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Radosława WOLNIAKA

Edited by
Bożena SKOTNICKA-ZASADZIEN
Radosław WOLNIAK

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REDAKTOR NACZELNY – Dr hab. inż. Barbara KULESZ, prof. PŚ
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**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**

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FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Contemporary management. Presented papers contain result of researches conducted by authors from Poland. The number consists of 33 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: finance management, change management, the influence of COVID-19 pandemic on management, sustainable development, quality of life, environmental management, logistic, strategic management, human resource management, risk management, production management, social economy, innovation management, marketing, Industry 4.0, leadership and project management.

*Bożena Skotnicka-Zasadzień
Radosław Wolniak*

FINANCE MANAGEMENT IN A TURBULENT ENVIRONMENT ON THE EXAMPLE OF A COMPANY OPERATING IN THE VIDEO GAMES INDUSTRY

Joanna ANTCZAK

Military University of Technology; joanna.antczak@wat.edu.pl, ORCID: 0000-0001-5691-2525

Purpose: The changing market conditions in which an economic entity operates requires its executives to choose management support tools, in particular in the area of locating the company's "bottlenecks". The knowledge of the financial situation of an economic entity becomes indispensable in making decisions at both operational and strategic levels. The aim of the article was to indicate that finance management is one of the most important areas in both current and long-term management of the company's operations in a turbulent environment.

Design/methodology/approach: CD PROJEKT Group operating on the global video game market, which is one of the most dynamic sectors of the world economy, was selected for research through purposive sampling. The solutions were developed on the basis of the following research methods: analysis of the literature on the subject, case study, analysis of documents. The financial analysis was conducted on the basis of the inductive inference method, consisting in the examination of the details in the first order, followed by generalizing them in the form of conclusions, synthetic assessment and diagnosis. Trend analysis was used to estimate the likelihood of improvement or deterioration of the financial situation. The temporal scope of the research covered in the period of 2017-2021. During the analytical procedure, selected detailed methods were used, which depended on the issues under consideration as well as problems: balance sheet method, comparative method, indicator method, descriptive methods supported by tables and graphs.

Findings: The study confirmed that a turbulent environment has a direct impact on the management, functioning and financial performance of the company.

Originality/value: The value of the article is in the analysis of the financial situation of CD PROJEKT Group over the five years and indication of the impact of the turbulent environment on the company's operations. The article is addressed to executive staff in order to make them realize the necessity of conducting ongoing financial analysis in order to locate weak areas of activity and properly adjust the strategy to the capabilities and objectives of the company.

Keywords: finance management, cyber-attack, financial analysis.

Category of the paper: case studies.

1. Introduction

Aggressive competition, expansion of new technologies, the precarious situation on global markets, unstable fiscal and economic policies of governments, a tendency to complicate the processes taking place within a company itself and their excessive growth are only some of the issues with which the management of an average company copes. Efficient corporate management increasingly becomes a "tough trade" rather than an intuitive "art" (Skowronek-Mielczarek, Leszczyński, 2007).

The economic crisis is merciless for most companies, but there are industries that are treated by the crisis extremely gently. In case of some companies, the pandemic or war in Ukraine is accelerating the introduction of new, innovative solutions. By analysing sales profits, one can tell which companies are making money during the crisis. The following years will show in the case of which companies these are only periodic fluctuations in demand, and not permanent changes.

According to the KPMG report, the outbreak of the COVID-19 pandemic, in the opinion of 55% of the surveyed companies in Poland, contributed to an increase in the risk of cyberattacks. 64% of organizations recorded at least one cyber incident in 2020. At the same time, 51% of companies admitted that the need to organize remote work was a challenge in terms of ensuring security, as it increased the vulnerability of cyberattacks. In 1/4 of companies, spending on ensuring security was increased. The year 2020 turned out to be more dangerous in terms of attempted cyberattacks compared to 2019. In 2020, at least one cyber incident was recorded by the majority of the surveyed organizations (64% of indications). This means an increase of 10 p.p. compared to 2019. In 2020, an increase in the number of cyberattack attempts was observed by 19% of entrepreneurs, while the decrease was recorded by 4% of survey respondents. It is worth noting that medium-sized companies more frequently were observing cyberattack attempts in 2020 than large enterprises employing more than 250 employees.

Entrepreneurs are most afraid of malware and social engineering attacks (phishing). Such cyberattacks may result in the leakage of sensitive data or blocking access to it by encrypting it and then demanding a ransom.

According to a study prepared by the Polish Economic Institute in cooperation with Bank Gospodarstwa Krajowego, the vast majority of companies (94%) felt the negative, weaker or stronger impact of the war in Ukraine on at least one area of their activity. The effects of the war affect Polish enterprises regardless of the size of the company or the type of business activity. The ongoing war translates into high uncertainty of the economic situation. Since the outbreak of the war, 75% of surveyed companies indicate it as a barrier strongly hindering business.

The changing business environment and the accompanying risks force company managers to modify their strategies, in particular in the area of financial management. A good business unit manager is more valuable in difficult times than in times of prosperity, because such person confidently holds the reins of the organization and is able to take advantage of opportunities to ensure further development of the company.

2. Financial analysis as a tool for managing the finances of the enterprise

Corporate finance management focuses on decisions regarding the value and type of assets acquired and at the same time conducting business so as to maximize the value of assets.

The primary objective of finance management is not to maximize the value of accounting indicators, such as net profit or earnings per share, but to maximize the value for shareholders. (...) accounting data has an impact on share prices and, on the basis thereof, it can be determined where such and not other results of the company came from and in what direction it is heading (Brigham, Houston, 2012). Corporate finance deals with the financing and investment decisions set by the corporations' management in order to maximize the value of the shareholders' wealth. However, due to the separation of ownership and control, managerial goals are pursued at the expense of the shareholders. Stockholder prosperity is enlarged through financial managers making rational investments, financing, and dividend resolutions. Moreover, for the longstanding success of the corporation, the board should be operative and be jointly accountable (Gherghina, 2021). In order to maximize the value of the company, the company's management must utilise its strengths and work to eliminate its weaknesses. One of the tools used to identify bottlenecks in individual areas of the company's operations is the analysis of financial statements.

A comprehensive and rigorous analysis of company's economic and financial situation always involves significant amount of information (of both financial and non-financial nature). However, the financial statements of an investigated company constitute by far the most important information source. The purpose of the full set of financial statements is to present the comprehensive picture of the company's historical performance (Welc, 2022).

Financial statements are the basis for a wide range of business analysis. Managers use them to monitor and assess their firms' performance relative to competitors, to communicate with external investors, to help to determine what financial policies they should pursue, and to evaluate potential new businesses to acquire as part of their investment policy (Welc, 2022; Fossung et al., 2020; Palepu, Healy, 2021).

A primary approach to evaluating and comparing financial performance of enterprises is a ratio analysis, which deals with a set of values that are typically computed on the basis of inputs extracted from primary financial statements and notes to them (Welc, 2022).

The goal of financial analysis is to use financial data to evaluate the current and past performance of a firm and to assess its sustainability. There are two important skills related to financial analysis. First, the analysis should be systematic and efficient. Second, it should allow the analyst to use financial data to explore business issues. Ratio analysis and cash flow analysis are the two most commonly used financial tools. Ratio analysis focuses on evaluating a firm's product market performance and financial policies, while cash flow analysis focuses on a firm's liquidity and financial flexibility (Palepu, Healy, 2021). Modern financial analysis should be useful to the company not only for interpreting the figures contained in the financial statements, but above all for better use of resources and external conditions, improvement of financial results,

meeting market needs and expectations of the owners. It should facilitate it for a company to make decisions which would enable its effective development in the future (Gabrusewicz, 2014).

Establishing the analysis of an appropriate cause and effect chain on the basis of indicators may identify areas which have not been previously an object of interest for the executive staff. The pyramid of conclusions obtained in this way often allows for taking actions which radically change the pattern of procedure implemented before (Nowak, Nieplewicz, 2011, p. 15).

3. Methodology

For the purposes of this article, a research scheme was prepared (Figure 1).

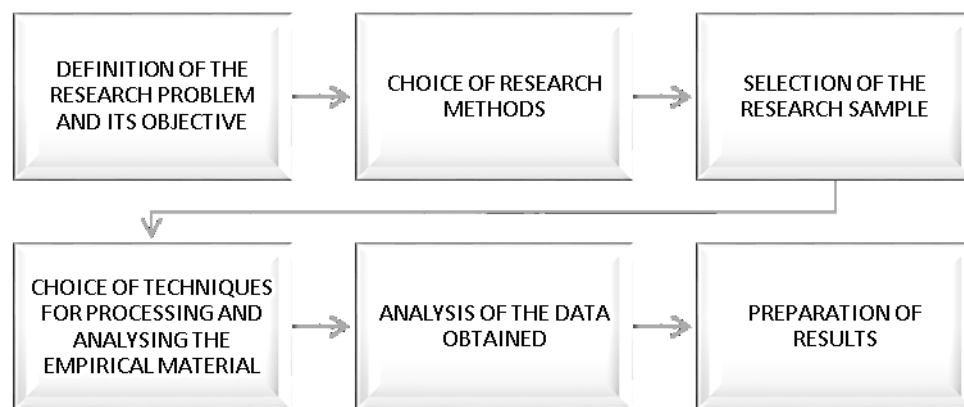


Figure 1. Research scheme.

Source: own elaboration.

The research problem formulated in this way implies the main goal of the research, which is to indicate that financial management is one of the most important aspects both in the current and long-term management of the company's activities in a turbulent environment.

CD PROJEKT Capital Group operating on the global video game market, which is one of the most dynamic sectors of the world economy, was selected for research through purposive sampling.

The solutions were developed on the basis of the following research methods: analysis of the literature on the subject, case study, analysis of documents. As part of the case analysis, diagnostic and prognostic sheets were employed, as well as the analysis of source documents.

The financial analysis was conducted on the basis of the inductive inference method, consisting in the examination of the details in the first order, followed by generalizing them in the form of conclusions, synthetic assessment and diagnosis. Trend analysis was used to estimate the likelihood of improvement or deterioration of the financial situation.

The temporal scope of the research covered the period of 2017-2021, in which the following events took place, which the analyzed Company had to face:

1. In March 2020, in connection with the growing threat caused by the coronavirus (COVID-19) pandemic, the Company took a range of preventive measures aimed

at precluding the occurrence and possible spread of infection within the structures of the Capital Group. Among other things, the so-called Home Office has been introduced allowing employees to continue working remotely. The pandemic may have had a negative impact on the sales of physical products offered by the Company. The sale was made by mail order or was moved to a digital channel.

2. On February 2021, CD PROJEKT fell victim to a hacker's attack. The hacker group gained access to CD Projekt RED's servers, stole contained there and encrypted some of them. The hacker's attack caused the Company's stock market shares to decline.
3. In March 2022, in response to the invasion of the Russian armed forces in Ukraine, the Management Board of CD PROJEKT decided to suspend the sale of CD PROJEKT Group's products and the sale of games available on the GOG.COM platform in Russia and Belarus.

During the analytical procedure, selected detailed methods were used, which depended on the issues under consideration as well as problems: balance sheet method, comparative method, indicator method, descriptive methods supported by tables and graphs. The indicator analysis presents indicators such as: liquidity, operational efficiency, profitability, debt, efficiency and sufficiency of cash, net working capital (Table 1). Activity and operational efficiency indicators were calculated as cycle indicators, i.e., they were calculated over the cycle duration of 365 days (year). The average state of receivables, liabilities and inventories was calculated as the arithmetic mean of the item value from the opening and closing balance sheet. Discriminatory models (Table 2), refer to one of the most important financial issues of an enterprise which is the assessment of its solvency. They allow early recognition of the symptoms of insolvency risk leading to bankruptcy.

Table 1.

Selected indicators (description and method of calculation)

Indicators	Method of calculation
Liquidity ratios	
– these allow for determining the company's ability to repay debts with a maturity date of up to twelve months	
Current liquidity ratio (safe index value: 1.2 - 2.0)	$\frac{\text{current assets}}{\text{short - term liabilities}}$
Increased liquidity ratio (safe index value: 0.8 - 1.5)	$\frac{\text{current assets} - \text{inventories}}{\text{short - term liabilities}}$
Cash ratio (safe index value: 0.1 - 0.2)	$\frac{\text{cash}}{\text{short - term liabilities}}$
Net working capital	
– the negative value of net working capital indicates an unstable financial situation, the solvency of which is at risk, which in consequence means that the liquidity of such a company should be assessed negatively;	
– the net working capital being higher than zero means that the company does not bear a high risk of liquidity loss and its ability to settle its current liabilities is unaffected;	
– a positive value of net working capital ensures smooth operation of the company;	
– in financial (capital) terms	(equity + long-term external capital) – fixed assets
– in terms of balance sheet (accounting)	current assets - short-term liabilities

Cont. table 1.

Activity ratios	
– these inform about the extent to which the company uses its assets efficiently	
Days sales outstanding	$\frac{\text{average amount of receivables} \times 365}{\text{sales revenues}}$
Average period of cover	$\frac{\text{average amount of inventories} \times 365}{\text{sales revenues}}$
Days payable outstanding	$\frac{\text{average amount of liabilities} \times 365}{\text{sales revenues}}$
Operating cycle	inventory turnover + days of sales outstanding
Cash conversion cycle	operating cycle – days of payables outstanding
Debt ratios	
– these inform about how the company finances its assets and about the capabilities of the company in the area of long-term debt repayment	
Total debt ratio (safe index value: 0.57 – 0.67)	$\frac{\text{total liabilities}}{\text{total assets}}$
Debt-to-equity ratio (safe index value: 1.0 – 3.0)	$\frac{\text{total liabilities}}{\text{equity}}$
Long-term debt ratio (safe index value: 0.5 – 1.0)	$\frac{\text{long – term liabilities}}{\text{equity}}$
Profitability ratios	
– these inform about the profitability of the company's operating cash flow The following relationship should be maintained in a well-functioning company: the return on equity ratio should be higher than the return on assets ratio, which should be higher than the return on sales ratio, i.e.: ROE > ROA > ROS.	
Return on equity (ROE)	$\frac{\text{net profit}}{\text{equity}}$
Return on assets (ROA)	$\frac{\text{net profit o}}{\text{total assets}}$
Return On Sales (ROS)	$\frac{\text{net profit}}{\text{sales revenues}}$
Return on investment (ROI)	$\frac{\text{operating profit}}{\text{total assets}}$

Source: own elaboration based on: Skowronek-Mielczarek, Leszczyński, 2007; Sierpińska, Wędzki, 1997; Antczak, 2014.

