to respond to evolving social needs and expectations, including the growing demand for digital, remote and user-oriented services. A key prerequisite for the effective design, implementation and maintenance of high-quality digital public services is the possession and continuous development of digital competences among public administration employees. These competences encompass not only technical skills but also the ability to adapt to organisational and technological changes. Their importance is particularly evident at the level of local government, which remains closest to citizens and plays a fundamental role in the everyday delivery of public services as well as in shaping citizens' experiences of digital public administration.

4. Study methodology and characteristics of results

The study constituted part of a broader research project concerning the analysis of information inefficiencies and the digital solutions intended to mitigate them in the Krakow City Hall.

The analytical framework adopted in the study was based on a multidimensional approach to information processes in the context of digital transformation. The analysis incorporated four interrelated dimensions discussed in the theoretical section: the quantitative dimension (related to information overload and information scarcity), the temporal dimension (related to the timeliness and circulation of information), the qualitative dimension (related to the clarity, completeness and interpretability of information), and the competence dimension (related to employees' digital competences and organisational support for their development). These dimensions were operationalised through a set of survey questions included in the CAWI questionnaire, enabling the empirical assessment of both the level of digital competences and the occurrence of information inefficiencies within the analysed organisational units of the Krakow City Hall.

The empirical research sought to answer the following questions:

1. In the opinion of the employees of the Krakow City Hall, are their digital competences sufficient for the efficient use of digital solutions supporting information processes?
2. Does the level of digital competences among employees of the Krakow City Hall influence the occurrence of errors in the information processes they perform?

These questions formed the basis for the formulation of the following research hypotheses:

- H1. Despite initiatives undertaken by the management of the Krakow City Hall, the level of employees' digital competences requires further support.
- H2. The level of digital competences among employees influences the occurrence of errors in information processes.

The study was conducted at the Krakow City Hall between 18 and 25 October 2024 using the CAWI survey method. A total of 245 employees participated in the survey, representing nine organisational units of the office that most frequently reported problems related to the functioning of information processes. The detailed structure of the research sample is presented in Table 1.

Table 1.
Structure of respondents by organizational units

Code	Organisational units of the Krakow City Hall (departments)	Number of respondents	Percentage of respondents
W1	Department of Education	49	20.00
W2	Department of Municipal Services and Climate	42	17.14
W3	Department of Vehicle and Driver Registration	34	13.88
W4	Department of Social Communication	29	11.84
W5	Department of Entrepreneurship and Innovation	23	9.39
W6	Department of Investment Strategy, Planning and Monitoring	20	8.16
W7	Department of Tourism	18	7.35
W8	Department of Spatial Planning	17	6.94
W9	Department of Administrative Enforcement and Debt Recovery	13	5.30

Source: authors' own elaboration.

Differences in the number of respondents representing particular organisational units of the office resulted primarily from differences in the number of employees working in these units. To verify Hypothesis H1, responses to the following three questions posed to employees of the analysed organisational units were used:

1. In your opinion, do employees of the Krakow City Hall possess sufficient digital competences?
2. In your opinion, does the office provide training aimed at developing digital competences?
3. In your opinion, does the management of the office actively encourage employees to develop their digital competences?

Respondents had the opportunity to answer these three questions using a five-point Likert scale, where a score of 1 meant "definitely not", 2 – "rather not", 3 – "moderately", 4 – "rather yes" and a score of 5 meant "definitely yes".

Respondents answered these questions using a five-point Likert scale, where a score of 1 indicated "strongly disagree", 2 "rather disagree", 3 "moderately", 4 "rather agree", and 5 "strongly agree".

To verify Hypothesis H2, responses to the questions used to test H1 were analysed together with a set of questions concerning errors occurring in the office's information processes. These questions were grouped into three thematic blocks related to: the quantity of information available to employees, the timeliness of information delivery, and the manner in which information is formulated or presented. The first block consisted of four questions:

1. Does it happen that you receive information that is unnecessary for the tasks you perform?
2. Does it happen that you receive so much information that it cannot be effectively analysed and used?
3. In your work, is there a risk of making an incorrect decision due to a lack of information?
4. In your work, is there a risk of making an incorrect decision due to receiving incomplete information?

The second block included two questions:

1. Does it happen that information necessary for making specific decisions reaches you much too early?
2. Does it happen that another employee withholds information needed for your work?

The third block also consisted of two questions:

1. Does it happen that the information you receive creates difficulties in interpretation?
2. Does it happen that the information you receive for your work is mutually contradictory?

As in the case of the questions concerning digital competences, respondents answered using the same five-point Likert scale, where 1 indicated "very rarely", 2 "rather rarely", 3 "moderately", 4 "rather often", and 5 "very often".

The first question used in the survey was: "In your opinion, do employees of the Krakow City Hall possess sufficient digital competences?" The responses obtained for the entire research sample (mean score on the five-point scale: 2.93) indicate that the office still has considerable room for improvement in the area of employees' digital skills. Responses to this question varied across the individual organisational units of the office (Table 2). The lowest level of digital competences was reported by employees of the Department of Administrative Enforcement and Debt Recovery (mean score: 2.38), while the highest assessments were provided by respondents representing the Department of Spatial Planning (3.18) and the Department of Entrepreneurship and Innovation (3.17).

Table 2.*Answers to questions about digital competences*

Digital competence questions	Mean responses to questions concerning digital competences by organisational unit									Overall mean
	W1	W2	W3	W4	W5	W6	W7	W8	W9	
Do the employees of the Office have sufficient digital competences?	2.88	2.95	2.82	3.14	3.17	3.05	2.61	3.18	2.38	2.93
Does the Authority provide training on improving digital competences?	3.12	3.38	2.50	3.14	3.39	3.35	3.11	2.65	3.31	3.10
Does the management of the Office actively motivate employees to develop digital competences?	3.06	2.81	2.53	3.10	2.83	2.70	2.78	2.41	2.38	2.80

Source: authors' own elaboration.

The next two questions were intended to indicate the possibilities for the further development of digital competences. The first concerned the opportunities available to employees of the Krakow City Hall to participate in training aimed at improving their digital literacy. The mean score obtained for the entire sample of 245 employees (3.10) suggests that either the training opportunities offered in the area of digital competences are insufficient or that information about the possibility of participating in such training does not effectively reach employees. The lowest evaluation of the possibility of participating in such training was reported by employees of the Department of Vehicle and Driver Registration (mean: 2.50), while the highest was reported by respondents representing the Department of Entrepreneurship and Innovation (3.39) and the Department of Municipal Services and Climate (3.38). The third question concerned the active encouragement of employees by the management to improve their digital competences. The overall result, which was below three points (2.80), indicates a need to strengthen managerial efforts aimed at motivating employees to develop their digital skills. The lowest level of support in this area was reported by employees of the Department of Administrative Enforcement and Debt Recovery (2.38), while the highest was reported by respondents from the Department of Social Communication (3.10). An analysis of responses to all three questions indicates that employees perceive a need for stronger managerial efforts aimed at developing their digital competences. Hypothesis H1 was therefore confirmed.

The next block of questions concerned errors occurring in information processes. The first four questions referred to the amount of information reaching employees who use it in the course of their work. Responses to the first of these questions indicate that problems related to the amount of information within information processes occur at a moderate level (Table 3). Similar results were obtained both for questions concerning excessive information and for those concerning insufficient information.

Situations in which employees receive information that is unnecessary for the tasks they perform were rated at 2.80, which corresponds to a level between “rather rarely” and “moderately”. The lowest frequency of such situations was reported by employees of the Department of Spatial Planning (2.18), while the highest was reported by employees of the Department of Municipal Services and Climate (3.10). According to respondents, situations in which the information received is relevant but so abundant that it cannot be fully utilised occur slightly more frequently (overall mean: 2.84). Employees of the Department of Administrative Enforcement and Debt Recovery identified with this situation most strongly (3.23), while employees of the Department of Spatial Planning reported it least frequently (2.35).

Table 3.

Problems related to the amount of information

Problems related to excess or insufficient information	Department mean									
	W1	W2	W3	W4	W5	W6	W7	W8	W9	
Receiving information that is unnecessary for the tasks performed.	2.92	3.10	2.65	2.86	2.78	2.60	2.67	2.18	3.00	2.80
Receiving such a large amount of information that it cannot be effectively analysed and used.	2.98	3.12	2.65	2.38	2.83	3.00	2.89	2.35	3.23	2.84
Risk of making an incorrect decision due to a lack of information.	2.80	3.07	2.91	2.66	2.70	2.70	2.61	2.71	3.15	2.82
Risk of making an incorrect decision due to incomplete information.	2.92	3.05	2.82	2.72	2.70	2.90	2.78	2.82	3.15	2.88

Source: authors' own elaboration.

Respondents provided very similar answers to questions concerning situations related to the lack of information necessary for work. In response to the question about the absence of information required to make a specific decision, the mean response for the entire sample was 2.82, indicating a moderate likelihood of such situations. Employees of the Department of Tourism encountered such situations least frequently (2.61), while they were reported most frequently by employees of the Department of Administrative Enforcement and Debt Recovery (3.15). According to the respondents, situations in which the information received is incomplete occur slightly more often (2.88), which may lead, for example, to incorrect decisions. Such situations are reported most frequently by employees of the Department of Municipal Services and Climate (3.05) and least frequently by respondents from the Department of Entrepreneurship and Innovation (2.70).

The next two questions concerned errors related to the timing of information delivery to its users. The first question was: “Does it happen that the information you need reaches you too early and you have to return to it after a longer period of time?” Responses suggest that such situations occur rather infrequently. The mean response to this question was 2.32 (see Table 4).

The lowest value was recorded among employees of the Department of Vehicle and Driver Registration (2.09), while the highest—approaching a moderate level of occurrence—was observed in the Department of Education (3.06). According to the results obtained, situations in which employees withhold information, resulting in delays in its delivery to the position requiring it, occur more frequently in the office. The mean score for the occurrence of such situations was 3.11.

Table 4.

Issues related to the time of acquisition of information

Problems of transmitting information over time	Department mean									Overall mean
	W1	W2	W3	W4	W5	W6	W7	W8	W9	
Receiving information too early to be used effectively	3.06	2.21	2.09	2.24	2.65	2.45	2.28	2.18	2.69	2.32
Withholding information required by other positions	2.92	3.48	2.59	2.90	3.30	3.50	3.33	3.18	3.15	3.11

Source: authors' own elaboration.

In three of the nine organisational units of the Office included in the study, this value did not exceed 3. Respondents representing the Department of Vehicle and Driver Registration assessed the occurrence of this phenomenon at 2.59. The highest values were recorded among employees of the Department of Strategy, Planning and Investment Monitoring (3.50) and the Department of Municipal Services and Climate (3.48).

The final group of questions used in the study concerned problems in information processes related to the content of information received by users. The distribution of responses to these questions is presented in Table 5.

Table 5.