Table 2.

Selected Polish discriminatory models (description and calculation method)

Model	Calculation formula
A. Hołda's model	$Z = 0.605 + 0.681X_1 - 0.0196X_2 + 0.00969X_3 + 0.000672X_4 + 0.157X_5$ where: X_1 - current assets / short-term liabilities; X_2 - total liabilities / total assets; X_3 - net profit / total assets; X_4 - short-term liabilities / cost of products, goods and materials sold; X_5 - total revenue / total assets. The limit value was set at 0,0 (the author defined a "grey zone" within the <-0.3 - 0.1> area).
E. Mączyńska and M. Zawadzki's model	$Z = 9.498X_1 + 3.556X_2 + 2.903X_3 + 0.452X_4 - 1.498$ where: X_1 - operating profit/assets; X_2 - equity/assets; X_3 - (net profit + depreciation)/total liabilities; X_4 - current assets/short-term liabilities The critical value of the indicator is 0.
E. Mączyńska's model (adaptation of O. Jacobs' model to Polish conditions)	$Z = 1.5X_1 + 0.08X_2 + 10.0X_3 + 5.0X_4 + 0.30X_5 + 0.10X_6$ where: X_1 - gross profit + depreciation / total liabilities; X_2 - assets/total liabilities; X_3 - operating profit/assets; X_4 - operating profit/sales revenues; X_5 - inventory/sales revenues; X_6 - assets/sales revenues The value of the Z-meter is interpreted as follows: $Z < 0$ – a company at risk of bankruptcy; $Z = 0$ – limit value; $0 < Z < 1$ – a weak company but not at risk of bankruptcy; $1 < Z < 2$ – a fairly good company; $Z > 2$ - a very good company
J. Gajdka and D. Stos's model	$Z = 0.7732059 - 0.0856425X_1 + 0.0007747X_2 + 0.9220985X_3 + 0.6535995X_4 - 0.594687X_5$ where: X_1 - sales revenues/balance sheet total; X_2 - liabilities x 365/manufacturing costs of products sold; X_3 - net profit/balance sheet total; X_4 - gross profit/sales revenues; X_5 - total liabilities/assets. The critical value of the model is 0.45.

Cont. table 2.

The Poznań model (developed by a team led by M. Hamrol, B. Czajka, and M. Piechocki)	$Z = -2.368 + 3.562X_1 + 1.5887X_2 + 4.288X_3 + 6.719X_4$ <p>where: X_1 - net profit /assets; X_2 - current assets - inventories/short-term liabilities; X_3 - constant capital/assets; X_4 - profit on sales/sales revenues The limit value was set at 0.0.</p>
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Source: own elaboration based on: Antczak, Maśloch, 2017.

4. Case study

4.1. Description of CD PROJEKT Group

CD PROJEKT S.A. (the Company, the Group), with its registered office in Warsaw, is active in the global, dynamically developing video game industry. The Company was founded in 1994 by Marcin Iwiński and Michał Kiciński. Initially, the Company was involved in delivering computer software on CDs from the United States to Poland. The breakthroughs in the history of the Group were: the establishment of the CD PROJEKT RED development studio in 2002 and the commencement of work on developing their first RPG2 game – The Witcher, and the launch of the GOG.COM website in 2008.

CD PROJEKT S.A. acts as the holding company of the CD PROJEKT Group, and coordinates the operations conducted through subsidiaries within the Capital Group.

At the end of 2021, the CD PROJEKT Group consisted of the parent company CD PROJEKT S.A. and 7 subsidiaries: GOG sp. z o.o., CD PROJEKT Inc., CD PROJEKT Co. Ltd. (in liquidation), Spokko sp. z o.o., CD PROJEKT RED Store sp. z o.o., CD PROJEKT RED Vancouver Studio Ltd., and The Molasses Flood LLC (a subsidiary of CD PROJEKT Inc.) (Figure 2).

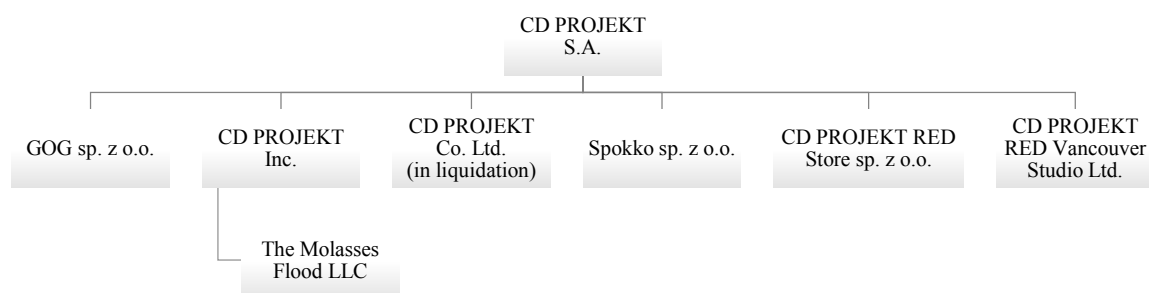


Figure 2. Structure of the CD PROJEKT Group.

Source: own elaboration based on: Sprawozdanie Zarządu z Działalności Grupy Kapitałowej CD PROJEKT za 2021 rok.

The CD PROJEKT Group operates in two key business segments: CD PROJEKT RED and GOG.COM (Figure 3).

CD PROJEKT RED	GOG.COM
<ul style="list-style-type: none"> • production and release of video games and related products using the brands owned by the Company 	<ul style="list-style-type: none"> • digital distribution of computer games using a proprietary GOG.COM platform and GOG GALA application

Figure 3. Business segments of CD PROJEKT Group.

Source: own elaboration based on: Sprawozdanie Zarządu z Działalności Grupy Kapitałowej CD PROJEKT za 2021 rok.

Since March 2018, CD PROJEKT has been listed in the WIG20 index, which consists of the 20 largest and having highest liquidity companies on the Warsaw Stock Exchange. As of 5 April 2022, the Company's share in the index was 5.3%. CD PROJEKT is also included in the WIG.GAMES5 index, which brings together the five largest games producers listed on the Warsaw Stock Exchange. Due to the significantly higher market capitalization than other index companies, the share of CD PROJEKT in WIG.GAMES5 was limited — as of 5 April 2022, it amounted to 41.7%. Since 21 March 2022, a new WIG-Gry index, which represents the gaming industry companies listed on the WSE Main Market, has been published. As of 5 April 2022, the Company's share in this index was 73.3%. CD PROJEKT is also a part of WIG-ESG, the portfolio of which includes shares of companies considered to be socially responsible, i.e., those that comply with the principles of socially responsible business, particularly, in the fields of environmental, social, economic, and corporate governance issues. The CD PROJEKT's share in the index portfolio as of 5 April 2022 was 4.9% (Skonsolidowane Sprawozdanie 2021).

4.2. Micro and macro environment of the CD PROJEKT Group

The Group's development prospects are influenced not only by the systematic popularization of video games as entertainment available and attractive to the mass user, but also by the constant development of technology enabling the creation of better and even more realistic products, increasing availability and affordability of gaming devices, and further development in the field of digital methods for reaching potential gamers and games distribution (Skonsolidowane Sprawozdanie, 2021).

According to Newzoo, one of the leading research companies involved in the analysis of the gaming and e-sport market, the global video games market will have reached USD 218.8 billion by 2024, which implies a cumulative annual growth rate (CAGR) of this market over at the level of 5.0% the years 2021–2025. On the other hand, the report by PwC "Global Entertainment & Media Outlook 2021–2025" indicates that the video games and e-sport market will grow by 5.1% annually on average over the same period.

For the further development of the Group, the ability to maintain and develop a team of the best creators and specialists, as well as attract new experts both domestic and foreign ones to work on the projects implemented in the Group, is critical (Skonsolidowane Sprawozdanie, 2021).

The Group is exposed to a number of risks, both financial and non-financial ones, related to its current operations. The Company has implemented a Risk Management Procedure, which is a set of clearly defined rules of conduct enabling identification, assessment, analysis and further

handling of the risk. For the purposes of this article, two types of risks are presented in Table 3: cybersecurity risk as well as the risk of liquidity and creditworthiness loss.

Table 3.

Selected types of risks (description and measures undertaken)

Description of the risk:	Measures undertaken:
BUSINESS RISK: Cybersecurity risk related to the danger of leakage, loss or unauthorized modification of data	
<ul style="list-style-type: none"> – storing and processing data in IT or communication systems is exposed to the risk of leakage, loss or unauthorized modification; – cybersecurity risks extend beyond data damage and destruction or financial loss, and may also include intellectual property theft, loss of productivity or reputation; – cybersecurity risk factors may be internal or external factors of a deliberate or unintentional nature, e.g., resulting from cyber-attacks, malware installation or other security breaches. 	<ul style="list-style-type: none"> – an action plan was developed based on the "Defence in depth" principle, which envisages employment of overlapping defence mechanisms; – the technical functionality increasing the cyber resilience of the IT infrastructure is systematically introduced and improved; – security requirements are normalized and improved so that the processing and access to information is under constant control; – monitoring the data-processing system to ensure adequate technical safeguards preventing circumvention of security mechanisms.
FINANCIAL RISK: Liquidity reduction and credit risk	
<ul style="list-style-type: none"> – improper management of current assets, dependence on one or a narrow group of recipients and excessive concentration of funds in one financial institution may generate liquidity risk; – as part of sales with deferred payment dates or revenues from license fees usually reported and settled post factum after the end of the period for which royalties are due, the Group is exposed to the risk of insolvency on the part of the contractors with whom it cooperates. 	<ul style="list-style-type: none"> – monitoring the level of financial resources, financial debt in relation to equity, current and planned financial results, as well as future investment plans; – cooperation with several banks by diversifying the allocation of cash and bank deposits held; – investing share of the reserves in treasury bonds and bonds secured with a guarantee of the State Treasury; – ongoing monitoring of the inflow of receivables is conducted; – collection of difficult receivables is outsourced to external, specialized entities.

Source: own elaboration based on: Sprawozdanie Zarządu z Działalności Grupy Kapitałowej CD PROJEKT za 2021 rok.

4.3. Impact of the COVID-19 pandemic on the operations of the CD PROJEKT Group

In March 2020, in connection with the growing threat caused by the coronavirus (COVID-19) pandemic, the Company took a range of preventive measures aimed at precluding the occurrence and possible spread of infection within the structures of the Capital Group. The technical infrastructure and software supporting it were expanded in order to increase network capacity, equipment efficiency and security standards, making it possible to transfer all the persons working in the office so far into remote work mode. From 16 March 2020, there was a transition to the so-called Home Office, enabling all the personnel employed by the CD PROJEKT Group to continue work remotely (with the exception of necessary individual persons being on duty on the premises of the office). In the following months, in order to increase safety and enable some of the employees to do office work in a hybrid mode, the Group's subsidiaries introduced additional initiatives in the field of caring for the mental and physical health of their team members (Skonsolidowane Sprawozdanie, 2020).

The vast majority of sales are made by the Group through digital distribution, which kept gaining popularity during the pandemic and periods of the so-called lockdown. The pandemic could have had a negative impact on the sales of physical products offered by the Company, however it should be assumed that some of these sales were naturally made by mail order or were transferred to the digital channel (Skonsolidowane Sprawozdanie, 2020).

The Company has identified the risks associated with the COVID-19 pandemic, both in the short and long term, as illustrated in Figure 4.

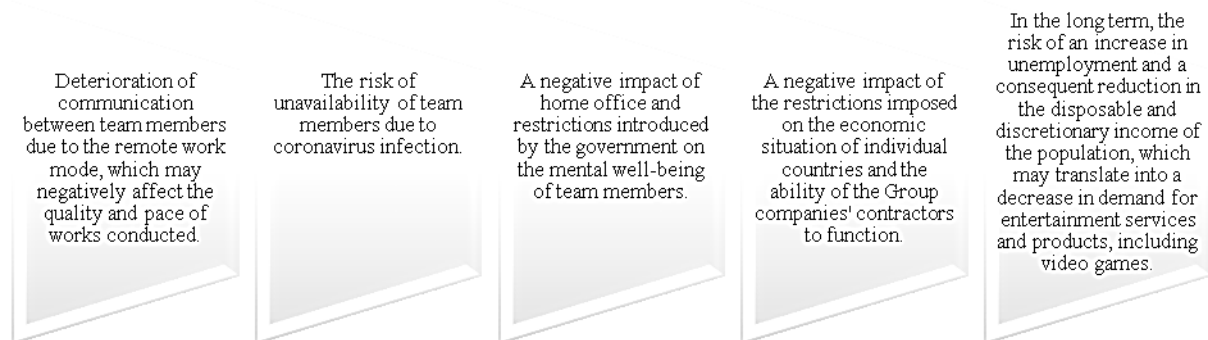


Figure 4. Risks related to the COVID-19 pandemic.

Source: own elaboration based on: Sprawozdanie Zarządu z Działalności Grupy Kapitałowej CD PROJEKT za 2020 rok.

In the opinion of the Management Board of the Company, the COVID-19 virus pandemic did not have a significant negative impact on the Group's results in 2021 and does not threaten the continuation of the Company's operations over the period of 12 months from the end of the reporting period.

4.4. The impact of a cyber-attack on the operations of the CD PROJEKT Group

On 7 February 2021, CD PROJEKT fell victim to a hacker's attack. Cybercriminals spread information that they had stolen the source codes of Cyberpunk, Gwent and The Witcher 3 and that they were in possession of administrative, accounting and investment documents. The hacker threatened that if CDP Red did not contact them within 48 hours, all the data would go online or be sold. An official statement on Twitter confirmed a successful hacking attack on CD Projekt RED's servers (Figure 5).

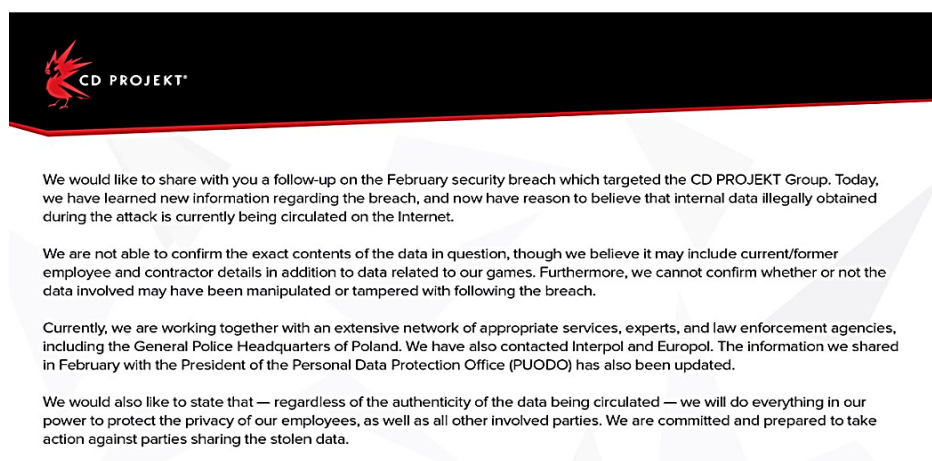


Figure 5. An official statement on Twitter CD Projekt RED's servers.

Source: <https://twitter.com/CDPROJEKTRRED>.

The company took steps to improve the security of IT infrastructure, which include, among others: new solutions for remote work, less privileged accounts, better firewalls, expansion of the security department and cooperation with external companies in the field of cybersecurity.

The hacker's attack on CD PROJEKT RED caused the Company's stock market shares to drop. From the time of the publication of the blackmail letter, the stock rate began to drop rapidly from PLN 287.20, reaching PLN 268.90 per share at the critical moment.

The CEO of CD PROJEKT RED, Adam Kiciński, confirmed shortly after the hacker's attack that his company was restoring the lost data from backups. He also added that the attack would have a short-term impact on the pace of development work carried out by the studio. The Management Board of the Company intends to significantly increase the budget for data security, enhance barriers so that hackers could never repeat their assault on the Company and its products. According to data from the company's balance sheet, the financial outlays increased from about PLN 200,000 per month to about PLN 1,000,000.

4.5. The influence of the political and economic situation in Ukraine on the operations of the CD PROJEKT Group

In response to the invasion of the Russian armed forces in Ukraine, on 3 March 2022, the CD PROJEKT Management Board decided to suspend the sale of CD PROJEKT Group products and the sale of games available on the GOG.COM platform in Russia and Belarus. The company estimates that within 12 months from March 2021 to February 2022, the combined share of Russia and Belarus in the sales revenues of the CD PROJEKT RED segment products and in the sales revenues of the GOG.COM segment amounted to approx. 5.4% and approx. 3.7%. During the initial period of the invasion of Ukraine by the Russian military forces, the PLN currency significantly weakened in relation to the USD and the EUR, i.e., the main currencies in which the Group receives sales revenues. For the Group, which receives most of its revenues from export, strengthening the currencies in which revenues are earned in relation to the local currency is a beneficial phenomenon. In connection with the risks related to the political and economic situation in Ukraine, the Company continuously monitors the impact of the political and economic situation in Ukraine, Russia and Belarus on the activities of the CD PROJEKT Group. The Company has completed or is in the process of finalizing cooperation with Russian suppliers. Currently, the Company is not considering entry into a new cooperation with Russian or Belarusian economic entities (Skonsolidowane Sprawozdanie, 2021).

4.6. Financial analysis of the CD PROJEKT Capital Group in the period: 2017-2021

The premieres of new titles exert a big impact on the revenues and results of the CD PROJEKT RED segment. The development cycle of a computer game carried out by the Company usually lasts from 2 to 5 years. Typically, the first development works on the next game are started before the end of the development and market premiere of the previous game. In turn, the sector of digital gaming distribution, in which GOG.COM operates, is characterized by

seasonality of revenues. On a yearly basis, the highest revenues are usually reported in the second and fourth quarter, with the first and third quarters yielding lower ones. The sales in the second and fourth quarter are periodically boosted by the standard promotional campaigns occurring during these quarters. The catalogue of products introduced to the service offer in a given period may also have a significant impact on the level of sales.

The financial analysis of the studied Company covers the years 2017-2021. Table 4 presents selected data on balance sheet and profit and loss account. The graph in Figure 6 illustrates the asset and equity structure of the Company.

When analysing the balance sheet dynamics in the period 2017-2021, it can be noted that the Company recorded the largest decreases in 2021. The balance sheet total in 2021 decreased by 25% compared to the previous year, which was influenced by the decrease in working assets and equity. The decrease in working assets (41%) was mainly due to a decrease in trade receivables (90%). In 2021, fixed assets increased (19%), which was influenced in particular by an almost four-fold increase in shares in subordinated entities not included in consolidation. On the capital side, long-term liabilities decreased by 78% and short-term liabilities by 58% y/y in 2021. In 2021, the equity decreased by 13% compared to the previous year. The greatest impact on the change in equity had the dividend payment to shareholders of CD PROJEKT S.A. in the amount of PLN 503,694 thousands and the financial result of the current period (PLN 208,908 thousands).

During the analysed period, the Company recorded the highest increase in the balance sheet total in 2020 by 106% compared y/y, which was mainly influenced by almost twofold increase in working assets and increase in long-term foreign capital.

Table 4.

Selected financial data of CD PROJEKT in the period: 2017-2021 (thousands PLN)

SPECIFICATION	2021	2020	2019	2018	2017
TOTAL LIABILITIES	2,158,735	2,890,299	1,404,108	1,126,838	981,513
FIXED ASSETS	905,846	759,999	679,389	388,309	255,535
WORKING ASSETS	1,252,889	2,130,300	724,719	738,529	725,978
EQUITY	1,894,356	2,183,177	1,105,651	1,002,864	882,899
FOREIGN CAPITAL	264,379	707,122	298,457	123,974	98,614
SALES REVENUES	888,172	2,138,875	521,272	362,901	463,184
COST OF PRODUCTS, SERVICES, GOODS AND MATERIALS SOLD	250,234	491,364	161,308	106,254	82,174
EBIT (OPERATING PROFIT)	232,903	1,157,077	180,286	112,392	240,940
NET PROFIT (LOSS)	208,908	1,150,148	175,315	109,334	200,270

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

When analysing the profit and loss account, it can be noticed that the year 2020 was the best of all the audited years for the Company, in which the net profit achieved more than a five-fold increase compared to the previous year and attained the level of PLN 1,150,148 thousand. In 2020, the inequality of cost dynamics < revenue dynamics < profit dynamics was maintained. In 2021, net sales revenues, costs of products and services sold, and net profit decreased compared to the previous year, by 58%, 49% and 82%, respectively, which could have been affected by the cyber-attack.

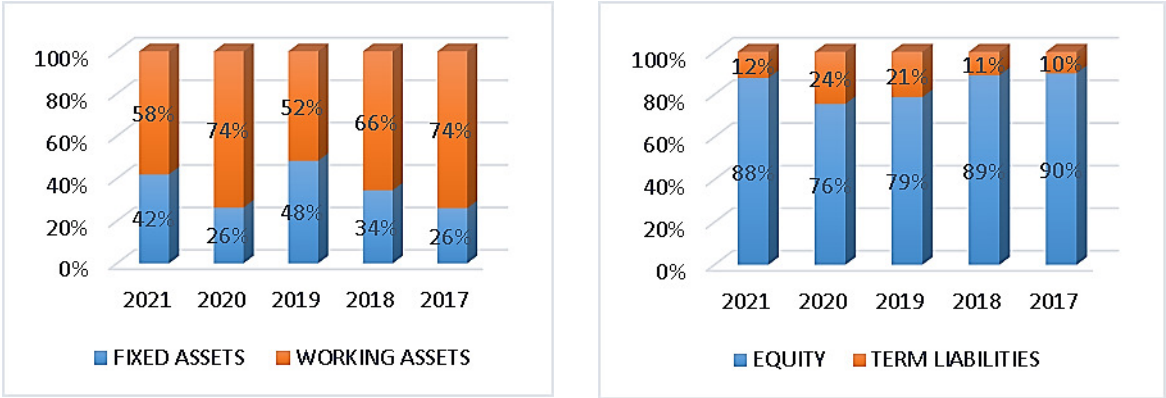


Figure 6. Structure of the CD PROJEKT balance sheet in the period: 2017-2021

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

When analysing the balance sheet structure over 5 years, it can be noted that the structure of the company's assets and at the same time the capital did not change significantly. On the asset side, the largest share is held by fixed assets, which amounted to 58% in 2021, in terms of liabilities, the largest share is held by equity capital 88%.

The graph in Figures 7-10 illustrates the indicator analysis carried out.

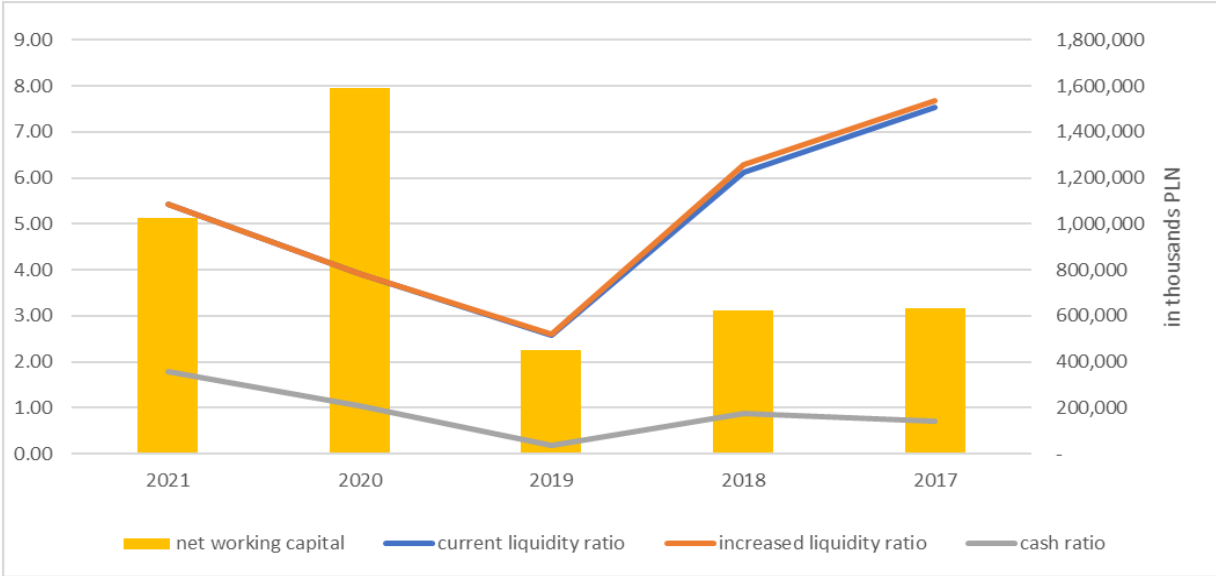


Figure 7. Liquidity ratios CD PROJEKT in the period: 2017-2021

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

Liquidity ratios indicate excess liquidity, which means that the Company has no problems with settling its current liabilities. A positive relation occurs between current and increased liquidity ratios. The difference between them is small, which results from the low share of inventory in the Company's assets. The working capital achieved a positive value during the period under study.

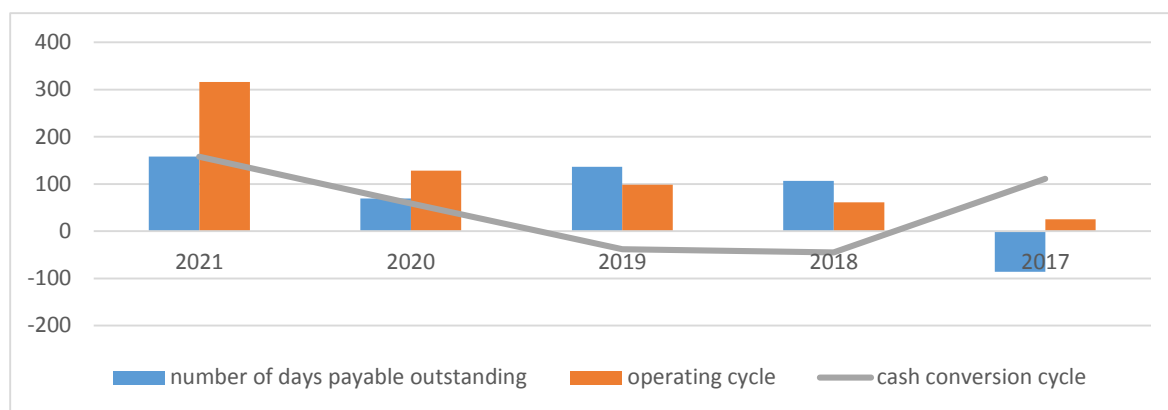


Figure 8. The operational efficiency ratios of CD PROJEKT in the period: 2017-2021.

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

The operational efficiency ratios, from a financial point of view, indicate a disadvantageous situation from 2020 onwards. The Company settles its liabilities before the closing of the operating cycle. Such a situation may be influenced by the fact that in the course of the operations conducted, there occur cases of the concentration of the largest recipients, whose purchases exceed 10% of the total revenue from the Group's sales.

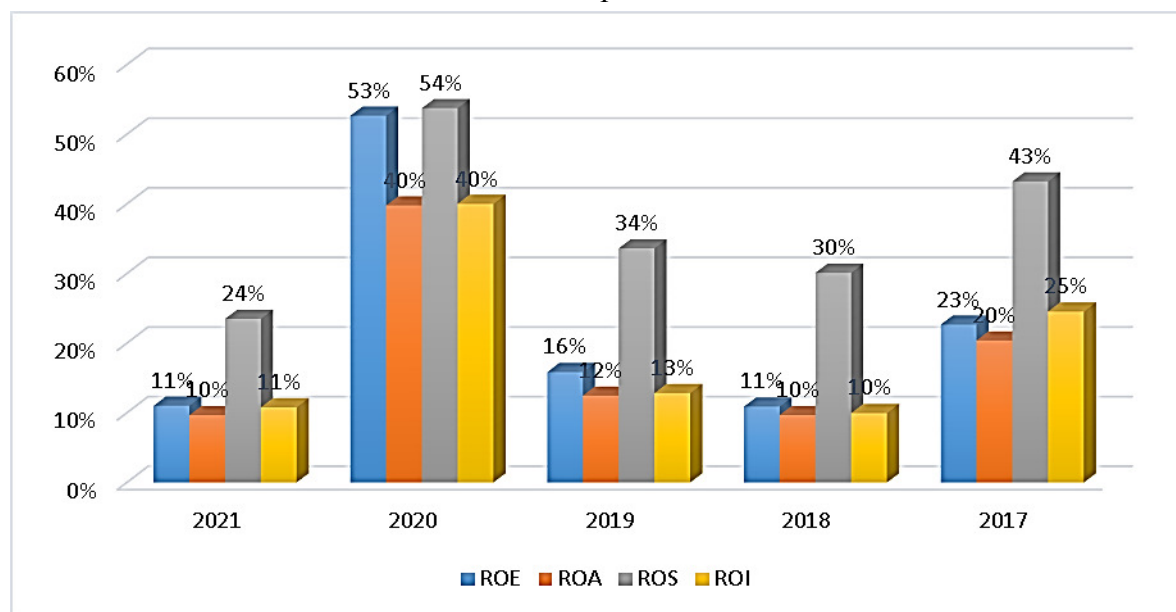


Figure 9. The ratios of CD PROJEKT profitability in the period: 2017-2021.