Content issues

Problems of information formulation and interpretation	Department mean									Overall mean
	W1	W2	W3	W4	W5	W6	W7	W8	W9	
Receiving information that is difficult to interpret correctly	3.06	3.50	3.21	2.79	3.35	3.50	2.83	2.65	3.38	3.16
Receiving mutually contradictory information	2.65	3.02	2.85	2.62	2.61	2.55	2.22	2.47	3.23	2.71

Source: authors' own elaboration.

In response to the question concerning difficulties in interpreting the information received, the mean score for all respondents was 3.16. Such situations were reported most frequently by employees of the Department of Municipal Services and Climate and the Department of Strategy, Planning and Investment Monitoring (3.50 in both cases), and least frequently by employees of the Department of Spatial Planning (2.65). Cases of receiving mutually

contradictory information were also reported. The overall mean score for this phenomenon was 2.71. It was observed most frequently by respondents representing the Department of Administrative Enforcement and Debt Recovery (3.23) and least frequently by employees of the Department of Tourism (2.22).

Responses to the questions concerning errors occurring in information processes indicate a moderate level of their occurrence in the Krakow City Hall. When these results are considered together with the relatively low assessment of digital competences by employees, it may be concluded that errors in information processes are partly a consequence of an insufficient level of such competences. This relationship was particularly evident in the Department of Administrative Enforcement and Debt Recovery, whose employees assessed their digital competences as the lowest among the units analysed. This organisational unit also reported a higher frequency of the analysed errors in information processes than the other units included in the study. By contrast, in the Department of Social Communication and the Department of Spatial Planning, where employees assessed their digital competences more highly than in other departments, the reported occurrence of individual errors in information processes was in most cases below the overall mean. This indicates that in organisational units whose employees assess their digital competences at a higher level, errors in information processes occur less frequently. The obtained results therefore confirm hypothesis H2.

5. Discussion of the results of the study

The conducted study enabled a multidimensional assessment of the level of digital competences among employees of the Krakow City Hall and their relationship with the quality of information processes carried out within the organisation. The obtained results indicate that the overall assessment of digital competences in the analysed sample is moderate (mean score 2.93 on a five-point scale), suggesting that the organisation's digital potential is not yet fully developed. The variation in assessments between organisational units shows that digital competences are not evenly distributed across departments. They were rated highest in the Department of Spatial Planning and the Department of Entrepreneurship and Innovation, while the lowest ratings were recorded in the Department of Administrative Enforcement and Debt Recovery. These differences may result both from the specific nature of the tasks performed and from the varying extent to which digital tools are used in everyday work.

The analysis of responses concerning opportunities for developing digital competences indicates the existence of a gap between the need for improvement and the perceived level of organisational support. Although the assessment of training availability (3.10) is slightly higher than the overall assessment of competences, it still does not indicate the existence of systematic and fully satisfactory solutions. An even lower score was recorded for the extent to which

management motivates employees to improve their digital competences (2.80), which may suggest that a culture of learning and development in the area of digital transformation is not yet sufficiently embedded within the organisation. The confirmation of hypothesis H1 therefore indicates that employees perceive a need to intensify managerial efforts aimed at developing digital competences, both by expanding the training offer and by strengthening motivational mechanisms.

The results concerning errors in information processes reveal moderate but regularly occurring problems related to information overload, information shortages and incomplete information. Mean scores in most cases range between 2.8 and 3.1, indicating that these phenomena cannot be regarded as merely incidental. From the perspective of organisational efficiency, particularly significant are situations involving information withholding (mean 3.11) and difficulties in interpreting information (3.16), which may lead to delays in decision-making, increased risk of errors and a decline in the quality of public tasks performed. The occurrence of mutually contradictory or incomplete information further increases decision-making uncertainty and may generate additional organisational costs.

A key conclusion from the conducted analyses is the clear relationship between the level of digital competences and the frequency of errors in information processes. Departments in which employees assessed their digital skills more highly generally reported a lower intensity of information-related problems. The opposite pattern was observed in the Department of Administrative Enforcement and Debt Recovery, where the lowest self-assessment of digital competences coincided with the most frequent reporting of errors in information circulation. These findings allow hypothesis H2 to be confirmed and indicate that the level of digital literacy may constitute an important factor influencing the efficiency of information processes in public administration.

Similar conclusions can also be found in the national literature. In her study, Łukaszuk (2022) assessed the current level of digital competences among public administration staff as an important factor in the digital transformation of local government units in Poland. The author's findings indicate that one of the main challenges of digital transformation is the insufficient level of administrative staff competences in the areas of procuring, designing, implementing and maintaining IT systems. The lack of specialised knowledge results in a growing dependence on external providers, limits the ability to make informed technological decisions and weakens control over the quality and security of implemented solutions. This deficit has both a quantitative dimension (an insufficient number of experts) and a qualitative dimension (a mismatch between existing competences and rapidly evolving technologies). Another important dimension of civil servants' digital competences is digital awareness, understood as the ability to adopt a process-oriented and digitally oriented approach from the very beginning of the implementation of public tasks. Digital transformation requires a shift towards an organisational model based on data integration, system interoperability and user orientation. Without a mental and cultural change among administrative staff, even the

most advanced technological tools will not deliver the expected results. The author also points to significant psychological and organisational barriers related to the digital transformation of public offices. Concerns among civil servants about job losses resulting from process automation, a lack of motivation to improve qualifications and insufficient institutional support weaken the dynamics of transformation. At the same time, the absence of a systemic approach to the development of digital skills—including the lack of central coordination and a coherent strategy—leads to the fragmentation of training activities and limits their effectiveness. Łukaszuk (2022) also highlights the importance of cybersecurity, which constitutes an integral component of civil servants' digital competences. Ensuring the confidentiality, integrity and availability of public data requires not only appropriate technological infrastructure but also aware and responsible system users. A low level of awareness of digital threats increases the vulnerability of public administration to incidents and undermines citizens' trust in electronic services.

A comparison of the empirical findings with the previously conducted theoretical analysis makes it possible to observe that the phenomena identified within the structures of the Krakow City Hall constitute a clear example of broader mechanisms accompanying the digital transformation of the public sector. The inversely proportional relationship identified in the study between the level of employees' self-assessment of digital competences and the frequency of operational errors in information processes corresponds directly with the key arguments presented in the literature. The competence deficit observed in the analysis, particularly among respondents representing the Department of Administrative Enforcement and Debt Recovery, has also been identified in international studies conducted by Lopes et al. (2023). These authors, analysing the European public sector, demonstrated the existence of similar barriers related to competence self-assessment, which hinder the development and implementation of modern e-government solutions. The situation observed in the Krakow City Hall confirms that low confidence in one's digital skills, often associated with limited participation in professional training, may significantly reduce the overall operational efficiency of public administration units.

By contrast, the results obtained for organisational units such as the Department of Social Communication and the Department of Spatial Planning indicate that a relatively higher self-assessment of technological competences among employees is accompanied by a lower frequency of errors in information flows. Such a distribution of variables supports the thesis that an appropriately high level of digital literacy constitutes an essential buffer ensuring the overall quality and reliability of public services (Hamouche et al., 2025). As Firmansyah et al. (2025) argue, effective management of intellectual capital and the development of digital leadership within public administration institutions represent key determinants of institutional capacity. At the organisational level, these factors contribute directly to reducing information noise and improving decision-making processes. Importantly, the higher level of irregularities in information circulation observed in departments characterised by lower competence

indicators can also be interpreted in the context of the previously discussed quantitative and qualitative dimensions of information processes. In this area, a clear relationship emerges with the phenomenon of information overload described by van Veen et al. (2020) and with the mechanisms of information avoidance highlighted in the studies of Kumalasari and Priharsari (2023). It can therefore be concluded that employees with less developed digital competences reach the threshold of cognitive capacity much faster in an environment characterised by intensive and multi-channel data flows. Under conditions of time pressure and an excess of digital stimuli, insufficient ability to effectively use digital tools may hinder the selection and prioritisation of information, ultimately manifesting itself as errors, delays or distortions in the implementation of administrative processes.

6. Conclusions

From a broader perspective, the results obtained contribute to the discussion on the role of digital competences as a key resource of public organisations in the context of ongoing digital transformation. The efficient functioning of information processes requires not only appropriate technological infrastructure but, above all, competent users capable of critical analysis, selection and interpretation of data. An insufficient level of competences may lead both to information overload and decision-making errors, which in public administration directly affects the quality of services provided to citizens.

The empirical material collected in this study also illustrates the problem of institutional mismatch, highlighted in the analyses of Jafari et al. (2025). These authors demonstrate that the implementation of technological infrastructure alone, without an adequate adjustment of organisational culture and a substantial development of human resource competences, may lead to organisational dissonance that significantly limits the potential of implemented innovations. This phenomenon is reflected in the intra-organisational asymmetry observed in the study. The fact that individual departments within the same office—operating in a very similar legal and technological environment—display noticeable differences in the efficiency of information processes indicates a form of internal reproduction of digital inequalities. In this sense, the asymmetry of digital maturity identified by Valaskova et al. (2025) at the macrostructural level, when analysing development gaps between European Union countries, is reflected at the micro level in the case of the Krakow City Hall, in the form of uneven rates of digital adaptation across organisational units.

In summary, the results indicate the need for a systemic approach to the development of digital competences within the organisation, including the diagnosis of training needs, increasing the availability and relevance of training programmes, and strengthening the role of management in building a digital organisational culture. Improving employees' digital skills

may contribute to reducing errors in information processes, improving organisational efficiency and enhancing the quality of public services.

Despite their significant analytical value, the conducted study has several limitations. First, it was based on self-assessment by employees, which means that the results reflect the subjective perceptions of respondents rather than objectively measured levels of digital literacy. The research also had a cross-sectional design, which prevents the analysis of changes over time and limits the possibility of drawing clear causal conclusions regarding the relationship between digital competences and the quality of information processes. Moreover, the study was conducted in a single organisation, which restricts the generalisability of the findings to other public administration units. In addition, broader contextual variables—such as age, length of professional experience or the level of use of digital tools—were not included in the analysis, although they could potentially explain differences observed between departments.

Future research should therefore employ more diverse methodological approaches, including objective competence assessments and qualitative research methods. Longitudinal studies would also be valuable in order to analyse changes over time, particularly in the context of implementing training programmes and introducing new technologies. Extending the scope of research to other public administration institutions would enable inter-organisational comparisons and the identification of best practices. An important direction for further research is also the deeper exploration of the relationship between digital competences and organisational performance, service quality and the role of leadership and organisational culture in the digital transformation of public administration.

Acknowledgements

The publication was financed from the subsidy granted to the Krakow University of Economics – Project nr 042/ZZN/2025/POT and Project nr 043/ZZO/2025/POT.

References

1. Alvarenga, A., Matos, F., Godina, R., Matias, J.C.O. (2020). Digital transformation and knowledge management in the public sector. *Sustainability*, 12(14), 5824. DOI:10.3390/su12145824.
2. Council Recommendation of 22 May 2018 on key competences for lifelong learning (2018). [https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32018H0604\(01\),03.02.2026](https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32018H0604(01),03.02.2026).

3. Council Recommendation of 22 May 2018 (2018). *Official Journal of the European Union*, [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604\(01\)&rid=7](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&rid=7), 06.05.2025.
4. *Definition and levels of digital competences* (10.12.2024). Ministry of Digital Affairs, <https://kompetencjeczifrowe.gov.pl/aktualnosci/wpis/definicja-i-poziomy-kompetencji-cyfrowych>, 03.02.2026.
5. Digital Competences (23.01.2020). Ministry of Digital Affairs, <https://www.gov.pl/web/cyfryzacja/kompetencje-cyfrowe>, 03.02.2026.
6. Digital Education Action Plan (2021-2027). *Resetting education and training for the digital age, European Commission 2021*. https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en, 06.05.2025.
7. Dufva, T., Dufva, M. (2019). Grasping the future of the digital society. *Futures*, 107, 17-28. DOI: 10.1016/j.futures.2018.11.001
8. Firmansyah, A., Irawan, F., Wijaya, S. (2025). Unlocking public sector excellence: The synergy of intellectual capital and digital leadership in tax administration. *Intangible Capital*, 21(2), 201-230. <https://doi.org/10.3926/ic.3147>
9. Fitzgerald, M., Kruschwitz, N., Bonnet, D., Welch, M. (2013). Embracing Digital Technology: A New Strategic Imperative. *MIT Sloan Management Review, Research Report*, https://www.academia.edu/28433565/Embracing_Digital_Technology_A_New_Strategic_Impervative, 12.05.2025.
10. Jafari, P., Van Looy, A., Helbin, T. (2025). About the interplay between technological resources and institutional factors for realizing digital work: A public sector long-term view. *Journal Of Advances In Management Research*. <https://doi.org/10.1108/JAMR-11-2024-0412>
11. Kumalasari, R., Priharsari, D. (2023). Investigating the Role of SNS Design on Covid-19 Information Avoidance: The Perspectives of the Stimulus-Organism-Response Theory. *Telematics and Informatics Reports*, 11, 100083. <https://doi.org/10.1016/j.teler.2023.100083>
12. Liu, D., Chen, S., Chou, T. (2011). Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project. *Management Decision*, 49(10), 1728-1742. DOI: 10.1108/00251741111183852
13. Lopes, A., Sargento, A., Farto, J. (2023). Training in Digital Skills-The Perspective of Workers in Public Sector. *Sustainability*, 15(13). <https://doi.org/10.3390/su151310577>
14. Łukaszuk, A. (2022). The issue of digital competences of public administration personnel as an important factor in the digital transformation process of local government units in Poland. *Studia Prawnoustrojowe*, 58, <https://doi.org/10.31648/sp.7985>
15. Mazzone, D.M. (2014). *Digital or Death: Digital Transformation – The Only Choice for Business to Survive Smash and Conquer*. Mississauga: Smashbox Consulting Inc.

16. Mergel, I., Edelmann, N., Haug, N. (2019). Defining digital transformation: Results from expert interviews. *Government Information Quarterly*, 36, <https://www.sciencedirect.com/science/article/pii/S0740624X18304131?via%3Dihub>, 12.05.2025.
17. Miazga, A., Dziadowicz, K., Pistelok, P. (2022). *Digitization of city offices, Urban Policy Observatory research*. Warsaw/Krakow: Institute for Urban and Regional Development, <https://doi.org/10.51733/opm.2022.01>
18. Obora, H., Teczek, M. (2024). Information inefficiencies in the digital age – a case study of the municipality of Krakow. *Scientific Papers of Silesian University of Technology Organization and Management Series*, 212, 429-450. <https://doi.org/10.29119/1641-3466.2024.212.25>
19. Rozkrut, D., Rozkrut, M. (2015). Digital skills as a factor in the development of the knowledge-based economy. *Studies and Works of the Faculty of Economic Sciences and Management of the University of Warsaw*, 42(1), 75-87. <https://doi.org/10.18276/sip.2015.42/1-05>
20. Rust, R.T., Kannan, P.K. (2003). E-service: A New Paradigm for Business in the Electronic Environment. *Communications of the ACM*, 46(6), 37-42. DOI: 10.1145/777313.777336
21. Tarkowski, A., Mierzecka, A., Jasiewicz, J., Filiciak, M., Kisilowska, M., Klimczuk, A., Bojanowska, E. (2015). *Taxonomy of functional digital competences and methodology for measuring the level of functional digital competences of people from the 50+ generation*. "Cities on the Internet" Association, 1-164. https://depot.ceon.pl/bitstream/handle/123456789/8309/taksonomia_funkcjonalnych_kompetencji_cyfrowych.pdf?sequence=1&isAllowed=y
22. Valásková, K., Nagy, M., Figura, M., Rousek, P. (2025). Res publica digitalis: The uneven digital transformation of the European public sector and the impact of policy disparities on governance, service efficiency, and socioeconomic inclusion. *Oeconomia Copernicana*, 16(3), 1177-1260. <https://doi.org/10.24136/oc.3866>
23. van Veen, D., Kudesia, R., Heinimann, H. (2020). An Agent-Based Model of Collective Decision-Making: How Information Sharing Strategies Scale With Information Overload. *IEEE Transactions On Computational Social Systems*, 7(3), 751-767. <https://doi.org/10.1109/TCSS.2020.2986161>
24. Vieira, I.D.O., Razzolini Filho, E. (2019). Overloading information in the decision-making: Legitimation of scales and its relationship to the need for cognition of the decision. *AtoZ: Novas Práticas Em Informação e Conhecimento*, 8(1), 32. <https://doi.org/10.5380/atoz.v8i1.67257>

GREENWASHING AS A GOVERNANCE CHALLENGE: THE *EVIDENCE* MODEL FOR ENVIRONMENTAL CLAIMS

Paweł ZABILSKI

Expert of banking sector, Warsaw, Poland; zabilski.pawel@gmail.com, ORCID: 0009-0003-6263-3751

Purpose: This paper proposes the EVIDENCE model - a conceptual governance framework for assessing the credibility and evidentiary strength of environmental claims - and addresses the persistent gap between greenwashing typologies and EU regulatory requirements introduced through Directive (EU) 2024/825, CSRD, and the forthcoming Green Claims Directive.

Design/methodology/approach: A qualitative, theory-building design grounded in legitimacy, signalling, institutional, and stakeholder theories. The study draws on a structured narrative review of literature from Scopus and Web of Science (2011-2026), supplemented by EU regulatory documents, ESMA guidance, UOKiK enforcement materials, and international standards (ISO 14021, 14024, 14040/14044, 14068, GRI, ESRS). The model is illustrated through an e-commerce case.

Findings: Greenwashing is best understood as a structural information asymmetry rooted in governance failures rather than isolated communication errors. The EVIDENCE model articulates eight interlocking dimensions - Evidence, Verifiability, Impact scope, Disclosure clarity, Enforcement alignment, Narrative consistency, Certification, and Easy access - each linked to a formal proposition. The e-commerce application demonstrates how the model translates abstract substantiation logic into concrete governance design.

Originality/value: The paper integrates four theoretical perspectives into a unified framework and introduces eight empirically testable propositions. It provides Polish and EU practitioners with an audit-ready instrument compatible with UOKiK enforcement, ESRS reporting, and EU substantiation requirements.

Research limitations/implications: The EVIDENCE model has not yet undergone empirical validation. The analysis is anchored in the European regulatory environment, which may limit global generalisability. Future research should pursue experimental designs and cross-sector content analyses.

Practical implications: The EVIDENCE model offers a structured, audit-ready governance instrument applicable across sectors and organisational sizes, compatible with GRI Standards, ESRS, and Directive 2024/825. For Polish organisations, alignment with UOKiK guidance directly reduces enforcement exposure.

Category of the paper: Conceptual paper.

Keywords: greenwashing, environmental claims, EVIDENCE model, EU regulation, ESG governance.

1. Introduction

The acceleration of regulatory pressure for sustainable business conduct has fundamentally repositioned environmental communication as a core governance and strategic function. Driven by the European Green Deal, the Corporate Sustainability Reporting Directive (CSRD), Directive (EU) 2024/825 empowering consumers for the green transition, and the forthcoming Green Claims Directive, organizations now operate within a regulatory architecture that demands traceable, verifiable, and proportionate environmental claims (European Commission, 2019, 2023b; European Parliament and Council, 2022; 2024a; ESMA, 2024). At the same time, public scrutiny by non-governmental organizations, financial-sector supervisors, and increasingly informed consumers has reached a level at which symbolic communication detached from operational performance carries meaningful reputational and economic costs.

In this context, greenwashing - understood as a discrepancy between actual environmental performance and its symbolic representation - has resurged as a systemic risk. Recent reviews indicate that the phenomenon has not only persisted but intensified in connection with ESG investing, corporate net-zero commitments, and the proliferation of unregulated sustainability labelling (Montgomery, Lyon, Barg, 2024; Nemes et al., 2022). The European Commission Sweep on environmental claims documented that 42% of analyzed claims were exaggerated, false, or deceptive, and 59% lacked substantiation (European Commission, 2021), and the follow-up CPC sweep in 2023 confirmed continued non-compliance across sectors (CPC Network, 2024).

This persistence raises a substantive theoretical and managerial question: why do organizations - even those with material exposure to legal sanctions and reputational damage - continue to deploy greenwashing practices, and what governance architectures can constrain them? Existing scholarship has produced extensive typologies of greenwashing forms (TerraChoice, 2010; de Freitas Netto et al., 2020; Pope, Worrall, 2023) and has documented its determinants at firm and industry level (Delmas, Burbano, 2011; Marquis, Toffel, Zhou, 2016; Bowen, 2014). However, the literature remains fragmented in three ways that limit its operational utility for management practice. First, typologies catalogue the phenomenon without specifying organizational mechanisms that produce or prevent it. Second, theoretical accounts grounded in legitimacy or signalling theory illuminate motivation but rarely connect to the evidentiary architecture of contemporary regulation. Third, the rapid evolution of EU instruments has outpaced the conceptual frameworks used to assess organizational compliance (Bernini, La Rosa, 2024).

This paper addresses these gaps by developing the EVIDENCE model: a conceptual framework that operationalizes greenwashing prevention as a multidimensional governance function. The model integrates legitimacy, signalling, institutional, and stakeholder theories

with the substantiation logic of the new EU anti-greenwashing regime, and translates this synthesis into eight organizational dimensions amenable to managerial diagnosis and audit.

1.1. Research objective and questions

The primary objective of this paper is to systematize existing definitions of greenwashing and to develop an interpretative framework that aligns environmental communication with contemporary evidentiary and regulatory requirements. The overarching research question is:

RQ: How can organizations bridge the gap between actual environmental performance and sustainability communication to maintain long-term reputational resilience under tightening EU regulation?

Four specific research questions refine the theoretical scope:

RQ1: How do visual environmental cues and symbolic green signals influence stakeholder perceptions, and how should organizations manage them under Directive 2024/825?