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

The profitability ratios peaked in 2020. In 2021, they deteriorated, but their level was above the inflation. In all the years under study, the highest level was achieved by the return on sales.

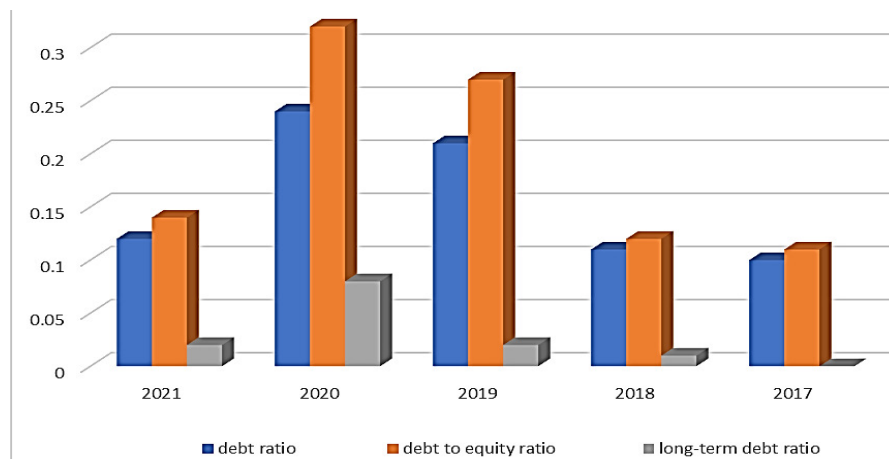


Figure 10. The debt ratios of CD PROJEKT in the period: 2017-2021.

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

Debt ratios during the analysed years indicate that the Company does not incur debt from foreign capital.

Table 5 presents the structure of the cash flow statement of the studied Company in the period: 2017-2021.

Table 5.

Structure of the cash flow statement of CD PROJEKT in the period: 2017-2021 (in thousand PLN)

STATEMENT OF CASH FLOWS	2021	2020	2019	2018	2017
Net cash flows from operating activities	967,825	711,708	216,706	132,591	233,085
Net cash flows from investment activities	-613,795	-106,386	-164,498	-94,494	-282,114
Net cash flows from financial activities	-505,779	-91,393	-107,180	-706	-101,353

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

From the analysis of the structure of the cash flow statement, it can be noticed that the situation did not change during the analysed period. The Company achieves a positive balance from operating activities, while investment and financial activities yield a negative balance, which is characteristic of a mature enterprise.

Table 6 illustrates the results of the analysis of the studied Company using selected discriminatory models in the period: 2017-2021.

Table 6.

Z-global indicator according to discriminatory models CD PROJEKT in the period: 2017-2021

SPECIFICATION	2021	2020	2019	2018	2017
Hołda's model					
Z-global indicator	4.408506	3.404108	2.469824	4.945179	5.919299
E. Mączyńska and M. Zawadzki's model					
Z-global indicator	8.572	12.591	5.790	8.410	13.545
J. Gajdka and S. Stos's model					
Z-global indicator	1.174	1.599	1.446	1.303	1.535
E. Mączyńska's model					
Z-global indicator	4.687	10.086	4.552	5.015	9.317
The Poznań model					
Z-global indicator	14.734	14.282	9.970	16.019	20.426

Source: own compilation based on: The financial reports of CD PROJEKT for the years 2017-2021.

When assessing the conducted analysis of unit values and noticeable trends in the behaviour of the "Z" value in the studied Company over a period of 5 years, it can be noticed that there is no risk of bankruptcy.

5. Summary and conclusions

Maintaining the company's solvency is an extremely important element for its existence, both in the short and long term. One of the company's financial management processes is financial monitoring, which is a systematic and methodical activity assessing its financial condition, and in particular identifying bottlenecks that could indicate a threat of bankruptcy.

Summing up the financial analysis of the surveyed Company over 5 years, it is concluded that on the one hand, the Company invests in its development and achieves revenues as well as profits, but on the other hand, the impact of the turbulent environment on their level is clearly visible, which is particularly noticeable in the last year of the studied period.

It is worth noting that despite a difficult period for the Company, the time of the pandemic, the cyber-attack, the invasion of Ukraine by the Russian armed forces, the decrease in sales revenue and net profit (58% and 82% respectively in 2021, comparing them y/y, both the preliminary analysis of the financial statements, followed by indicator analysis and the analysis of discriminatory models indicate that the Company faces no solvency risk, nor does it have any external debts in the form of loans or credit or any bankruptcy risk.

The cyber-attack had a direct impact on the Company's listing on the WSE. From 1 January 2021 to 31 December 2021, the closing price of the Company's shares fluctuated from PLN 153.38 (1 June 2021) to PLN 365.00 (28 January 2021). During the year, CD PROJEKT's share price fell by 29.8%, reaching PLN 192.90 on 30 December 2021. In the corresponding period, the WIG20 index gained 14.3%, while the WIG broad market index increased by 21.5%. At the end of 2021, the market capitalization of CD PROJEKT S.A. amounted to PLN 19.4 billion.

The presented cyber-attack points to the fact that the risk related to cyberspace poses a serious threat to the continuity of business and at the same time to the reputation of the enterprise in each industry. The introduction of a cybersecurity system gains increasing importance in terms of "competitive advantage" on the market. Good antivirus systems often reassure business counterparties that their choice is correct or dissuade them from the decision to cooperate taken by them (Antczak, 2020).

In 2021, the Company implemented a Risk Management Procedure, on the basis of which the principles of management and handling strategic risks were formalized. The purpose of the procedure is to achieve the acceptable level of risk for the identified hazards, and thus to limit the consequences of potential events which may have a negative impact on the Company's operations, including financial stability.

The actions taken by CD Projekt's executives in such difficult times confirm the principle of "fair play" which the Group adheres to, i.e., that it "behaves" honestly both towards its employees and business partners. They observe the principles of responsible business and engage in social actions.

References

1. Antczak, J. (2014). *Analizy i raporty w controllingu*. In: A.M. Wiśniewska, J. Antczak, *Controlling a strategię rozwoju MSP z województwa mazowieckiego* (pp. 121-165). Warszawa: Akademia Finansów i Biznesu Vistula.
2. Antczak, J. (2020). *Zarządzanie przedsiębiorstwem w cyberprzestrzeni*. Warszawa: Akademia Sztuki Wojennej.
3. Antczak, J., Maśloch, P. (2018). Wybrane aspekty zarządzania przedsiębiorstwem logistyczny. *Gospodarka Materialowa i Logistyka*, nr 11, pp. 1-17.
4. *Atak hakerski na CD Projekt RED. Jest postępowanie*. Retrieved from: <https://businessinsider.com.pl/gielda/cd-projekt-red-atak-hakerski-wszczeto-postepowanie/nph6g50>, 2.09.2022.
5. *Atak na CD Projekt przestroga dla biznesu. Hakerzy tylko czekają na szansę*. Retrieved from: <https://www.money.pl/gospodarka/atak-na-cd-projekt-przestroga-dla-biznesu-hakerzy-tylko-czekaja-na-szansę-6608799701908288a.html>, 2.09.2022.
6. *Barometr cyberbezpieczeństwa COVID-19 przyspiesza*. Retrieved from: <https://home.kpmg/pl/pl/home/insights/2021/04/raport-barometr-cyberbezpieczenstwa-2020-covid-19-przyspiesza-cyfryzacje-firm.html>, 10.01.2023.
7. Brigham, E., Houston, J. (2012). *Fundamentals of Financial Management*. Mason: South-Western Cengage Learning.
8. *CD Projekt informuje o ataku ransomware na swoją sieć*. Retrieved from: <https://niebezpiecznik.pl/post/cd-projekt-informuje-o-ataku-ransomware-na-swoja-siec/>, 5.09.2022.
9. *CD PROJEKT RED*, Retrieved from: <https://twitter.com/CDPROJEKTRED>, 10.09.2022.
10. *CD Projekt SA (CDR)*. Retrieved from: <https://www.bankier.pl/inwestowanie/profile/quote.html?symbol=CDPROJEKT>, 10.09.2022.
11. Davues, D. (1992). *Sztuka zarządzania finansami*. Warszawa-Londyn: McGraw Hill.
12. Fossung, M.F., Agbor, L., Ntoug, T., Santos de Oliveira, H.M., Ferreira Pereira, C.M., Moreira Carvalho Bastos, S.A., Marques Pimentel, L. (2020). Transition to the Revised OHADA Law on Accounting and Financial Reporting: Corporate Perceptions of Costs and Benefits. *Journal of Risk and Financial Management*, 13, 172. <https://doi.org/10.3390/jrfm13080172>.

13. Frączyk, J. *Prezes CD Projekt o pracy zdalnej. "Duża część procesów zwolniła"*. Retrieved from: <https://businessinsider.com.pl/gielda/wiadomosci/prezes-cd-projekt-o-pracy-zdalnej-duza-czesc-procesow-zwolnila-wywiad/24v46cw>, 18.09.2022.
14. Gabrusewicz, W. (2014). *Analiza finansowa przedsiębiorstwa. Teoria i zastosowanie*. Warszawa: PWE.
15. Gherghina, S.C. (2020). Corporate Finance. *Journal of Risk and Financial Management*, 14, 44. <https://doi.org/10.3390/jrfm1402004>.
16. Gołębiowski, G., Taczała, A. (2005). *Analiza ekonomiczna – finansowa w ujęciu praktycznym*. Warszawa: Difin.
17. Jak wojna wpływa na działalność polskich firm? *Tygodnik Gospodarczy PIE 27*, Retrieved from: https://pie.net.pl/wp-content/uploads/2022/07/Tygodnik-Gospodarczy-PIE_27-2022.pdf, 10.01.2023.
18. Kotowski, A. *W ataku hakerskim na CD Projekt RED mogły wyciec dane pracowników*. Retrieved from: <https://www.komputerswiat.pl/aktualnosci/bezpieczenstwo/w-ataku-hakerskim-na-cd-projekt-red-mogly-wyciec-dane-pracownikow/6b1xjpt>, 2.09.2022.
19. Nowak, E., Nieplewicz, M. (2011). *Rachunkowość a controlling*. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.
20. Palepu, K.G., Healy, P.M., Wright, S., Bradbury, M., Coulton, J. (2021). *Business analysis and valuation: Using financial statements*. South Melbourne: Cengage Learning.
21. Sierpińska, M., Wędzki, D. (1997). *Zarządzanie płynnością finansową w przedsiębiorstwie*. Warszawa: PWN.
22. *Skonsolidowane Sprawozdanie Finansowe Grupy Kapitałowej CD PROJEKT za lata 2018 - 2021 rok*. Retrieved from <https://www.cdprojekt.com/pl/typ-informacji-prasowej/year>; 10.08.2022.
23. Skowronek-Mielczarek, A., Leszczyński, Z. (2007). *Controlling analiza i monitoring w zarządzaniu przedsiębiorstwem*. Warszawa: Difin.
24. *Sprawozdanie Zarządu z Działalności Grupy Kapitałowej CD PROJEKT za lata 2018 - 2021 rok*. Retrieved from <https://www.cdprojekt.com/pl/typ-informacji-prasowej/year>; 10.08.2022.
25. Welc, J. (2022). *Evaluating Corporate Financial Performance Tools and Applications*, Palgrave Macmillan, <https://doi.org/10.1007/978-3-030-97582-1>.

CHANGES IN DWELLING SIZE PREFERENCES IN THE POZNAŃ HOUSING MARKET

Piotr BARTKOWIAK¹, Łukasz STRĄCZKOWSKI*²

¹ Department of Investment and Real Estate, Poznań University of Economics and Business;
piotr.bartkowiak@ue.poznan.pl, ORCID: 0000-0001-9678-3465

² Department of Investment and Real Estate, Poznań University of Economics and Business;
lukasz.straczkowski@ue.poznan.pl, ORCID: 0000-0002-5555-5324

*Correspondence author

Introduction: Local governments should see striving for a sustainable development of their towns, cities, municipalities and communes as a key policy objective. Achieving that objective requires that the needs and preferences of local communities are properly identified and recognised in various areas, including the housing market – a specific segment of the real estate market that is characterised by its locality and uniqueness, and which serves to accommodate the needs of households, both the basic ones (such as physiological needs, security or belonging) and those higher up the hierarchy (such as esteem or self-actualisation).

Aim of the paper: This paper presents data on dwelling size preferences in the local housing market in Poznań, showing that such preferences remained unchanged over 2010-2021. The paper identifies housing affordability as a potential limiting influence on such changes and a factor that may negatively affect the sustainable development of both the city and its population.

Materials and methods: The paper uses relevant aggregate data on the real estate market, including those found in publications from Statistics Poland (GUS) and the National Bank of Poland (NBP), and the results of research conducted by the Poznań University of Economics and Business, Department of Investment and Real Estate.

Results and conclusions: The results show that the local housing market saw no changes in dwelling size preferences over 2010-2021. On average, dwelling units bought are not big – they have two or three rooms and an area of around 50 sqm. This is caused by relatively low housing affordability in Poznań (too low incomes in relation to dwelling prices), giving rise to concerns regarding proper and sustainable development of local communities going forward.

Keywords: housing preferences, changes in housing preferences, local housing market, housing demand.