RQ2: How does consumer literacy regarding environmental labels and certifications affect susceptibility to greenwashing, and what implications follow for stratified communication strategies?

RQ3: How does misalignment between communicated and actual environmental performance influence institutional trust and reputational capital?

RQ4: How effective are contemporary European and Polish regulatory mechanisms in mitigating greenwashing practices, and what governance instruments anticipate this regulatory convergence?

The analysis is anchored in management sciences and focuses on the European regulatory context, with particular emphasis on the Polish enforcement regime administered by the Office of Competition and Consumer Protection (UOKiK).

2. Literature review

The origins of the term greenwashing are typically traced to Jay Westerveld's 1986 essay critiquing hotel-industry environmental messaging used as a substitute for substantive ecological performance (Westerveld, 1986). From this rhetorical origin, the concept has matured into a multidimensional construct embedded in organizational behaviour, communication theory, and information economics.

A widely cited contemporary definition characterizes greenwashing as a situation in which an organization with poor environmental performance communicates positive environmental messages, thereby creating a misleading perception of responsibility (Delmas, Burbano, 2011, p. 65). Lyon, Montgomery (2015) extend this by characterizing greenwashing as strategic decoupling, in which symbolic communication systematically replaces substantive operational

change. From an institutional theory perspective, this decoupling reflects the tension between ceremonial conformity and technical efficiency identified by Meyer, Rowan (1977), now applied to sustainability claims rather than to formal organizational structures.

Contemporary scholarship views greenwashing as institutionally embedded in governance structures, compliance processes, and reporting routines. de Freitas Netto et al. (2020), in a systematic review of 67 articles, identify two core dimensions: claim greenwashing (focused on the message) and executional greenwashing (focused on imagery and atmospherics). Testa, Sarti, Frey (2021), reviewing 110 publications, classify greenwashing along a substantive-symbolic continuum and argue that the field itself shows signs of conceptual greenwashing, the term being applied to phenomena it does not adequately describe. Santos, Coelho, Marques (2024) further synthesize this body of literature into a stakeholder-centric framework that distinguishes producer-side practices from consumer-side perceptions.

2.1. Greenwashing: definitions and typologies

One of the most influential typologies remains the Seven Sins of Greenwashing (TerraChoice, 2010), which identifies hidden trade-off, no proof, vagueness, irrelevance, lesser of two evils, fibbing, and worship of false labels. Although developed for consumer-product communication, the framework continues to inform regulatory taxonomies, including the Annex of Directive 2024/825.

Recent literature expands this typology with more granular and theory-grounded dimensions. Walker, Wan (2012) distinguish between claim-level greenwashing (specific deceptive statements) and firm-level greenwashing (overall pattern of deceptive communication). Lyon, Montgomery (2015) differentiate selective disclosure (revealing only favorable information) from decoupling (sustained inconsistency between claims and operations). Cho, Michelon, Patten (2021), in a 20-year review of impression management in sustainability reporting, separate symbolic from substantive greenwashing. Pope, Worrall (2023) introduce a typology of visual greenwashing distinguishing executional, atmospheric, and structural visual deception. Bernini, La Rosa (2024) operationalize reporting-level greenwashing as deviation from internationally recognized evidentiary standards.

Polish scholarship has also engaged with the concept. Witek and Kuźniar (2021) document the prevalence of green-marketing claims among Polish consumers and the uneven development of consumer skepticism. Studies of sustainability reporting practices among Polish listed companies indicate systematic gaps in evidentiary substantiation, particularly in supply-chain disclosures, and growing exposure to enforcement under the unfair-commercial-practices regime (Hąbek, Wolniak, 2016).

2.2. Visual greenwashing and the role of signals

Advances in consumer psychology demonstrate that greenwashing is frequently non-verbal. Visual elements - green colour palettes, natural imagery, plant motifs, leaf icons - function as heuristics that shape consumer judgment even in the absence of supporting evidence. Visual greenwashing exploits the logic of signalling theory (Spence, 1973): firms send low-cost signals conveying environmental responsibility without verifiable evidence, thereby deepening information asymmetry between producers and consumers (Parguel, Benoît-Moreau, Russell, 2015; Magnier, Schoormans, 2019). Schmuck, Matthes and Naderer (2018) experimentally show that nature-evoking visuals trigger automatic positive evaluations even when textual content is neutral. The green halo effect arising from these visuals is particularly resilient to corrective information, presenting a substantial regulatory and managerial challenge.

The convergence of these strands suggests that greenwashing should be understood not as a discrete deceptive act but as a structural information asymmetry rooted in governance failures, communication routines, and the cognitive economics of symbolic signalling. This understanding informs the theoretical framework developed in Section 2.3.

2.3. Theoretical framework

Contemporary research demonstrates that greenwashing is a multidimensional phenomenon at the intersection of organizational behaviour, stakeholder expectations, information economics, and institutional pressures. This paper draws on four theoretical lenses, organized into two clusters: theories explaining organizational motivation (legitimacy theory and institutional theory) and theories explaining stakeholder interpretation and the strategic implications of communication (signalling theory and stakeholder theory). Together, these perspectives provide the conceptual foundation for the EVIDENCE model developed in Section 5.

2.3.1. *Legitimacy theory: the social licence to operate*

Legitimacy theory remains a foundational lens for analyzing environmental communication. Suchman (1995, p. 574) defines organizational legitimacy as a generalized perception that the actions of an entity are desirable, proper, or appropriate within a socially constructed system of norms and beliefs. Organizations seek to secure a social licence to operate by projecting conformity with societal expectations. From this perspective, greenwashing constitutes symbolic management - a strategy used to reduce a perceived legitimacy gap without implementing substantive operational improvements (Cho et al., 2015). Boiral (2013) demonstrates that sustainability reports often function as simulacra: representations that bear little correspondence to underlying operational reality.

The legitimacy account is particularly powerful in explaining the timing and intensity of greenwashing. Empirical work shows that greenwashing intensifies when organizations face scrutiny they cannot satisfy through substantive change, for instance after environmental scandals, during regulatory transitions, or when peer pressure for ESG performance accelerates faster than organizational capacity (Marquis, Toffel, Zhou, 2016).

2.3.2. Institutional theory: isomorphic pressures and decoupling

Institutional theory complements legitimacy theory by explaining the structural conditions under which greenwashing emerges. DiMaggio and Powell (1983) identify three isomorphic pressures - coercive, mimetic, and normative - that drive organizations toward similar structures. In the sustainability domain, these pressures generate convergence in reporting frameworks (GRI, ESRS) and in the rhetorical conventions of environmental communication. Where capacity does not match expectations, organizations decouple formal compliance from operational practice (Meyer, Rowan, 1977; Scott, 2014). Greenwashing, in this view, is a predictable institutional response to misalignment between expectation and capacity.

2.3.3. Signalling theory: signal quality and information asymmetry

Signalling theory (Spence, 1973; Connelly et al., 2011) provides the analytical apparatus for distinguishing credible from non-credible environmental claims. The theory holds that signal credibility depends on signal cost: high-cost signals (third-party certifications, peer-reviewed Life Cycle Assessments, audited Scope 3 disclosures) are more credible because their falsification is expensive or risky. Low-cost signals (green colour palettes, vague eco-slogans, unverified self-declarations) are easily imitated and therefore convey limited information.

Greenwashing exploits this distinction by substituting low-cost for high-cost signals while attempting to extract reputational and market benefits commensurate with credible signalling. The economic logic links to Akerlof's (1970) market-for-lemons mechanism: when consumers cannot reliably distinguish credible from non-credible signals, the market for genuine sustainability claims deteriorates, disadvantaging firms that invest in substantive performance.

2.3.4. Stakeholder theory: differentiated audiences and trust

Stakeholder theory (Freeman, 1984; Mitchell, Agle, Wood, 1997) directs attention to the heterogeneous audiences that interpret environmental claims. Stakeholder salience - determined by power, legitimacy, and urgency - varies by stakeholder type, and so do the cognitive resources stakeholders bring to claim interpretation. NGOs, regulators, and ESG analysts are increasingly capable of detecting greenwashing through forensic comparison of claims with disclosed data (Marquis, Toffel, Zhou, 2016; ESMA, 2024). Retail consumers, by contrast, remain disproportionately exposed to executional greenwashing and visual heuristics (Schmuck, Matthes, Naderer, 2018; Szabo, Webster, 2021).

This heterogeneity carries an important implication for greenwashing prevention: a single communication template cannot satisfy all stakeholder groups. Effective sustainability communication requires a stratified architecture in which substantive evidentiary content is

layered behind audience-appropriate interfaces while remaining traceable to a common evidentiary base.

2.3.5. Attribution theory and the backlash effect

Attribution theory (Heider, 1958; Kelley, 1973) explains how stakeholders interpret detected greenwashing. When discrepancies between claims and performance are exposed, audiences typically attribute deceptive intent to the organization rather than framing it as a communication error (Torelli, Balluchi, Lazzini, 2020). This perceived intent amplifies reputational damage through a backlash effect: the penalty observed after greenwashing detection is asymmetrically large relative to the original discrepancy. Empirical evidence connects detected greenwashing with decreased brand trust (Szabo, Webster, 2021), deteriorating share-price performance (Teti, Etro, Pausini, 2024), and increased cost of capital (Ghitti, Gianfrate, Palma, 2024).

2.3.6. Synthesis: greenwashing as a governance design problem

Synthesizing across these lenses, greenwashing is best understood as organizational misalignment between declared corporate identity and operational reality - the authenticity gap. From a strategic-management perspective, greenwashing is a symptom of insufficient internal controls, fragmented ESG governance, and weak alignment between communications, operations, and assurance functions (Santos, Coelho, Marques, 2024; Ghitti, Gianfrate, Palma, 2024). This framing positions greenwashing prevention as a governance design problem rather than as a communication problem - the conceptual move that grounds the EVIDENCE model.

2.4. Research gap

Despite the growing body of research on greenwashing, a significant research gap persists. Existing typologies catalogue greenwashing forms without specifying the organizational mechanisms required to prevent them (TerraChoice, 2010; de Freitas Netto et al., 2020; Pope, Worrall, 2023). Theoretical frameworks grounded in legitimacy or signalling theory illuminate organizational motivation but rarely connect to the evidentiary architecture of contemporary regulation. The rapid evolution of EU instruments - particularly Directive 2024/825, CSRD, and the forthcoming Green Claims Directive - has outpaced the conceptual frameworks used to assess organizational compliance (Bernini, La Rosa, 2024).

To the best of the author's knowledge, no existing study integrates typological, theoretical, and regulatory dimensions into a single operationalizable governance framework aligned with contemporary EU substantiation requirements and expressed through empirically testable propositions. The literature has not yet produced an audit-ready instrument that simultaneously operationalizes the substantiation logic embedded in Directive 2024/825, connects it to organizational governance mechanisms, and links these mechanisms to formal propositions testable at firm level. This paper addresses that gap through the development of the EVIDENCE model.

3. EU and Polish regulatory architecture

The European Union has, over the past five years, transformed environmental claims from a domain of soft-law guidance into a tightly regulated component of consumer protection and corporate disclosure law. Three convergent legislative streams structure this architecture: consumer protection law, sustainability reporting law, and sectoral environmental law.

3.1. Consumer protection: from UCPD to Directive 2024/825

The foundational instrument remains Directive 2005/29/EC on unfair business-to-consumer commercial practices (UCPD), which prohibits misleading commercial communications including misleading omissions (European Parliament and Council, 2005). Its 2021 Guidance Notice clarified the application of UCPD to environmental claims, establishing principles of truthfulness, evidentiary substantiation, and clarity of scope (European Commission, 2021).

Directive (EU) 2024/825 amending Directives 2005/29/EC and 2011/83/EU - the Empowering Consumers for the Green Transition Directive - represents a structural intensification of these principles (European Parliament and Council, 2024a). It introduces categorical prohibitions of generic environmental claims (such as eco-friendly, green, natural, climate-friendly) unless substantiated; bans claims of carbon neutrality based on offsetting; restricts the use of self-issued sustainability labels; and imposes pre-purchase information requirements regarding product durability and reparability. Member States are required to transpose the Directive by 27 March 2026, with national rules applying from 27 September 2026.

The forthcoming Green Claims Directive is intended to operationalize these prohibitions by introducing ex ante substantiation and verification requirements, including independent third-party assessment of explicit environmental claims and harmonized rules for environmental labelling schemes (European Commission, 2023b). Together, Directive 2024/825 and the Green Claims Directive establish what may be characterized as a substantiation regime: the legal centre of gravity shifts from prohibiting specific deceptive claims toward requiring evidentiary support for any environmental claim made.

3.2. Sustainability reporting: CSRD and ESRS

The Corporate Sustainability Reporting Directive (Directive (EU) 2022/2464) extends sustainability disclosure obligations to approximately 50,000 European companies, with phased application from 2024 onwards (European Parliament and Council, 2022). The European Sustainability Reporting Standards (ESRS), adopted through Commission Delegated Regulation (EU) 2023/2772 (European Commission, 2023a), prescribe the content of these disclosures across environmental, social, and governance topics, with double-materiality

assessment as a core methodological requirement. Mandatory third-party assurance creates a verification layer that substantially raises the cost of inflated or unverifiable disclosures.

For greenwashing analysis, CSRD and ESRS introduce two structural shifts. First, the ratio of disclosed to communicated sustainability information rises sharply, reducing the practical scope for selective disclosure. Second, the integration of disclosed data into financial reporting infrastructure exposes inconsistencies between marketing claims and financial-grade ESG data to professional scrutiny by auditors, ESG analysts, and supervisors (ESMA, 2024).

3.3. EU Taxonomy and sectoral instruments

The EU Taxonomy Regulation (EU 2020/852) defines the technical screening criteria under which an economic activity may be classified as environmentally sustainable (European Parliament and Council, 2020). Its do-no-significant-harm and minimum-safeguards conditions establish a structured evidentiary base that increasingly anchors financial-product disclosures under the Sustainable Finance Disclosure Regulation (SFDR). Where sustainability marketing claims diverge from Taxonomy alignment, the divergence is forensically observable.

In the financial sector, ESMA's 2024 Final Report on Greenwashing identifies greenwashing as a supervisory priority and provides a typology of misleading claims at the level of entities, products, and services (ESMA, 2024). The report aligns supervisory expectations with the substantiation logic now embedded in Directive 2024/825 and CSRD.

3.4. Polish enforcement: UOKiK and the national institutional context

In Poland, enforcement of environmental claims rests primarily with the President of the Office of Competition and Consumer Protection (UOKiK) under the Act of 23 August 2007 on Combating Unfair Commercial Practices, transposing UCPD, and the Act of 16 February 2007 on Competition and Consumer Protection. UOKiK applies a reversed burden of proof to environmental claims: the trader bears the obligation to substantiate claims when challenged. The institution analyzes both textual and visual claims, may impose financial sanctions of up to 10% of annual turnover for the prior financial year, and routinely publishes its decisions to amplify deterrent effects (UOKiK, 2024a).

UOKiK has integrated greenwashing into its strategic priorities, treating it as a category of misleading commercial practice with cross-sectoral relevance (UOKiK, 2023). The institution participated in the EU-wide Sweep on environmental claims (CPC Network, 2024) and has published guidance for traders on the substantiation of environmental claims, drawing on ISO 14021 principles (UOKiK, 2024b). Recent enforcement activity has covered fashion retail, e-commerce platforms, food, energy, and financial-services advertising. Particular attention has been directed at unsubstantiated claims of ecological, natural, or biodegradable products and at carbon-neutrality statements based exclusively on offsetting.

The convergence of EU instruments, Polish enforcement, and international technical standards generates a coherent substantiation regime - the structural environment that the EVIDENCE model is designed to navigate.

Table 1.
Evidentiary risks of typical environmental claims

Type of claim	Potential evidentiary risks	Management requirements
"100% eco/natural"	High risk of ambiguity; unclear scope; undefined ingredients or processes.	Verification of raw materials and process boundaries; ISO 14021 self-declaration controls.
"Climate neutral"	Over-reliance on offsetting; lack of Scope 3 data; reliance on non-permanent removals.	Full Scope 1-3 disclosure; offset transparency; alignment with SBTi and ISO 14068.
"Biodegradable"	Conditional truth - requires industrial composting; misrepresentation of timeframe.	Specification of timeframe and environmental conditions; EN 13432 conformity.
"Plastic-free"	Imprecision; presence of polymer-based coatings or labels.	Strict definition; value-chain audit; substantiation data.
"Recyclable"	Lack of access to recycling infrastructure in target market.	Geographic specification; verification of effective recyclability under PPWR.
"Circular"	Absence of material-flow data; limited reuse share.	Mass-balance documentation; ESPR substantiation.

Source: own elaboration based on ISO 14021 (ISO, 2016), Directive 2024/825 (European Parliament and Council, 2024a), Regulation (EU) 2024/1781 (European Parliament and Council, 2024b), UOKiK (2024b).

International standards provide the technical framework for substantiating claims, including ISO 14021 for self-declared environmental claims (ISO, 2016), ISO 14024 for Type I ecolabels (ISO, 2018), ISO 14040/14044 for Life Cycle Assessment (ISO, 2006a; 2006b), and ISO 14068 for carbon-neutrality claims (ISO, 2023). Together with GRI sustainability reporting standards (GRI, 2021) and ESRS, these instruments reduce ambiguity and support regulatory compliance.

4. Research methodology

This study adopts a qualitative, theory-building research design combining a structured narrative literature review with conceptual synthesis (Snyder, 2019; Templier, Paré, 2015). The narrative-review format is appropriate when the goal is to integrate diverse theoretical perspectives into a unified conceptual framework rather than to enumerate empirical findings. A systematic review protocol, while appropriate for aggregating comparable empirical results, would not serve this integrative purpose: the study's value lies in synthesising theoretical

mechanisms and regulatory logic rather than in meta-analysing effect sizes across studies. The large initial dataset of 1247 records reflects comprehensive search coverage, while the structured inclusion and exclusion criteria (Section 4.2) ensure that the narrative synthesis remains methodologically disciplined and reproducible. Conceptual analysis was used to articulate the dimensions of the EVIDENCE model and the eight propositions presented in Section 5 (Jaakkola, 2020).

4.1. Search strategy

The literature search was conducted between January and March 2026 using the Scopus and Web of Science databases. Search strings combined the core concept (greenwashing) with theoretical anchors (legitimacy, signalling, stakeholder, institutional), regulatory anchors (CSRD, ESRS, Directive 2024/825, Green Claims Directive, UCPD), and managerial anchors (ESG governance, sustainability reporting, consumer skepticism). Boolean operators and field-specific syntax were adapted to each database.

4.2. Inclusion and exclusion criteria

Inclusion criteria comprised: (1) peer-reviewed journal articles published between 2011 and 2026 in English or Polish; (2) relevance to management, sustainability, communication, behavioural science, or regulatory studies; and (3) availability of full text. Exclusion criteria comprised: (1) purely technical environmental engineering studies without managerial relevance; (2) articles unrelated to communication or governance; and (3) non-academic sources, except where cited as regulatory or institutional context.

Table 2.
Literature filtering process

Stage	Records
Initial database search (Scopus + WoS)	1247
After deduplication	884
After title/abstract screening	217
After full-text review	96
Cited in this paper	51

Source: own elaboration.

The final dataset prioritizes contributions from journals including Business Strategy and the Environment, Corporate Social Responsibility and Environmental Management, Journal of Business Ethics, Organization & Environment, Management Review Quarterly, Journal of Management and Governance, and Critical Perspectives on Accounting. Polish-language sources were drawn from journals indexed in the Polish Ministry of Science list.

4.3. Conceptual synthesis approach

Following Jaakkola (2020), the conceptual synthesis combined two operations. First, a theoretical synthesis integrated legitimacy, signalling, institutional, and stakeholder theories to specify the mechanisms by which greenwashing arises and propagates. Second, a regulatory synthesis aligned theoretical mechanisms with the evidentiary architecture of EU instruments to identify the organizational dimensions through which greenwashing prevention can be operationalized. The output of these two operations is the EVIDENCE model presented in Section 5, articulated as a set of governance dimensions linked to formal propositions.

5. The EVIDENCE model

Building on the synthesis of regulatory trends, signalling theory, legitimacy theory, institutional theory, and stakeholder theory, this study proposes the EVIDENCE model: a conceptual verification framework designed to assess the credibility, consistency, and evidentiary strength of environmental claims. The model responds directly to RQ1-RQ4 and is grounded in recognized methodological frameworks, including Life Cycle Assessment (ISO 14040/14044), international labelling standards (ISO 14021, ISO 14024), and the ESRS architecture under CSRD.

The model articulates eight organizational dimensions, each representing a governance lever that constrains greenwashing risk. The components are not sequential stages but interlocking conditions, the joint satisfaction of which constitutes a credible communication regime. Each dimension is associated with a formal proposition (P1-P8) testable in subsequent empirical work.

5.1. E - Evidence

The Evidence dimension mandates a robust evidentiary base for every public environmental declaration. Required elements include applicable ISO standards, laboratory tests, third-party-verified Life Cycle Assessments, and current third-party certifications. The dimension responds directly to the substantiation requirements of Directive 2024/825 and the Green Claims Directive, and operationalizes the high-cost-signal logic of signalling theory (Spence, 1973; Connelly et al., 2011).

Proposition 1: The probability that an organization's environmental claims are perceived as credible by external stakeholders increases with the depth and traceability of the underlying evidentiary base.