Introduction

Research into housing preferences is a part of a broader research into the housing market, and more specifically, its demand side. There is a view among those looking into housing preferences that this is needed because preference information is important and must be current, while the local market it comes from is changing rapidly. The importance of housing preference research is emphasised by Gawron (2012), among others. Gaining insight into what housing buyers find to be preferable is justified both theoretically and practically and those that should have an interest in the results of such studies include:

- property developers – as their task is to supply new dwellings meeting the expectations of their future occupants,
- urban planners and architects – as those with responsibility for designing residential estates and dwelling units (premises) to the highest possible satisfaction of their occupants,
- officials and decision-makers (whether at the central or local levels) – as those who set housing policy and make policy decisions, including how any housing needs will be accommodated, and as such are in need of good insight into housing preferences,
- banks – because in addition to providing housing loans (where knowledge of preferences is helpful in planning loan portfolios, for example in terms of how much can be loaned) banks also provide housing investment finance (here, knowledge of preferences is helpful in project evaluation and adjustment in line with market expectations).

It is generally accepted that adequate recognition of preferences supports rational decision-making across various areas and may be conducive to a sustainable regional development policy. On the connection between sustainability and the housing market, read, for example, in: Bryx (2021) or Strączkowski, Bartkowiak (2022).

The literature on the subject sees preferences as:

- a rating and prioritising system whereby certain goods can be ranked higher than others,
- the ability to prioritise certain products over others,
- the valuation of objectives when selecting goods,
- the inclinations when selecting goods,
- one of the three factors shaping a specific consumption plan (the other two being income and prices of goods or services), with the structure of preferences themselves affected by various factors, including age, family status, education, existential needs, and economic and social development (Szymańska, 2012, pp. 67-68).

There are numerous factors influencing buyers' preferences. According to A. Szymańska, they are both internal and external. The internal factors are associated with the psychological sphere because decisions we make can be affected by our current emotional state, mood, fear, or greed (Szyszka, 2009, pp. 67-71). The external factors derive from the consumer's immediate environment or surroundings. Here, we can distinguish demographic, economic, social, cultural and marketing factors. The latter group features some interesting factors relating to preferences induced by other people. These would be the so-called "bandwagon effect", which is when consumers mirror other market participants in their behaviour; internalisation, which is when individuals accept to be influenced by others, expecting greater benefits to themselves; recognition, which is when individuals accept to be influenced by others, expecting to maintain good relationships with them; or submission, which is when individuals accept to be influenced by others, thus avoiding punishment or, possibly, being rewarded (Szymańska, 2012, pp. 68-71).

In the housing market, preferences may also be affected by technological factors, such as novel construction techniques or how new dwellings look. The observable market trends, which change the behaviour of buyers, may also play a particularly important role in shaping their preferences. When given the opportunity to watch things, to test and become familiar with them, consumers can explore new housing ideas with greater acceptance and confidence. Discussions about preferences are also concerned with revealed and stated preferences. These are addressed by A. Bąk (2004, pp. 42-43), T.M. Wanat (2010, pp. 52-53), M. Głuszak (2006, p. 178), among others. They can be analysed once historical data (reflecting past consumer behaviour) have been gathered. Next to them, there are the so-called stated preferences. These are concerned with consumers' stated (or declared) market choices, that is, when consumers indicate their intended choice.

Recent years have seen a very dramatic change in the housing market and its surrounding areas. Apartment prices are in a state of flux and new products are introduced to meet population needs. Scholars address the subject of preferences in a variety of contexts. Following the outbreak of the COVID-19 pandemic, there have been studies recently on the impact of the pandemic on changes in housing preferences. One example is a study by Tjiputra and Sutrisno showing that the key preferences during the pandemic for households with young couples and small children were the type and design of house, security, and distance to shopping districts (Tjiputra, Sutrisno, 2022). Similar topics are addressed by Bottero, Bravi, Caprioli, Dell'Anna, Dell'Ovo and Oppio. They have examined the specific situation in Italy and concluded that the pandemic triggered changes in people showing the need for adaptation and changes to housing (Bottero, Bravi, Caprioli, Dell'Anna, Dell'Ovo i Oppio, 2021). Cuerdo-Vilches, Navas-Martín and Oteiza, who examined the Spanish market, have reached similar conclusions, pointing to the need for new housing solutions that would protect people in situations similar to the COVID-19 pandemic (Cuerdo-Vilches, Navas-Martín i Oteiza, 2019). Stankowska and Stankowska-Mazur, in turn, examined a number of economic factors and psychological

conditions relating to the third COVID-19 wave. In their study, they sought to establish the relationship between preferences for access to nature in one's place of residence before and during the third wave of the COVID-19 pandemic, and such variables as gender, age, background or how far one's residence was from natural or urban greens (Stankowska, Stankowska-Mazur, 2022). Nanda, Thanos, Valtonen, Xu and Zandieh, too, have joined the discussion on the impact of the pandemic on people's preferences, indicating the areas to be taken into account in any conclusions on the subject, such as the built area environment (development density, transport network, green spaces), key amenities for people's daily lives (educational, retail, recreational), socio-economic factors (household type, household income), or access to work (Nanda, Thanos, Valtonen, Xu, Zandieh, 2021). The pandemic and preferences were also addressed in a study by Bartkowiak and Strączkowski. While noting a difficult situation in the housing market during the pandemic, the authors are of the opinion that the pandemic have not changed the housing preferences significantly, albeit it revealed pre-existing problems to some occupants (Bartkowiak, Strączkowski, 2021).

It is not just the pandemic that can be examined in terms of choices or possible differences in preferences. Other such factors include: human life cycle and lifestyle (Palicki, 2020; Beamish, Carucci Goss, Emmel, 2015; Gawron 2012; McAuley, Nutty, 1982), income, work and potential buyers' education background (Hartono, Irawan, Khoirunurrofik, Partama, Mujahid, Setiadestriati, 2021; Opoku, Abdul-Muhmin, 2010), or modern technologies (van Rijnsoever, Farla, 2014; Górska, Mazurczak, Strączkowski, 2021).

Studies on changes in preferences over time are relatively harder to come by. The likely reason is that any conclusions here would require systematic years-long research. That said, it seems that some conclusions might be drawn based on research from the U.S.-based National Association of Realtors (NAR) or the National Association of Home Builders (NAHB). Each year, the NRA tries to issue a report addressing a number of subjects, including buyers and their profiles, buying choices, housing search process, financing, or sales experience. The NAR carries out its research via (paper-form and web-based) surveys including approximately 130 questions and addressed to random samples of house buyers. The results are presented for the USA as a whole and separately for its north-east, central-west, south and west areas (NAR, 2018, p. 142). Importantly, the NAR focuses its research on actual customer choices – as such, therefore, these are their revealed preferences. In turn, the NAHB website offers a selection of interesting studies on customer behaviour in the U.S. market. Notably, the results of NAHB's 2003-2018 research point to a change in buying preferences (for homes and their furnishing) over the 15 years covered (Brady, 2018).

Regarding preference research in Poland, a dozen or so individual studies have been conducted. Their summary can be found in Strączkowski's paper (2021, pp. 71-82). However, they were all one-off efforts, differing in terms of subject-matter and research timeframes. Most importantly, though, they all had mainly local housing markets as their focus, which relates to how the property market operates. Now, referring to changes in preferences over time,

one can quote Kulesza and her view that “housing preferences change very slowly, seeing as they are overwhelmingly influenced by the force of inertia, habit and custom” (Kulesza, 1996, p. 51).

Investigating changes in preferences in the local housing market. Methodological assumptions

Our research into changes in preferences in the local housing market had the following objectives:

- C1: To identify preferences in the local Poznań market as they were in 2019;
- C2: To present changes in preferences regarding the size of dwellings (area and number of rooms);
- C3: To identify the price barrier inhibiting changes in preferences relating to housing size.

To achieve this, a decision was made to collect data from various sources. These included research findings from studies done by Poznań University of Economics and Business, Department of Investment and Real Estate, and information published by Statistics Poland and the National Bank of Poland. The methodological assumptions behind this work are presented in Table 1.

Table 1.

Study of changes in preferences in the local housing market: basic information

Item	Description
Research timeframe and data sources	<ul style="list-style-type: none"> • Stated preference studies for 2011, 2012, 2018, 2019 • Housing transactions in the primary market, data from the National Bank of Poland for 2015-2021 • Housing transactions on the market generally, data from Statistics Poland for 2010-2021 • Dwelling unit completions by developers, data from Statistics Poland for 2010-2021
Spatial scope	<p>Local rental market for residential properties in Poznań. This is a local housing market. Each such market is different, as demonstrated by numerous domestic and foreign studies in this field (m.in.: Schmitz and Brett, 2001, pp. 3-18; Stefaniak, 1997, p. 33; Kucharska-Stasiak, 2016, p. 59; Belniak, Wierzchowski, 2001, p. 42, Górska, Mazurczak, Strączkowski, 2021, pp. 38-43).</p> <p>The changes that took place in the local housing market during the period under review are described in, among other places: (Matusiak, Palicki, Strączkowski, 2017), (Gawron, Strączkowski, 2018), (Strączkowski, Koszel, 2021), (Strączkowski, Bartkowiak, 2022).</p>
Material scope	<ul style="list-style-type: none"> • Buyers' preferences in the local housing market • Changes in buyers' preferences regarding housing size (area and number of rooms) • Average sizes of dwellings sold in the primary market • Average sizes of dwellings sold in the market generally (primary and secondary markets together) • Average sizes of dwellings completed by property developers • Average numbers of rooms in dwellings completed by property developers • Housing affordability for dwellings in primary and secondary markets

Source: Own compilation.

Housing buyers' preferences: Poznań, 2019

The most recent study of preferences covering the local housing market in Poznań is from 2019. Information was then gathered from a non-random purposive sample of potential housing buyers in a direct questionnaire-based survey. The respondents were visitors to housing fairs (mostly showcasing properties offered by developers) who made clear their buying intention and were actively searching for housing. Research material was obtained from $n = 276$ respondents who stated their preferences regarding the dwelling, building and location parameters.

The respondents (potential homebuyers) might be broadly characterised as follows:

- Most were young people: the under-30s made up more than half of those surveyed (53%), followed up by 32% of those in the next age bracket, 31 to 40, and 15% of older respondents.
- Women were more likely to respond: 60% of respondents were women and 40% – men (women were more willing to complete the questionnaires).
- Most respondents had families: those with families made up 78% of total respondents.
- Most were childless: 20% of respondents said they had one child, 16% – two children, and 4% – three or more children.

Table 2.

Preferred options for dwellings, buildings and surroundings

Preferred option	As %
Balcony/terrace	95
Housing estate with retail facilities	74
Lift in the building	73
Playgrounds and leisure facilities on the estate	71
Low-rise building – no more than 4 storeys	63
Estate cheaper but away from the city centre	58
Space for prams and/or bicycles	45
Bathroom with a toilet	44
Walled community	44
Small common areas to be kept	37

Note: The table only includes those preference items for which there were more responses stating that respondents found any given item to be important than those in which respondents found it to be unimportant or were indifferent about it. Accordingly, the percentages in the table are for responses in which the respondents indicated that the element was important to them. For a broader discussion of these results, see: Strączkowski, 2021, pp. 164-167.

Source: own compilation.

If we consider the respondents' main preferences regarding dwellings, buildings and surroundings, these would be: having a balcony (95% of respondents), living on a housing estate with retail and service facilities (74%), and having a building with a lift (73%). Pricing preferences for housing are notable too: 58% of the respondents said they would choose unit on a housing estate that was cheaper but located further away from the city centre (Table 2). The price can therefore be assumed to be a key factor in their choice.

Completing the picture of housing preferences are the respondents' answers regarding dwelling sizes and the number of rooms. A summary of their responses is shown in Figure 1a and 1b.

As shown, regarding dwelling sizes, the preferred option with most respondents was for units with an area between 36 and 50 sqm (45% of all respondents). The second largest group of respondents showed preference for units with an area between 51 and 65 sqm (29%). This is somewhat reflected in the number of rooms, with 25% of all respondents choosing two-room dwellings, 40% – three-room ones, and 30% – four-room or larger units. Of course, the differences between percentage figures for dwelling sizes and room numbers vary, reflecting different architectural concepts. For instance, market listings for 50 sqm dwellings can be for either two- or three-room units.

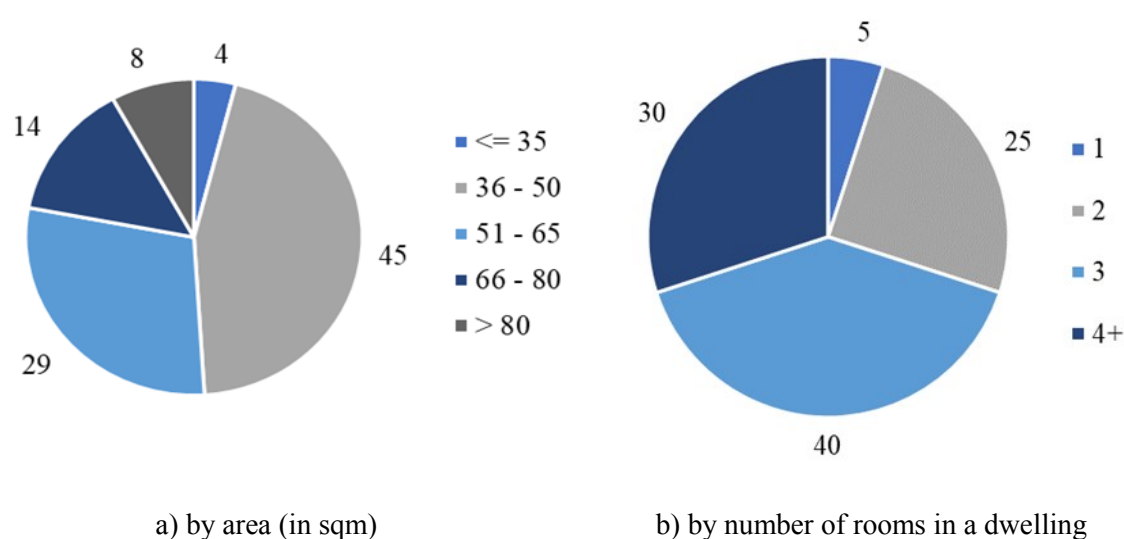


Figure 1. Preferred dwelling size, Poznań housing market, 2019.

Source: own compilation.

This begs the question of what main conclusion should be drawn from these findings. Here is what is notable:

- 1) More than half of the respondents showed interest in cheaper housing outside the city centre. One can assume, therefore, that prices are an important guiding factor in their decisions and that they are willing to accept less attractive housing locations for a lower price.
- 2) In terms of size, the preference structure shows that nearly $\frac{3}{4}$ of the respondents are interested in units between 36 and 65 sqm in size. That is reflected in the average preferred area, which was 56.5 sqm.
- 3) In terms of rooms, looking at Figure 1b and bearing in mind the qualitative nature of this parameter, one can assume that, on average, three-room units are among the most sought-after dwellings.

An inference one could venture at this point, therefore, is that the preferred dwellings are not large at all. Another question worth exploring is whether there have been any changes in dwelling size preferences over, say, a ten-year period. An attempt to answer this question is presented later in the paper.

Housing size preferences in Poznań: a dynamic approach

The first source that could help in answering the question of whether there was any variability in preferences over time is the research into stated preferences which the Poznań University of Economics and Business, Department of Investment and Real Estate, carried out in 2011-2019. Due to organisational and time constraints these studies were not conducted every year but only in 2011, 2012, 2018, and 2019. Their detailed description, including the results, can be found in Ł. Strączkowskiego (2021).

The following metrics were adopted to identify changes in preferences:

- 1) the *mean preferred housing size* among potential buyers. This size was determined based on all responses from the respondents regarding the size of dwelling they were looking for;
- 2) the *average preferred number of rooms*. Bearing in mind the qualitative character of this parameter, statistical studies with information on the average number of rooms per dwelling were considered.

In general terms, the research conducted in 2011-2019 has found that:

- 1) In 2011, the preferred dwelling area was 57.0 sqm on average. In 2012, it was 56.1 sqm, in 2018 – 54.8 sqm, and in 2019 – 56.5 sqm. This means that, in terms of preferred housing area, there has been little change, arguably from 55 to 57 sqm. By and large, therefore, one could generalise that the decade in question saw no change in preferences.
- 2) In 2011, the preferred number of rooms was 2.5 on average. In 2012, it was 2.6, in 2018 – 3.3; and in 2019 – 3.1. This means that the changes in this metric were also small, with a growth here at half a room, so to speak. Generally, three-room dwellings were the preferred option.

Accordingly, the stated preference studies do not corroborate any changes in preferred housing sizes.

Information collected and published by the National Bank of Poland provides the other source of data for determining whether the Poznań market has seen any changes in dwelling size preferences. Here, the underlying data-handling operations and assumptions were as follows:

- 1) Data obtained from the National Bank of Poland were available as quarterly datasets for 2015-2021. For this study, they have been aggregated and presented on an annual basis. There were no data for earlier periods on the NBP's website that would match the periods for which the stated preference studies were carried out.
- 2) The average dwelling size was estimated by reference to data on primary market housing sales. It was assumed that this metric will be comparable to the one obtained from the stated preference study and that an attempt could be made on its basis to illustrate market changes (if any).
- 3) The published NBP data do not include information on sales by number of rooms. Therefore, this parameter was omitted from the analysis.
- 4) Housing sales on the primary market in Poznań are shown in Figure 2. In each year under examination the biggest sales were in the 40-60 sqm housing segment. The last two years in that period saw the sales figures for that segment decreasing, with the 60-80 sqm housing segment slightly gaining in significance.

As shown, then, in terms of size, the following dwellings were purchased on average: in 2015 – 50.1 sqm; in 2016 – 49.7 sqm; in 2017 – 50.0 sqm; in 2018 – 51.0 sqm; in 2019 – 50.0 sqm; in 2020 – 50.8 sqm; and in 2021 – 52.7 sqm. This means that, in terms of size, there has been little change in purchased dwellings, from 50 to 53 sqm. By and large, therefore, one could generalise that the seven years in question saw no change in that metric. Obviously, while there are slight differences here compared to data from stated preference studies, it must be remembered that what buyers declare may differ from they ultimately decide (due to financial constraints, how attractive properties they are offered are, etc.).

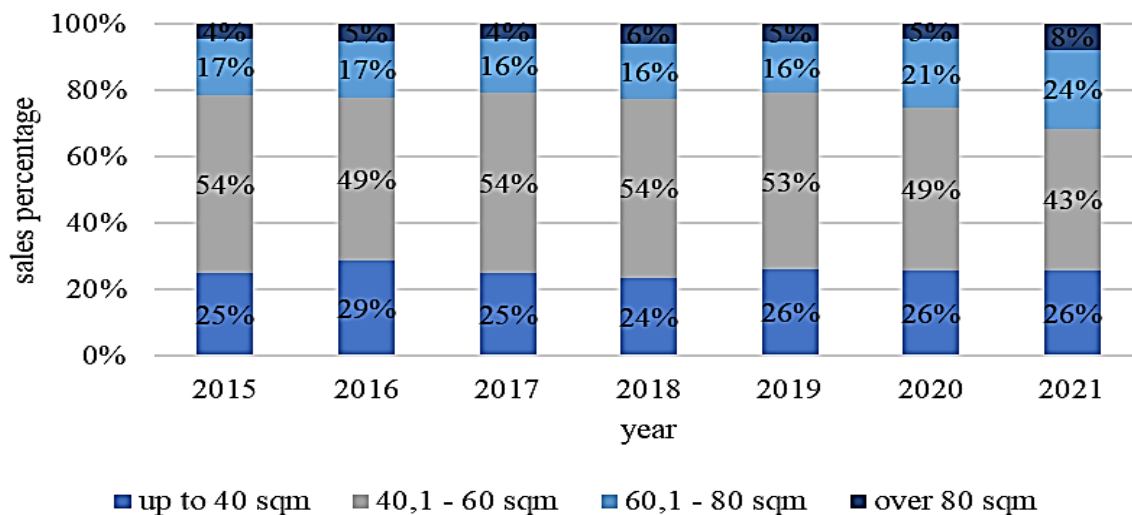


Figure 2. Housing sales on the primary market in Poznań, 2015-2021.

Source: own compilation based on data from the National Bank of Poland.

A third source to rely on in verifying if there have been any changes is provided by data from Statistics Poland on total housing sales in Poznań (primary and secondary markets together). Here, the underlying data-handling operations and assumptions were as follows:

- 1) The data from Statistics Poland are available as annual datasets for 2010-2021 and record housing transactions in the Poznań market. Those data can be compared with those from the National Bank of Poland and stated preference studies.
- 2) The average size of purchased housing was estimated by reference to data on market sales. It was assumed that this metric will be comparable to the one obtained from the stated preference studies and that an attempt could be made on its basis to illustrate market changes (if any).
- 3) As with data from the National Bank of Poland, the number-of-rooms parameter was omitted from the analysis.
- 4) Housing sales on the Poznań market are shown in Figure 3. As before, the biggest sales in each year under examination were in the 40-60 sqm housing segment. The last two years in that period saw diminishing sales figures for the largest and smallest dwellings, with the 60-80 sqm housing segment slightly gaining in significance.

As shown, then, in terms of size, the following dwellings were purchased on average: in 2010 – 53.0 sqm; in 2011 – 52.9 sqm; in 2012 – 52.4 sqm; in 2013 – 52.0 sqm; in 2014 – 51.7 sqm; in 2015 – 51.0 sqm; in 2016 – 51,5 sqm; in 2017 – 51,6 sqm; in 2018 – 52,0 sqm; in 2019 – 51,1 sqm; in 2020 – 51,7 sqm; and in 2021 – 52,1 sqm. This means that, in terms of size, there has been little change in purchased dwellings, from 51 to 53 sqm. By and large, therefore, one could generalise that the decade in question saw no change in that metric. Also, there are slight differences between these figures and data from stated preference studies.

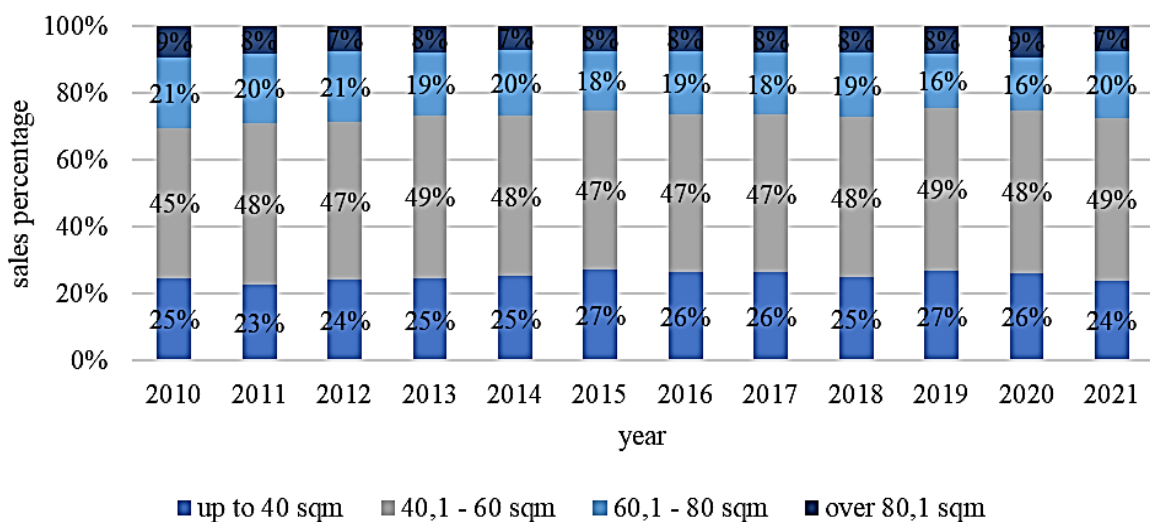


Figure 3. Sales of flats in Poznań in 2010-2021.

Source: own compilation based on data from Statistics Poland.

A fourth data source to corroborate any local-market changes in preferences is found on the supply side. These are the Statistics Poland data on sizes of completed dwellings from property developers. The underlying reason why these data are analysed is the belief that developers are rational in what they do: if they want to operate in the market, they should plan and construct the kind of housing that sells best in that market. Accordingly:

- 1) Data was obtained on the number of dwellings completed by developers in Poznań, included their sizes and the number of enclosed spaces (*izby*) within a dwelling. While enclosed spaces are not the same as rooms (*pokoje*), the metric was considered suitable to illustrate certain trends.
- 2) Based on those data, the average size of constructed dwellings was estimated. It was assumed that this metric will be comparable to the one obtained from stated preference studies and to those derived from the NBP and Statistics Poland data. Based on this metric, an attempt could be made on its basis to illustrate market changes (if any).
- 3) Since no data could be obtained to illustrate the structure of completed dwellings with, the final results are shown in Table 3.

Table 3.*Preferred options for dwellings, buildings and surroundings*

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dwelling units from property developers as a share of total dwelling completions (as %)	84	84	81	79	91	88	87	91	88	83	91	88
Average number of enclosed spaces in a dwelling unit from a property developer	2,8	2,8	2,7	2,5	2,7	2,5	2,7	2,6	2,7	2,8	2,5	2,7
Average area of a dwelling unit from a property developer (in sqm)	57,4	57,7	56,9	56,5	54,8	53,7	54,1	53,3	55,1	54,3	54,9	56,0

Source: own compilation based on data from Statistics Poland.

In terms of size, completed dwelling units from property developers averaged between 53 and 57 sqm over 2010-2021. This means that there has been little change on average in how large the purchased dwellings are. In fact, as a generalisation, the decade under consideration saw no change in that metric. Also, there are slight differences here compared to data from stated preference studies. The same is true regarding the average number of enclosed spaces in dwelling units from property developers, which ranged between 2.5 and 2.8.

Based on the results of calculations for 2010-2021, there has been no change in preferences, as is clear from both stated preference studies and the published data from the National Bank of Poland and Statistics Poland (Table 4).

Table 4.*Dwelling units in Poznań: average, minimum and maximum sizes, 2010-2021*

Item	Minimum	Maximum	Average	Difference between minimum and maximum
Preferred dwelling size in sqm (as declared, based on Department of Investment and Real Estate research)	54.8	57.0	56.1	2.2
Average dwelling size for housing purchased in Poznań primary market, in sqm (NBP data)	49.7	52.7	50.6	3.0
Average dwelling size for housing purchased in Poznań market generally, in sqm (Statistics Poland data)	51.0	53.0	51.9	1.9
Average dwelling size for units from property developers, in sqm (Statistics Poland data)	53.3	57.7	55.4	4.4
Preferred number of rooms in a dwelling (as declared, based on Department of Investment and Real Estate research)	2.5	3.3	2.9	0.7
Average number of enclosed spaces in dwelling units from property developers (Statistics Poland data)	2.5	2.8	2.7	0.4

Source: own compilation based on data from Statistics Poland and the National Bank of Poland and own research findings from Poznań University of Economics and Business, Department of Investment and Real Estate.

Regarding dwelling sizes, all four data sources indicate that, in square metre terms, there was little difference in the years under consideration, between 2 and 4 sqm. No particular upward or downward trends have been observed in this respect. The same is true of the number of enclosed spaces in a dwelling: the difference here is small as well. On that basis, it would be warranted to claim that units with an area of 50-57 sqm continue to attract the greatest interest. Regarding the number of rooms, units with two or three rooms continue to enjoy the greatest popularity, as has always been the case. One other conclusion is about stated preference studies: based on the comparison of results, it can be said that they provide a pretty accurate picture of what is happening in the market.

Another question that is worth asking, however, is about limitations on changes in housing size preferences. It would seem natural to want to expand one's living space, which in this context means having a bigger dwelling in square metre terms. As it is, however, basically nothing has changed in this regard in a decade. In searching for answers, it is only natural to look at housing prices and how much people in the local market earn. On that basis, one can determine the so-called "housing affordability indices". These can then be used to find out how expensive the housing on the market is in relative terms. The relevant data here are summarised in Table 5.