5.2. V - Verifiability

The Verifiability dimension emphasizes that claims must be supported by externally accessible proof - publicly available reports, retrievable certificates, accessible methodological documentation - rather than internal documents protected as proprietary. This dimension addresses the most common form of greenwashing detected in the EU Sweep: claims supported by undisclosed evidence (European Commission, 2021). It also responds to the legitimacy-theoretic insight that visible, externalized evidence converts symbolic claims into substantive ones (Suchman, 1995; Boiral, 2013).

Proposition 2: External verifiability of evidentiary materials moderates the relationship between sustainability disclosure and stakeholder trust, such that disclosure without external verifiability produces no significant trust gain.

5.3. I - Impact scope

The Impact-scope dimension requires that environmental claims reflect significant impacts across the product or service life cycle rather than isolated favourable characteristics. The dimension counters the hidden trade-off and irrelevance sins (TerraChoice, 2010), both of which remain prevalent in contemporary marketing practice (Pope, Worrall, 2023). Methodologically, the Impact-scope dimension is anchored in LCA boundaries under ISO 14040/14044.

Proposition 3: Environmental claims framed by life-cycle-bounded impact scope are less susceptible to selective-disclosure greenwashing than claims framed by single-attribute selection.

5.4. D - Disclosure clarity

The Disclosure-clarity dimension rejects ambiguous terminology in favour of quantified parameters, defined thresholds, and precise scope and unit specifications. This dimension directly operationalizes the categorical prohibition of generic claims under Directive 2024/825 and addresses the well-documented vulnerability of low-literacy audiences to vague claims (Szabo, Webster, 2021; Schmuck, Matthes, Naderer, 2018). At the level of organizational practice, it requires editorial controls that translate technical evidentiary content into precise but legible public language.

This requirement is particularly salient in the context of visual greenwashing: where textual claims are vague or absent, consumers rely disproportionately on visual cues such as colour, imagery, and iconography as proxies for environmental performance (Schmuck, Matthes, Naderer, 2018). Quantified, precise language counteracts this heuristic substitution by providing an evidentiary anchor that visual signals alone cannot supply.

Proposition 4: The propensity for visual or linguistic heuristics to override evidentiary content decreases as quantified specification of environmental claims increases.

5.5. E - Enforcement alignment

The Enforcement-alignment dimension positions claims management within the legal architecture of UCPD, Directive 2024/825, the Green Claims Directive, CSRD, and national enforcement (in the Polish context, UOKiK). It requires a documented audit trail capable of withstanding regulatory review, including the assignment of accountability for claim substantiation, retention of evidentiary materials, and procedures for managing claims throughout their public lifetime. It addresses the institutional-theory insight that decoupling between formal compliance structures and operational practice is the principal mechanism of greenwashing (Meyer, Rowan, 1977; DiMaggio, Powell, 1983).

Proposition 5: Organizations with formalized cross-functional governance of environmental claims (legal-marketing-sustainability) experience lower regulatory exposure than organizations in which claim governance is allocated unilaterally to marketing functions.

5.6. N - Narrative consistency

The Narrative-consistency dimension requires that public-facing claims align with operational data, ESG disclosures, supply-chain practices, and portfolio composition. It addresses the authenticity gap and the strategic-decoupling problem (Lyon, Montgomery, 2015; Cho, Michelon, Patten, 2021). Narrative consistency is the organizational counterpart to the legitimacy-theoretic insight that detected decoupling generates asymmetric reputational damage (Suchman, 1995; Delmas, Burbano, 2011).

Proposition 6: The reputational penalty associated with detected greenwashing increases with the magnitude of inconsistency between communicated narrative and disclosed operational data.

5.7. C - Certification and third-party validation

The Certification dimension prioritizes external validation of environmental claims and mandates a clear distinction between proprietary brand icons and officially recognized environmental labels under ISO 14024 (ISO, 2018). The dimension addresses the worship of false labels sin (TerraChoice, 2010) and the misuse of sustainability labelling that led the European Commission to propose harmonized rules under the Green Claims Directive (European Commission, 2023b).

Proposition 7: Stakeholder susceptibility to symbolic-greenwashing signals decreases with the visibility and recognizability of independent third-party certifications relative to internal brand icons.

5.8. E - Easy access

The Easy-access dimension translates evidentiary substance into consumer-accessible verification. Practical instruments include QR codes linking to evidentiary dashboards, machine-readable digital product passports under the Ecodesign for Sustainable Products Regulation (ESPR) (European Parliament and Council, 2024b), and structured public reports. It connects the substantiation regime to behavioural insights from consumer research, where access friction is a determinant of whether evidentiary content is consulted (Magnier, Schoormans, 2019).

The Easy-access dimension is thus the operational counterpart to the visual-greenwashing problem identified in Section 2.2: if substantive evidentiary content is technically available but practically inaccessible, consumers default to low-cost visual heuristics. Reducing access friction - through QR codes, digital product passports, and layered public dashboards - converts latent substantiation into active consumer verification.

Proposition 8: Consumer-facing access mechanisms (digital product passports, QR-linked evidentiary content) increase the conversion of evidentiary substance into stakeholder trust, particularly for low-literacy audiences.

5.9. The integrated model

The eight components form an integrated governance framework. Components E (Evidence), V (Verifiability), and I (Impact scope) constitute the substantive layer, anchored in evidentiary substance. Components D (Disclosure clarity) and E (Enforcement alignment) constitute the regulatory layer, ensuring legal defensibility. Components N (Narrative consistency) and C (Certification) constitute the strategic layer, aligning communication with operational reality. The final component E (Easy access) operationalizes the consumer-interface layer.

The model is intended for diagnostic, design, and audit purposes. As a diagnostic instrument, it permits structured assessment of an organization's claims management capacity. As a design instrument, it specifies the governance architecture required to align communication with the EU substantiation regime. As an audit instrument, it provides the categories against which both internal and external assurance can be conducted.

Table 3.
The EVIDENCE model: integrated layers of greenwashing prevention

Component	Description
E - Evidence	Mandates a robust evidentiary base for every declaration; requires a curated dossier including ISO standards, laboratory tests, Life Cycle Assessments (LCA), and valid third-party certifications.
V - Verifiability	Emphasizes data accessibility; claims must be supported by externally verifiable proof such as publicly available reports or certificates to eliminate proprietary pseudo-labels.

Cont. table 3.

I - Impact scope	Ensures holistic assessment; the narrative must reflect significant environmental impacts across the product life cycle rather than a single, isolated characteristic.
D - Disclosure clarity	Rejection of ambiguous terminology; necessitates quantified parameters, clear thresholds, and a precise indication of scope and scientific units.
E - Enforcement alignment	Critical compliance check; aligns messaging with UCPD directives and national legal standards (e.g., UOKiK) while maintaining a rigorous audit trail for regulatory review.
N - Narrative consistency	Strategic alignment ensures there is no fundamental contradiction between outward-facing messaging and operational realities such as emissions data, supply chain ethics, and portfolio performance.
C - Certification & third-party	Prioritization of external validation; mandates a clear distinction between internal brand icons and officially recognized environmental labels (ISO, 2018).
E - Easy access	Consumer-centric transparency facilitates immediate verification through tools such as QR codes, direct links to environmental dashboards, or comprehensive public reports.

Source: own elaboration.

6. Application of the EVIDENCE model: an e-commerce retailer

E-commerce platforms occupy a distinctive position in the greenwashing landscape. They aggregate environmental claims from large numbers of sellers, mediate consumer-facing communication through filters and product attributes, and operate at scale, which means that small per-claim error rates produce large aggregate consumer harm. UOKiK and the European Consumer Protection Cooperation Network identified online retail as a priority sector for environmental-claims enforcement (CPC Network, 2024; UOKiK, 2024a).

This section illustrates how the EVIDENCE model applies to the design of an environmental-claims governance system in a hypothetical mid-sized European e-commerce retailer - EcoCart - selling fashion, home goods, and personal-care products under both own-brand and third-party labels. The case is hypothetical and intended for illustrative purposes; it integrates patterns observed in the public enforcement record and in the academic literature on online sustainability communication (Sun, Shi, 2022).

6.1. Context

EcoCart's product catalogue includes a category labelled EcoCart Green Selection, combining own-brand items and curated third-party products. Marketing communications use claims such as 100% eco fabrics, climate-neutral delivery, and sustainable choice, supported by visual elements consisting of leaf icons, green badges, and Green Selection labels of proprietary design. Product pages link to a generic Sustainability Pledge corporate page rather than to product-level evidence.

6.2. Pre-EVIDENCE diagnosis: greenwashing risk profile

A diagnostic assessment using the EVIDENCE dimensions reveals systemic risk:

- E - Evidence: Self-declarations from third-party sellers without supporting LCA or ISO 14021 documentation; own-brand claims supported by partial supplier questionnaires.
- V - Verifiability: Underlying evidence is not externalized; product pages display the claim but not the supporting documentation.
- I - Impact scope: Claims focus on a single attribute (e.g. recycled fabric content of a garment) without addressing other significant impacts (transport emissions, dye chemicals, packaging).
- D - Disclosure clarity: Generic terms (eco, sustainable) used without quantified parameters or thresholds.
- E - Enforcement alignment: No documented governance for claim substantiation; Green Selection criteria are designed by marketing without legal or sustainability function review.
- N - Narrative consistency: Carbon-neutral delivery claim relies on offsetting without disclosure; conflicts with the disclosed Scope 3 trajectory in the platform's CSRD reporting.
- C - Certification: Proprietary Green Selection badge is visually similar to recognized ecolabels but reflects no independent assessment.
- E - Easy access: Substantiation links absent or pointing to generic CSR pages.

The aggregate profile constitutes textbook greenwashing under TerraChoice categories (hidden trade-off, vagueness, no proof, worship of false labels) and exposes the platform to enforcement under Directive 2024/825 and to UOKiK action under Polish unfair-competition law.

6.3. EVIDENCE-aligned redesign

Application of the EVIDENCE model produces the following redesign:

Evidence: Each product carrying a claim must include a documented evidentiary file: an ISO 14021 self-declaration template for type-II claims; a supplier-provided LCA summary or certified label for type-I claims; carbon-neutrality claims supported by ISO 14068 documentation including residual emissions and removal vintage.

Verifiability: Each product page exposes a Substantiation section containing links to evidentiary documents or third-party certificates; structured data compatible with the Digital Product Passport are exposed via API.

Impact scope: Claims are accompanied by life-cycle-bounded scope statements (e.g. recycled-fibre content represents 65% of garment mass; emissions during production reduced by 32% versus virgin baseline; transport emissions not included in claim scope). Single-attribute claims must include a What this claim does not cover disclosure.

Disclosure clarity: Eco and sustainable labels are eliminated or replaced with quantified attribute descriptors. The Green Selection category is renamed to Independently Certified Selection to align with Directive 2024/825.

Enforcement alignment: A Claims Substantiation Committee composed of legal, sustainability, marketing, and customer-trust functions reviews and approves each claim category; an audit trail is retained for each product. Quarterly internal audits sample products against UOKiK guidance and ESRS disclosures.