Table 5.*Housing availability, primary and secondary Poznań markets, 2010-2021*

Year	Average gross pay in the enterprise sector, (in PLN)	Transaction price per sqm, primary market (in PLN)	Housing availability, primary market* (score)	Transaction price per sqm, secondary market (in PLN)	Housing availability, secondary market* (score)
2010	3485,96	6 591	5,47	5 246	4,35
2011	4031,58	6 219	4,46	5 254	3,77
2012	4148,48	5 339	3,72	5 067	3,53
2013	4274,17	5 868	3,97	5 062	3,43
2014	4422,26	6 225	4,07	5 010	3,28
2015	4524,74	6 234	3,99	5 060	3,24
2016	4729,60	6 304	3,86	5 282	3,23
2017	5054,27	6 382	3,65	5 550	3,18
2018	5405,94	7 017	3,76	6 114	3,27
2019	5742,55	7 396	3,73	6 664	3,36
2020	5998,09	7 636	3,68	7 205	3,48
2021	6468,86	8 597	3,85	7 675	3,43

* This indicator is shown for a 50 sqm dwelling as a typical unit in development projects and for a two-person household's average annual net income (actual income received). This is the so-called P/I ratio which factors in housing prices and household's annual income. The score of up to 3 points reflects housing affordability for households; the score of 3.1-4.0 reflects moderate unaffordability; the score of 4.1-5.0 reflects unaffordability; and the score of more than 5 points means high unaffordability (for more on the ratio, see Mazurczak, Strączkowski, 2014, p. 107).

Source: own compilation based on data from Statistics Poland and the National Bank of Poland.

As can be seen, housing was relatively expensive in each year (2010-2021), both in the primary and secondary markets. The housing affordability indices for the primary market reveal a permanent moderate unavailability; in some periods this unavailability was exacerbated (2010, 2011, 2014). The situation looked a little better in the secondary market, even though better in this case only means that the indices were *relatively* better for buyers than in the primary market, but still revealed moderate housing unavailability. It would seem that the price factor is the primary barrier inhibiting housing size preferences. Even where buyers would want to buy a larger dwelling, property acquisition costs and constraints relating to interest rates and availability of home loans stand in their way. This, in turn, might mean that any changes in preferences would be with regard to interior design and colours, but not the "hard" parameters for housing, such as its size or how many rooms it has.

Summary

Based on this information, it can be said that customer preferences have not changed significantly over a dozen or so years. It seems that this is too short a timeframe for any far-reaching changes to take place. Generally, there has been no change in basic dwelling parameters. Units which continue to enjoy the greatest popularity are two- and three-room flats

in low-rise buildings, with an area of 36-50 and 51-65 sqm. There have been some changes regarding dwelling arrangements (such as the need for a balcony or terrace or diminished importance of a separate kitchen), deriving from greater acceptance of certain solutions and new furnishing styles. These subdued changes in preferences are not caused by buyers having less cash, either. It would seem, therefore, that households need more time to accumulate relevant housing experience, learn that each dwelling is a capital asset or that dwellings can be sold and bought more frequently, and that they do not need to live in one place for decades. These issues should be used as the basis for further research.

References

1. Bartkowiak, P., Strączkowski, Ł. (2021). Pandemia covid-19 a lokalny rynek nieruchomości mieszkaniowych – przypadek miasta Poznania. In: A. Jaki, B. Ziębicki, *Wyzwania współczesnych organizacji i gospodarek*. Warszawa: Instytut Nauk Ekonomicznych PAN.
2. Bąk, A. (2004). *Metody pomiaru preferencji w badaniach marketingowych*. Wrocław: Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu.
3. Beamish, J., O., Carucci Goss, R., Emmel, J. (2015). Lifestyle Influences on Housing Preferences. *Housing and Society*, Vol. 28 No. 1-2, pp. 1-28, DOI: 10.1080/08882746.2001.11430459.
4. Belniak, S., Wierzchowski, M. (2001). *System finansowania inwestycji mieszkaniowych w Polsce*. Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie.
5. *Biuletyn statystyczny Poznania. 4 kwartał 2021 r.* (2022). Poznań: Urząd Statystyczny w Poznaniu, Wielkopolski Ośrodek Badań Regionalnych.
6. *Biuletyn Statystyczny Poznania. I kwartał 2012 r.* (2012). Rok XXI, Nr 1. Poznań: Urząd Statystyczny w Poznaniu.
7. *Biuletyn Statystyczny Poznania. IV kwartał 2012 r.* (2013). Rok XXI, Nr 4. Poznań: Urząd Statystyczny w Poznaniu.
8. Bottero, M., Bravi, M., Caprioli, C., Dell'Anna, F., Dell'Ovo, M., Oppio, A. (2021). *New Housing Preferences in the COVID-19 Era: A Best-to-Worst Scaling Experiment*. 21st International Conference, September 13-16, 2021, Party 6, LNCS 12954. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-86979-3_9.
9. Brady, J. (2018). *Trends in home buyer preferences*. Washington: National Association of Home Builders (NAHB) Economics and Housing Policy Group. 6.09.2020, <https://www.nahb.org/-/media/9B6E74B4D03D48A79BA69E341ED4BC54.ashx>.
10. Bryx, M. (2021). *Mieszkanie dostępne w zrównoważonym mieście*. Warszawa: CeDeWu.

11. Cuerdo-Vilches, T., Navas-Martín, M.Á., Oteiza, I. (2019). A Mixed Approach on Resilience of Spanish Dwellings and Households during COVID-19 Lockdown. *Sustainability*, 12, 10198.
12. Gawron, H. (2012). Ewolucja funkcji mieszkania i preferencji klientów na rynku mieszkaniowym. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Poznaniu*, Nr 231, pp. 7-20.
13. Gawron, H. (2012). *Potrzeby mieszkaniowe klientów na lokalnym rynku nieruchomości mieszkaniowych i sposoby ich zaspokajania (na przykładzie Poznania)*. Poznań: Katedra Inwestycji i Nieruchomości, Uniwersytet Ekonomiczny w Poznaniu.
14. Gawron, H., Strączkowski, Ł. (2018). *Stan i perspektywy rozwoju budownictwa i rynku mieszkaniowego w aglomeracji poznańskiej*. Poznań: Katedra Inwestycji i Nieruchomości, Uniwersytet Ekonomiczny w Poznaniu.
15. Głuszak, M. (2006). Preferencje nabywców mieszkań i ich uwarunkowania na przykładzie Krakowa. *Zeszyty Naukowe Akademii Ekonomicznej w Krakowie*, 703, pp. 29-44.
16. Górska, A., Mazurczak, A., Strączkowski, Ł. (2021). *Lokalny rynek najmu mieszkań*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu. DOI: <https://doi.org/10.18559/978-83-8211-101-9>.
17. Hartono, D., Irawan, T., Khoirunurrofik, K., Partama, R., Mujahid, N.W., Setiadestriati, D. (2021). Determinant factors of urban housing preferences among low-income people in Greater Jakarta. *International Journal of Housing Markets and Analysis*. DOI: <https://doi.org/10.1108/IJHMA-05-2021-0056>.
18. Kucharska-Stasiak, E. (2016). *Ekonomiczny wymiar nieruchomości*. Warszawa: PWN.
19. Kulesza, H. (1996). *Prognoza mieszkaniowa do 2010 r. Uwarunkowania społeczne i ekonomiczne. Synteza*. Warszawa: Instytut Gospodarki Mieszkaniowej
20. Łaszek, J. et al. (2016). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2015 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_12_2015.pdf.
21. Łaszek, J. et al. (2017). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2016 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_4q_2016.pdf.
22. Łaszek, J. et al. (2018). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2017 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_12_2017.pdf.
23. Łaszek, J. et al. (2019). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2018 r.* Warszawa: Narodowy

- Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_12_2018.pdf.
24. Łaszek, J. et al. (2020). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2019 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_12_2019.pdf.
25. Łaszek, J., et al. (2021). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w IV kwartale 2020 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_12_2020.pdf.
26. Łaszek, J. et al. (2022). *Informacja o cenach mieszkań i sytuacji na rynku nieruchomości mieszkaniowych i komercyjnych w Polsce w I kwartale 2022 r.* Warszawa: Narodowy Bank Polski, Departament Stabilności Finansowej. 5.11.2022, https://www.nbp.pl/publikacje/rynek_nieruchomosci/ceny_mieszkan_03_2022.pdf.
27. Matusiak, M., Palicki, S., Strączkowski, Ł. (2017). Stan i kierunki rozwoju mieszkalnictwa w Metropolii Poznań. *Biblioteka Aglomeracji Poznańskiej, Nr 29*. Poznań: Bogucki Wydawnictwo Naukowe.
28. Mazurczak, A., Strączkowski, Ł. (2014). Analiza rynku a decyzje deweloperów w świetle badań lokalnego rynku mieszkaniowego w Poznaniu. In: K. Szczepaniak, A. Wojewnik-Filipkowska, *Inwestycje i nieruchomości w warunkach zrównoważonego rozwoju. Wybrane problemy*. Sopot: Wydział Zarządzania Uniwersytetu Gdańskiego.
29. McAuley, W.J., Nutty, C.L. (1982). Residential Preferences and Moving Behavior: A Family Life-Cycle Analysis. *Journal of Marriage and Family, Vol. 44, No. 2*, pp. 301-309. DOI: <https://doi.org/10.2307/351540>.
30. Nanda, A., Thanos, S., Valtonen, E., Xu, Y., Zandieh, R. (2021). Forced homeward: the COVID-19 implications for housing. *Town Planning Review, 92(1)*, pp. 25-31. DOI: <https://doi.org/10.3828/tpr.2020.79>.
31. NAR (2018). *Profile of home buyers and sellers*. National Association of REALTORS® Research Department. www.nar.com, Washington.
32. Opoku, R.A., Abdul-Muhmin, A.G. (2010). Housing preferences and attribute importance among low-income consumers in Saudi Arabia. *Habitat International, 34*, pp. 219-227. DOI: [doi:10.1016/j.habitatint.2009.09.006](https://doi.org/10.1016/j.habitatint.2009.09.006).
33. Palicki, S. (2020). Housing preferences in various stages of human life cycle. *Real Estate Management and Valuation, 28(1)*, pp. 91-99. DOI: <https://doi.org/10.2478/remav-2020-0008>.
34. *Poznań – biuletyn statystyczny. IV kwartał 2018 r.* (2019). Poznań: Urząd Statystyczny w Poznaniu, Wielkopolski Ośrodek Badań Regionalnych.
35. *Poznań. Biuletyn Statystyczny. IV kwartał 2015 r.* (2016). Rok XXIV, Nr 4. Poznań: Urząd Statystyczny w Poznaniu.

36. Schmitz, A., Brett, D.L. (2001). *Real estate market analysis. A case study approach*. Washington: Urban Land Institute.
37. Stankowska, A., Stankowska-Mazur, I. (2022). The Third Wave of COVID-19 versus the Residential Preferences in Poland: An Assessment of Economic Factors and Psychological Determinants. *Sustainability*, 14, 1339. DOI: <https://doi.org/10.3390/su14031339>.
38. Stefaniak, N. (1997). *Real estate marketing. Developing a professional career*. Wisconsin: Walker-Pearse, Ltd. Publishers.
39. Strączkowski, Ł. (2021). *Preferencje nabywców mieszkań na lokalnym rynku nieruchomości*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
40. Strączkowski, Ł., Bartkowiak, P. (2022). Poznań primary housing market: changes and sustainable development. *Scientific Papers of Silesian University of Technology – Organization and Management Series – Issue No. 156*, pp. 471-483. DOI: <http://dx.doi.org/10.29119/1641-3466.2022.156.32>.
41. Strączkowski, Ł., Górską, A., Mazurczak, A. (2021). Young Customers' Expectations in Terms of Implementing PropTech (Property Technology) on the Local Primary Residential Market in Poland. *Research Papers in Economics and Finance*, 5(1), pp. 61-77. DOI: <https://doi.org/10.18559/ref.2021.1.5>.
42. Strączkowski, Ł., Koszel, M. (2021). Rynek mieszkaniowy i polityka mieszkaniowa w dużym polskim mieście – studium przypadku Poznania. *Studia BAS, Nr 2(66)*, pp. 147-172. DOI: <https://doi.org/10.31268/StudiaBAS.2021.21>.
43. Szymańska, A.I. (2012). Preferencje konsumenckie i ich determinanty. *Zeszyty Naukowe Wyższej Szkoły Ekonomii i Informatyki w Krakowie, No. 8*, pp. 67-86.
44. Tjiputra, L.H., Sutrisno, T.FCW. (2022). Housing preferences of full nest 1 lifecycle stage customers in response to the pandemic. *Jurnal Ilmiah Bisnis dan Ekonomi Asia, Vol. 16, No. 1*, pp. 75-94. DOI: 10.32812/jibeka.v16i1.465.
45. Van Rijnsoever, F.J., Farla, J.C.M. (2014). Identifying and explaining public preferences for the attributes of energy technologies. *Renewable and Sustainable Energy Reviews, Vol. 31*, pp. 71-82. DOI: <https://doi.org/10.1016/j.rser.2013.11.048>.
46. Wanat, T.M. (2010). *Atrybuty produktu a konstruowanie preferencji przez nabywców*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.

COMPARISON OF THE FINANCIAL SITUATION OF LOCAL GOVERNMENT UNITS BEFORE AND DURING THE COVID PANDEMIC

Iwona BAŁ^{1*}, Dawid DAWIDOWICZ²

¹ West Pomeranian University of Technology in Szczecin, Faculty of Economics; iwona.bak@zut.edu.pl, ORCID: 0000-0001-8959-7269

² West Pomeranian University of Technology in Szczecin, Faculty of Economics; dawid.dawidowicz@zut.edu.pl, ORCID: 0000-0002-8218-8662

* Correspondence author

Purpose: The aim of this article was to determine the financial situation of various levels of local government units during the COVID-19 pandemic in comparison to selected periods from previous years.

Design/methodology/approach: To achieve the aim, the authors used one of the methods of multidimensional statistical analysis – the TOPSIS technique. The study included the most important indicators of the financial situation of local government units at all levels (voivodeships, poviats and communes). The authors used data from the Polish Ministry of Finance.

Findings: According to the study results, the lower the level of local government, the greater the share of current income in total income, current transfers per capita, operating surplus per capita and total liabilities per capita. However, a negative trend was observed as well: the share of investment expenditure in total expenditure decreased at all levels of local government units.

Research limitations/implications: An important limitation of the article was the inability to reach the managers of LGUs in order to learn their opinions on the functioning of these entities during the COVID-19 pandemic.