Narrative consistency: The carbon-neutral delivery claim is restated as Scope 1 and 2 delivery emissions offset through Verra-certified projects; Scope 3 emissions disclosed in CSRD report - ongoing reduction roadmap aligned with SBTi. Inconsistency between marketing communications and CSRD disclosures becomes a trackable governance metric.

Certification: Proprietary badges are replaced or restricted to a clearly explained internal-curation icon. Recognized third-party labels (EU Ecolabel, GOTS, Cradle to Cradle, FSC, ISO 14024 Type-I marks) are visually elevated and explained.

Easy access: A QR code on each product links to a public evidentiary dashboard; consumer-facing language is simplified but linked to underlying methodological documentation; downloadable evidence files are provided in machine-readable formats.

6.4. Outcomes and implications

The redesigned communication regime addresses each of the eight propositions developed in Section 5. From a legitimacy-theoretic perspective, the externalization of evidence converts symbolic claims into substantive ones, narrowing the legitimacy gap without dependence on rhetorical compensation (Suchman, 1995; Boiral, 2013). From a signalling-theoretic perspective, the substitution of high-cost (third-party-certified) signals for low-cost (proprietary) signals re-establishes signal credibility and counters the market-for-lemons deterioration of credible communication (Spence, 1973; Connelly et al., 2011). From a regulatory perspective, the redesign aligns the platform with Directive 2024/825 and CSRD substantiation requirements and reduces UOKiK enforcement exposure.

The case also illustrates a more general implication. Greenwashing prevention in e-commerce is not primarily a content-moderation problem - it is a governance problem distributed across platform-seller relations, claim approval workflows, evidentiary infrastructure, and consumer-interface design. The EVIDENCE model articulates the governance architecture required to manage these distributed responsibilities coherently.

The application also points to an unresolved governance challenge in platform commerce: liability allocation between platform and seller for claim substantiation. Under Directive 2024/825 and Polish enforcement practice, platforms increasingly face duty-of-care obligations regarding seller claims. The Verifiability and Enforcement-alignment components of the EVIDENCE model provide the operational instruments by which platforms can satisfy these obligations.

7. Discussion

The findings advance the understanding of greenwashing as a governance failure with systemic, cross-functional dimensions. The EVIDENCE model addresses a persistent gap in the literature: the absence of an integrative, operationalizable framework bridging greenwashing typologies, contemporary EU regulatory requirements, and organizational communication governance.

7.1. RQ1: Visual cues and the limits of heuristic-based trust

The analysis confirms that visual environmental signals function as low-cost signals in the sense of signalling theory (Spence, 1973), shaping stakeholder perceptions independently of underlying performance. This finding is consistent with experimental evidence showing that nature-linked imagery triggers a green halo effect even when contradicted by factual data (Magnier, Schoormans, 2019; Parguel, Benoît-Moreau, Russell, 2015; Schmuck, Matthes, Naderer, 2018). Directive 2024/825 explicitly prohibits generic visual and textual environmental signifiers because of their documented heuristic influence (European Parliament and Council, 2024a). The Verifiability and Disclosure-clarity components of the EVIDENCE model directly operationalize this regulatory shift, while the Easy-access component ensures that prohibited heuristic shortcuts are replaced by accessible substantive content rather than by inaccessible technical documentation.

7.2. RQ2: Consumer literacy as a moderating variable

While low-literacy consumers remain disproportionately vulnerable to visual heuristics and vague claims (Szabo, Webster, 2021; Schmuck, Matthes, Naderer, 2018), growing NGO activity, media scrutiny, and regulatory enforcement are generating rising skepticism among informed audiences. The Certification and Easy-access components of the EVIDENCE model address this heterogeneity by mandating a clear distinction between proprietary brand icons and internationally accredited ecolabels (ISO, 2018) and by providing layered access to evidentiary content. The model's stratified communication architecture is consistent with stakeholder

theory's insight that stakeholder salience varies across audience types (Mitchell, Agle, Wood, 1997) and that legitimacy is differentially constructed across audiences.

7.3. RQ3: The authenticity gap and its reputational consequences

The misalignment between communicated sustainability ambitions and actual environmental performance - the authenticity gap or organizational decoupling (Meyer, Rowan, 1977; Lyon, Montgomery, 2015) - constitutes the central mechanism through which greenwashing generates reputational, financial, and regulatory harm. Consistent with legitimacy theory (Suchman, 1995), organizations that deploy symbolic sustainability communication without substantive operational backing may temporarily close a perceived legitimacy gap; however, when decoupling is exposed, the reputational penalty is asymmetrically large and long-lasting (Delmas, Burbano, 2011; Testa, Sarti, Frey, 2021; Teti, Etro, Pausini, 2024; Bernini, La Rosa, 2024). The Narrative-consistency component of the EVIDENCE model prevents this decoupling by requiring systematic alignment between public-facing claims, ESG disclosures, and operational data. Empirical work by Teti, Etro, Pausini (2024) on European listed firms documents the share-price penalty associated with detected greenwashing, providing strong external support for the model's emphasis on narrative-operational alignment.

7.4. RQ4: EU regulatory mechanisms as boundary conditions

The EU's evolving anti-greenwashing architecture is rapidly closing enforcement gaps that historically enabled symbolic sustainability communication to persist without legal consequence. Directive 2024/825 introduces categorical prohibitions on generic environmental claims and carbon-offset-based neutrality declarations. CSRD mandates double-materiality reporting and third-party assurance for large undertakings. The forthcoming Green Claims Directive will introduce ex ante verification requirements. ESMA's 2024 supervisory framework aligns financial-sector oversight with these substantiation principles (ESMA, 2024). In the Polish context, UOKiK's reversed-burden-of-proof approach, integration of greenwashing into 2023-2026 strategic priorities, and active participation in EU consumer-protection cooperation generate a coherent national enforcement regime (UOKiK, 2023; 2024a; 2024b).

These instruments converge toward a single architectural logic: claims must be traceable, verifiable, and proportionate to their underlying evidentiary basis. The Enforcement-alignment, Evidence, and Verifiability components of the EVIDENCE model anticipate and operationalize this convergence.

7.5. Theoretical contributions

This study makes three contributions to the theoretical literature. First, it integrates four theoretical lenses - legitimacy, signalling, institutional, and stakeholder theory - into a unified explanatory framework, demonstrating that no single perspective is sufficient when applied independently to the greenwashing problem. Second, the EVIDENCE model connects these theoretical foundations to the EU regulatory architecture in a way that prior typological studies have not attempted, articulating eight formal propositions that translate theoretical mechanisms into testable governance dimensions. Third, the application to e-commerce illustrates how the model can be operationalized in a high-claim-density context and identifies platform-seller liability allocation as a frontier governance question.

The EVIDENCE model is distinct from existing ESG governance and assurance frameworks in three respects. Unlike GRI Standards and ESRS, which prescribe the content and format of sustainability disclosures, the EVIDENCE model operates at the level of individual environmental claims and governs the evidentiary architecture that supports them. Unlike greenwashing typologies (TerraChoice, 2010; de Freitas Netto et al., 2020), which catalogue forms of deception without prescribing organizational responses, the EVIDENCE model translates each identified risk into a concrete governance dimension. And unlike existing assurance frameworks, which apply retrospectively to disclosed information, the EVIDENCE model is designed for prospective use - enabling organizations to design claim-management systems that are compliant before claims are published rather than after they are challenged.

7.6. Practical implications

For practitioners, the EVIDENCE model offers a structured, audit-ready governance instrument applicable across organizational sizes and sectors. Its phased implementation logic - stabilization (E, V, D), standardization (I, E, N), and optimization (C, E) - is scalable and compatible with existing ESG reporting frameworks, including GRI Standards and ESRS. Organizations in sectors currently facing heightened greenwashing scrutiny - energy, aviation, financial services, fashion, and online retail - will find the model particularly actionable given its explicit alignment with Directive 2024/825 and CSRD. For Polish organizations, the model's alignment with UOKiK guidance reduces enforcement exposure under national consumer-protection law.

8. Conclusions

Several limitations must be acknowledged. First, the EVIDENCE model has not yet undergone empirical validation; the eight propositions are presented as conceptually grounded but await testing. Second, the analysis is anchored in the European regulatory environment, which may limit global generalizability; the substantiation logic, however, is increasingly mirrored in other jurisdictions, including the FTC Green Guides (United States) (FTC, 2012), the Competition Bureau guidance (Canada) (Competition Bureau Canada, 2025), and the ACCC framework (Australia) (ACCC, 2023). Third, the study relies exclusively on secondary sources; primary data on organizational claims-management practices would substantially strengthen the model's external validity. Fourth, the dynamic nature of EU regulation - implementing acts under Directive 2024/825, the final adoption of the Green Claims Directive, and revisions to ESRS - may modify specific provisions cited in this paper.

Future research should pursue four directions. First, content analyses of corporate sustainability communication using the EVIDENCE dimensions could establish baseline distributions of compliance across sectors and jurisdictions. Second, experimental designs could test stakeholder reactions to claims that vary across the model's components - particularly P4 (disclosure clarity) and P8 (easy access). Third, the proliferation of AI-based claim-verification tools (Bingler et al., 2022) suggests the value of comparative analyses between human-coded and AI-coded EVIDENCE assessments. Fourth, comparative cross-sectoral and cross-organizational-size studies would test the boundary conditions under which specific components dominate the prevention function. The application of the model to e-commerce platform governance offers a particularly tractable empirical context in which platform-seller liability allocation, claim density, and consumer-interface design intersect.

This paper advances four conclusions. First, greenwashing is a systemic management challenge reflecting structural failures in governance, evidence management, and interdepartmental collaboration rather than isolated communication errors. Treating greenwashing as a governance design problem, rather than a marketing problem or a legal problem, enables the integrated cross-functional response the phenomenon requires.

Second, reputational resilience under tightening EU regulation depends on evidence-based communication: organizations must ensure that public messaging aligns with verified environmental performance and externally accessible substantiation if they are to maintain stakeholder trust. The asymmetrically large reputational and financial penalties associated with detected greenwashing make symbolic compensation an economically irrational strategy for any organization with material market or regulatory exposure.

Third, the EVIDENCE model operationalizes a credible pathway from data to communication. Its eight components - Evidence, Verifiability, Impact scope, Disclosure clarity, Enforcement alignment, Narrative consistency, Certification, and Easy access -

articulate the governance architecture required to align communication with the new EU substantiation regime. The eight associated propositions provide a structured agenda for empirical validation.

Fourth, regulation is becoming a central tool in reducing greenwashing. EU and Polish frameworks - Directive 2024/825, CSRD, the Green Claims Directive, ESPR, and UOKiK enforcement - increasingly demand substantiation, verifiability, and auditability, making symbolic communication economically and legally unsustainable. The convergence of these instruments creates a single substantiation regime within which the EVIDENCE model is intended to operate.

As transparency expectations rise and regulatory oversight expands, evidence-based environmental communication will become an indispensable component of organizational strategy, while greenwashing - understood as a governance failure rather than a marketing tactic - will evolve into a prohibitively costly practice for organizations that cannot deliver substantive environmental performance.

References

1. ACCC (2023). *Environmental and sustainability claims: Guidance for business*. Australian Competition and Consumer Commission.
2. Akerlof, G.A. (1970). The market for “lemons”: Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, 84(3), 488-500.
3. Bernini, F., La Rosa, F. (2024). Research in the greenwashing field: Concepts, theories, and potential impacts on economic and social value. *Journal of Management and Governance*, 28(2), 405-444.
4. Bingler, J.A., Kraus, M., Leippold, M., Webersinke, N. (2022). Cheap talk and cherry-picking: What ClimateBert has to say on corporate climate risk disclosures. *Finance Research Letters*, 47, Article 102776.
5. Boiral, O. (2013). Sustainability reports as simulacra? A counter-account of A and A+ GRI reports. *Accounting, Auditing & Accountability Journal*, 26(7), 1036-1071.
6. Bowen, F. (2014). *After greenwashing: Symbolic corporate environmentalism and society*. Cambridge University Press.
7. Cho, C.H., Laine, M., Roberts, R.W., Rodrigue, M. (2015). Organized hypocrisy, organizational facades, and sustainability reporting. *Accounting, Organizations and Society*, 40, 78-94.
8. Cho, C.H., Michelon, G., Patten, D.M. (2021). Impression management in sustainability reporting: A 20-year review. *Critical Perspectives on Accounting*, 79, Article 102098.

9. Competition Bureau Canada (2025). *Environmental claims and the Competition Act: Final guidelines*. Competition Bureau Canada.
10. Connelly, B.L., Certo, S.T., Ireland, R.D., Reutzel, C.R. (2011). Signaling theory: A review and assessment. *Journal of Management*, 37(1), 39-67.
11. CPC Network (2024). *Sweep on environmental claims: Final report*. European Commission.
12. de Freitas Netto, J.S., Sobral, M.F.F., Ribeiro, A.R.B., Soares, G.R.L. (2020). Concepts and forms of greenwashing: A systematic review. *Environmental Sciences Europe*, 32(1), Article 19.
13. Delmas, M.A., Burbano, V.C. (2011). The drivers of greenwashing. *California Management Review*, 54(1), 64-87.
14. DiMaggio, P.J., Powell, W.W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160.
15. ESMA (2024). *Final report on greenwashing (ESMA36-287652198-2699)*. European Securities and Markets Authority.
16. European Commission (2019). *The European Green Deal (COM(2019) 640 final)*. Publications Office of the European Union.
17. European Commission (2021). *Guidance on the interpretation and application of Directive 2005/29/EC on unfair commercial practices (2021/C 526/01)*. Publications Office of the European Union.
18. European Commission (2023a). Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU as regards sustainability reporting standards. *Official Journal of the European Union*, L 22.
19. European Commission (2023b). *Proposal for a directive on substantiation and communication of explicit environmental claims (Green Claims Directive) (COM(2023) 166 final)*. Publications Office of the European Union.
20. European Parliament and Council (2005). Directive 2005/29/EC concerning unfair business-to-consumer commercial practices in the internal market. *Official Journal of the European Union*, L 149, 22-39.
21. European Parliament and Council (2020). Regulation (EU) 2020/852 on the establishment of a framework to facilitate sustainable investment. *Official Journal of the European Union*, L 198.
22. European Parliament and Council (2022). Directive (EU) 2022/2464 as regards corporate sustainability reporting. *Official Journal of the European Union*, L 322.
23. European Parliament and Council (2024a). Directive (EU) 2024/825 amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition. *Official Journal of the European Union*, L 2024/825.

24. European Parliament and Council (2024b). Regulation (EU) 2024/1781 establishing a framework for setting ecodesign requirements for sustainable products (ESPR). *Official Journal of the European Union*, L 2024/1781.
25. Freeman, R.E. (1984). *Strategic management: A stakeholder approach*. Pitman.
26. FTC (2012). *Guides for the use of environmental marketing claims (Green Guides) (16 CFR Part 260)*. Federal Trade Commission.
27. Ghitti, M., Gianfrate, G., Palma, L. (2024). The agency of greenwashing. *Journal of Management and Governance*, 28(3), 905-941.
28. GRI (2021). *GRI 1: Foundation 2021; GRI 2: General Disclosures 2021; GRI 3: Material Topics 2021*. Global Reporting Initiative.
29. Hąbek, P., Wolniak, R. (2016). Assessing the quality of corporate social responsibility reports: The case of reporting practices in selected European Union member states. *Quality & Quantity*, 50(1), 399-420.
30. Heider, F. (1958). *The psychology of interpersonal relations*. Wiley.
31. ISO (2006a). *ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework*. International Organization for Standardization.
32. ISO (2006b). *ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines*. International Organization for Standardization.
33. ISO (2016). *ISO 14021:2016 Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)*. International Organization for Standardization.
34. ISO (2018). *ISO 14024:2018 Environmental labels and declarations – Type I environmental labelling – Principles and procedures*. International Organization for Standardization.
35. ISO (2023). *ISO 14068-1:2023 Climate change management – Transition to net zero – Part 1: Carbon neutrality*. International Organization for Standardization.
36. Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, 10, 18-26.
37. Kelley, H.H. (1973). The processes of causal attribution. *American Psychologist*, 28(2), 107-128.
38. Lyon, T.P., Montgomery, A.W. (2015). The means and end of greenwash. *Organization & Environment*, 28(2), 223-249.
39. Magnier, L., Schoormans, J. (2019). How do packaging material, colour and environmental claim influence package, brand and product evaluations? *Packaging Technology and Science*, 32(1), 1-10.
40. Marquis, C., Toffel, M.W., Zhou, Y. (2016). Scrutiny, norms, and selective disclosure: A global study of greenwashing. *Organization Science*, 27(2), 483-504.
41. Meyer, J.W., Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2), 340-363.

42. Mitchell, R.K., Agle, B.R., Wood, D.J. (1997). Toward a theory of stakeholder identification and salience. *Academy of Management Review*, 22(4), 853-886.
43. Montgomery, A.W., Lyon, T.P., Barg, J. (2024). No end in sight? A greenwash review and research agenda. *Organization Environment*, 37(2), 221-256.
44. Nemes, N., Scanlan, S. J., Smith, P., Smith, T., Aronczyk, M., Hill, S., Lewis, S.L., Montgomery, A.W., Tubiello, F.N., Stabinsky, D. (2022). An integrated framework to assess greenwashing. *Sustainability*, 14(8), Article 4431.
45. Parguel, B., Benoît-Moreau, F., Russell, C.A. (2015). Can evoking nature in advertising mislead consumers? The power of executional greenwashing. *International Journal of Advertising*, 34(1), 107-134.
46. Pope, S., Worrall, R. (2023). Visual greenwashing: A new typology. *Journal of Business Ethics*, 189(4), 945-968.
47. Santos, C., Coelho, A., Marques, A. (2024). A systematic literature review on greenwashing and its relationship to stakeholders: State of art and future research agenda. *Management Review Quarterly*, 74(3), 1397-1421.
48. Schmuck, D., Matthes, J., Naderer, B. (2018). Misleading consumers with green advertising? An affect-reason-involvement account of greenwashing effects in environmental advertising. *Journal of Advertising*, 47(2), 127-145.
49. Scott, W.R. (2014). *Institutions and organizations: Ideas, interests, and identities (4th ed.)*. SAGE.
50. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333-339.
51. Spence, M. (1973). Job market signaling. *Quarterly Journal of Economics*, 87(3), 355-374.
52. Suchman, M.C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, 20(3), 571-610.
53. Sun, Y., Shi, B. (2022). Impact of greenwashing perception on consumers' green purchasing intentions: A moderated mediation model. *Sustainability*, 14(19), Article 12119.
54. Szabo, S., Webster, J. (2021). Perceived greenwashing and its impact on green purchase intention and brand trust. *Frontiers in Psychology*, 12, Article 640087.
55. Templier, M., Paré, G. (2015). A framework for guiding and evaluating literature reviews. *Communications of the Association for Information Systems*, 37, Article 6.
56. TerraChoice (2010). *The sins of greenwashing: Home and family edition*. TerraChoice Environmental Marketing.
57. Testa, F., Sarti, S., Frey, M. (2021). Are we greenwashing the greenwashing research? A systematic review. *Business Strategy and the Environment*, 30(8), 3583-3603.
58. Teti, E., Etro, L.L., Pausini, L. (2024). Does greenwashing affect company's stock price? Evidence from Europe. *International Review of Financial Analysis*, 93, Article 103195.
59. Torelli, R., Balluchi, F., Lazzini, A. (2020). Greenwashing and environmental communication: The dark side of CSR. *Sustainability*, 12(9), Article 3679.

60. UOKiK (2023). *Strategia Prezesa UOKiK na lata 2023-2026*. Urząd Ochrony Konkurencji i Konsumentów.
61. UOKiK (2024a). *Sprawozdanie z działalności Prezesa UOKiK*. Urząd Ochrony Konkurencji i Konsumentów.
62. UOKiK (2024b). *Wytyczne dotyczące oświadczeń środowiskowych przedsiębiorców*. Urząd Ochrony Konkurencji i Konsumentów.
63. Walker, K., Wan, F. (2012). The harm of symbolic actions and greenwashing: Corporate actions and communications on environmental performance and their financial implications. *Journal of Business Ethics*, 109(2), 227-242.
64. Westerveld, J. (1986). Save the towel [Unpublished essay]. As cited in Lyon, T.P., Montgomery, A.W. (2015). The means and end of greenwash. *Organization Environment*, 28(2), 223-249.
65. Witek, L., Kuźniar, W. (2021). Green purchase behavior: The effectiveness of sociodemographic variables for explaining green purchases in emerging markets. *Sustainability*, 13(1), Article 209.

REVIEWERS

Prof. Helena CIAŻELA, The Maria Grzegorzewska University, Poland

Prof. Grzegorz GŁÓD, Economic University in Katowice, Poland

Prof. Wiesław GREBSKI, The Pennsylvania State University, USA

Prof. Manuela INGALDI, Czestochowa University of Technology, Poland

PhD Judyta KABUS, Jan Długosz University in Czestochowa, Poland

Prof. Dorota KLIMECKA-TATAR, Czestochowa University of Technology, Poland

Prof. Aleksander LOTKO, Kazimierz Pułaski University of Technology and Humanities
in Radom, Poland

Prof. Andrzej PACANA, Rzeszów Technical University, Poland

Prof. Bożena SKOTNICKA-ZASADZIEN, Silesian University of Technology, Poland

PhD Izabela WIELEWSKA, Bydgoszcz University of Science and Technology, Poland

Prof. Radosław WOLNIAK, Silesian University of Technology, Poland

Prof. Tetiana VASYLIEVA, Freiberg University of Mining and Technology, Germany

Prof. Joanna ZARĘBSKA, University of Zielona Góra, Poland

Prof. Andra ZVIRBULE, Latvia University of Life Sciences and Technologies, Latvia