Practical implications: A proportional decrease of investment expenditure in the overall expenditure of local government units may lead to deteriorated financial situation of enterprises that were beneficiaries of these orders.

Social implications: A smaller proportion of investment expenditure in total expenditure means less investment for the local community (usually infrastructural) and, consequently, slower development of local government units.

Originality/value: The originality of the study is based on the fact that it was conducted comprehensively and covered all communes, poviats and voivodships in Poland in 2018-2020.

Keywords: LGUs, financial situation, COVID-19, TOPSIS technique.

Category of the paper: Research paper.

1. Introduction

Local government units (LGUs) are independent and autonomous entities that perform numerous tasks related to social and technical infrastructure, as well as order and security. The spread of the COVID-19 pandemic in 2020 and consequently the economic lockdown introduced by the government, which limited people's ability to move freely, affected the finances of both enterprises and LGUs. On the other hand, once the restrictions were lifted, some entrepreneurs were able to quickly make up for their losses. LGUs have taken many discretionary decisions to mitigate the negative effects of COVID-19. As a consequence of the pandemic, the profitable part of the finances of LGUs was disrupted.

Loss of liquidity and insolvency of LGUs may lead to their liquidation, which causes a number of negative consequences for both the local community and neighboring communes. Such a situation took place in the Ostrowice commune, which, after 70 years of existence, was liquidated on January 1, 2019, due to insolvency and relatively high debt. Meanwhile, the communes which 'absorbed' Ostrowice (i.e. the communes of Złocieniec and Drawsko), needed external support, mainly to implement investments. That bankruptcy of an LGU in Poland does not have to be the last one – and is certainly no exception in Central and Eastern Europe. The problem with insolvent communes also occurred in the Czech Republic and Slovakia, mainly due to implementation of high-capital investments (Hrůza, Novotná, 2017).

The aim of this study was to determine the financial situation of various levels of local government units during the COVID-19 pandemic in comparison to previous years. This is a research article that focuses on the identification of spatial connections within the financial situation of LGUs. The added value of this paper is the presentation of research results at individual levels of data aggregation (i.e. voivodships, poviats, communes). Usually, this type of research is limited to the assessment of the financial situation of a selected level of local government units, such as: only communes (Bieniasz et al., 2013), or a selected voivodship (Standar, 2017). Similarly, assessments of the financial situation or debt of LGUs usually focus on a specific voivodship (Dziekański, Leśna-Wierszołowicz, 2019) or a commune (Mrówczyńska-Kamińska et al., 2011), or selected communes, e.g. in the West Pomeranian Voivodeship (Zioło, 2011). The study included the most important indicators of the financial situation of local government units at all levels (voivodships, poviats and communes). The authors used data from the Ministry of Finance. To achieve the aim of the study, the authors used one of the taxonomic methods – the TOPSIS technique.

The originality of the study is based not only on the fact that it compares LGUs' financial situation during COVID-19 and pre-COVID, but it was also conducted comprehensively and covered all communes, poviats and voivodeships in Poland in 2018-2020. There are still relatively few studies that take into account the COVID-19 period; in some studies, the authors purposefully omit that period. Although the first studies that take into account the pandemic

period can already be found, they focus on LGUs in other countries, such as Bulgaria (Karatova, 2020), or are theoretical (Permanasari et al., 2022). An interesting study on the finances of LGUs in the first year of the COVID pandemic in Poland is the study by Malinowska-Miciąg (2022). The author points out that the situation of individual LGUs was very diverse, and the negative effects of the pandemic were visible mostly in urban communes and cities with poviatic rights. The author also stressed the fact that the total budget surplus in LGUs obtained in 2020 resulted primarily from a large decrease in capital expenditure and the government support for LGUs' investments.

Considering the above, it should be noted that the research presented in this article fits into the current debates on the impact of the COVID-19 pandemic on LGUs' situation.

2. The assessment of the financial situation and its importance for LGUs

Dziekański and Leśna-Wierszołowicz (2019) emphasized that the financial situation of communes (but it may be applied to all levels of LGUs) determines their effectiveness, as well as the ability to provide services and pay liabilities; it is also an element of competitiveness. The financial situation determines the development of LGUs, affects their independence and the ability to implement investments, and thus contributes to meeting the key needs of local communities. Additionally, knowing the financial situation makes it easier for LGUs to take strategic decisions, properly assess the state of public finances, and compare their financial situation with neighboring and similar units (Ślebocka, 2017).

Assessment of LGUs' financial situation is important not only in terms of ongoing control and prevention of LGU's liquidation, but also from the point of view of its further development. In the literature on the subject, one may find studies that prove that communes with a higher level of socio-economic development and better investment opportunities are more willing to incur investment expenditures (Tomal, Nalepka, 2018). Furthermore, the authors of the study claimed that the main determinant of the investment willingness of communes was their financial situation, which is important for their future development. The literature on the subject (especially in terms of financial situation assessments) is quite rich with studies on financial autonomy (Poniatowicz, 2015) and financial independence of LGUs (Mrówczyńska-Kamińska et al., 2011), which is closely related to their financial situation.

Zawora (2015) emphasized that the income and financial independence of rural communes is linked to the economic situation of the region and the country, i.e. external factors, which are independent of the direct activity of these units. In fact, the financial situation of LGUs may change from period to period; based on surveys carried out in 2016-2017 among 160 treasurers of selected communes, Wyszowska (2018) stated that communes were increasingly dependent on government subsidies, which limited their independence. In turn, Filipiak (2010) emphasized the importance of financial liquidity of LGUs in times of crisis. He pointed out that

it depends on the value of income and liabilities, and it affects the level of investment expenditure.

Studies by many authors have emphasized that the financial situation of LGUs is changing. In 2009-2010, there was a noticeable trend of increasing indebtedness of communes and the risk of losing liquidity by some LGUs (Parlińska, 2014). Communes with a higher level of development were more prone to investing. This correlation was particularly visible in technical infrastructure investments. The main determinant of the commune's willingness to investment was their financial situation (Tomal, Nalepka, 2018). It should be noted that the development of LGUs would not be possible without investment projects. However, as emphasized by Jurewicz (2016), the process of creating local development seems impossible without the use of repayable sources of financing. This generates debt and increases the risk of over-indebtedness, which may lead to the loss of liquidity of LGUs. Jastrzębska (2018) noted that the typical causes of LGUs debts are: lack of operating surplus, loss of creditworthiness and/or problems with maintaining financial liquidity.

The budget reflects the current economic situation of an LGU (Mrówczyńska-Kamińska after Miszczuk et al. (2011)). Therefore, financial situation assessments should be focused on the LGUs' budgets and their budget-related data.

The economic analysis of LGUs' financial situation (similarly to the economic analysis of enterprises) should be conducted through the prism of finance, mainly due to the fact that all income and expenses are expressed in monetary values (Bień, 2011). Various types of financial indicators are used to assess the financial situation. They usually focus on: income, expenses, creditworthiness, debt, financial liquidity, and level of investment expenses. As noted by Bal-Domańska (2018), one of the most important financial categories to be assessed in an analysis of the communal financial situation is income. It may be assessed as broken down into own revenues, subsidies and subventions, along with an assessment of the total income structure of the commune and its earning potential.

Assessment of the financial situation of an LGU is not an easy task. It may be further influenced by the choice of indicators. In the Czech Republic, the Ministry of Finance used an indicator called the Debt Service Indicator (DSI) to control the financial situation of LGUs; DSI values were calculated every year, and the indicator included EU subsidies. The credibility of the indicator was limited due to the fact that in the long term, in the absence of EU funds, the indicator values could quickly decrease (Čámská, 2013). Thus, the DSI helped in financial assessments only in the short term. It should also be emphasized that the assessment of the financial situation of LGUs based on the values of a single indicator is not optimal. By using many various indicators, the risk of erroneous assessment of the financial situation of LGUs as a result of indicator imperfections can be mitigated. As German researchers proved, the assessment of the financial situation (and more specifically: the cost effectiveness) may also be influenced by changes in the accounting of LGUs, e.g. introduction of accrual accounting method (Lampe et al., 2015).

3. Statistical material and research method

The study was based on the most important characteristics of the financial situation of LGUs at all levels (voivodships, poviats and communes) in 2018-2020. Apart from the Local Data Bank of the Polish Central Statistical Office (GUS), indicators for assessing the financial situation of LGUs developed by the Ministry of Finance were also used (Ministry of Finance, 2021); additionally, the authors used the share of investment expenditure in total expenditure. The study included 15 indicators (diagnostic features):

X_{1S} – share of current income in total income (%),

X_{2S} – share of own income in total income (%),

X_{3S} – share of operating surplus in total income (%),

X_{4S} – share of capital expenditure in total expenditure (%),

X_{5D} – the burden salaries and remuneration-derivatives on current expenditure (%),

X_{6S} – share of operating surplus and income from the sale of assets in total income (%),

X_{7S} – self-financing indicator,

X_{8S} – current transfers per capita (PLN/person),

X_{9S} – operating surplus per capita (PLN/person),

X_{10D} – total liabilities per capita (PLN/person),

X_{11D} – share of total liabilities in total income (%),

X_{12D} – burden of debt service on total income (%),

X_{13D} – burden of debt service on own income (%),

X_{14d} – share of due liabilities in total liabilities (%),

X_{15S} – share of investment expenditure in total expenditure (%).

The impact of each of these features on the analyzed phenomenon was also indicated by qualifying it to a set of features that stimulate development in a given area ('S' symbol) or destimulate it ('D' symbol). It should be noted that the majority of indicators are stimulants – they account for 60% of all indicators adopted for the study.

In order to classify the Polish LGUs according to their financial situation, one of the methods of multidimensional statistical analysis was used – the TOPSIS technique, which belongs to the multi-criteria decision-making methods (Yoon, Kim, 2017; Parida, Sahoo, 2013; Roszkowska, 2011; Zulqarnain et al., 2020; Ghose, 2021). It follows this order:

Step 1. The starting point is to define the matrix:

$$X = [x_{ij}] \quad (1)$$

where:

i – object number ($i = 1, 2, \dots, n$),

j – diagnostic feature number ($j = 1, 2, \dots, m$),

x_{ij} – value of the j^{th} diagnostic feature for the i^{th} object.

Step 2. In order to ensure the comparability of variables, the initial values of diagnostic features are normalized according to the formula:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}} \quad (2)$$

where:

z_{ij} – value of the j^{th} normalized diagnostic feature for the i^{th} object.

Step 3. The values of normalized diagnostic features are weighted in order to obtain the following matrix:

$$V = [v_{ij}] = [w_j z_{ij}] \quad (3)$$

for:

$$\sum_{j=1}^m w_j = 1 \quad (4)$$

where:

w_j – the weight of the j^{th} diagnostic feature.

Step 4. For each normalized weighted diagnostic feature from the matrix (3), two reference points are determined, which indicate the Positive Ideal Solution and Negative Ideal Solution coordinates – pattern and anti-pattern:

$$v_j^+ = \begin{cases} \max_i v_{ij} & \text{for stimulant} \\ \min_i v_{ij} & \text{for destimulant} \end{cases} \quad (5)$$

$$v_j^- = \begin{cases} \min_i v_{ij} & \text{for stimulant} \\ \max_i v_{ij} & \text{for destimulant} \end{cases} \quad (6)$$

where:

v_j^+ – j^{th} coordinate of the Positive Ideal Solution,

v_j^- – j^{th} coordinate of the Negative Ideal Solution.

Step 5. For all objects, their Euclidean distances from the pattern and anti-pattern are calculated:

$$d_i^+ = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^+)^2} \quad (7)$$

$$d_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^-)^2} \quad (8)$$

where:

d_i^+ – Euclidean distance of the i^{th} object from the Positive Ideal Solution,

d_i^- – Euclidean distance of the i^{th} object from the Negative Ideal Solution.

Step 6. The value of the aggregate variable denoting the relative proximity of the i^{th} object to the Positive Ideal Solution is determined as the quotient:

$$R_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (9)$$

where:

$$0 \leq R_i \leq 1.$$

The preferred object has the smallest distance from the pattern and simultaneously the greatest distance from the anti-pattern; in other words, it takes the highest value of the R_i coefficient.

Step 7. The linear ordering of the objects is made due to the non-increasing value of the aggregate variable (9).

Step 8. Division of objects into groups characterized by a similar financial situation:

$$\text{Group I: } \bar{R} + S(R) \leq R_i \leq 1 \quad (10)$$

$$\text{Group II: } \bar{R} \leq R_i < \bar{R} + S(R) \quad (11)$$

$$\text{Group III: } \bar{R} - S(R) \leq R_i < \bar{R} \quad (12)$$

$$\text{Group IV: } 0 \leq R_i < \bar{R} - S(R) \quad (13)$$

4. Research results

Tables 1-3 show selected descriptive parameters (\bar{x} – arithmetic mean, Vs (%) – coefficient of variation, As – asymmetry coefficient) which characterize the average degree of differentiation and asymmetry of the distribution of indicators at various levels of aggregation of LGUs in 2018-2020.

Table 1.

Selected descriptive parameters for indicators at various aggregation levels in 2018

Feature	Voivodeships			Poviats			Communes		
	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As
X ₁	78.04	13.65	-0.35	88.46	8.17	-1.22	92.13	6.85	-1.74
X ₂	44.96	41.60	0.74	34.50	27.06	0.83	37.43	34.49	0.58
X ₃	15.71	32.26	1.55	6.95	109.65	-11.45	8.56	52.33	1.19
X ₄	37.53	25.17	0.88	20.23	46.52	0.78	19.66	46.83	0.64
X ₅	28.68	14.86	-0.57	61.26	10.93	-1.37	38.74	10.53	-0.52
X ₆	16.24	33.03	1.44	7.73	99.47	-11.36	9.58	49.70	1.56
X ₇	102.35	19.02	0.74	94.95	70.91	-5.86	94.47	112.77	25.43
X ₈	154.95	39.08	-0.29	638.07	28.98	0.46	2663.93	21.98	0.19
X ₉	70.83	40.82	2.68	76.05	107.74	-12.01	422.08	91.41	16.44
X ₁₀	156.22	40.87	1.70	267.70	67.95	1.78	1129.98	70.88	2.23
X ₁₁	36.00	46.68	1.54	23.43	64.68	2.12	23.45	62.61	0.72
X ₁₂	6.04	46.66	0.38	3.35	102.44	8.31	3.91	71.22	2.73
X ₁₃	14.45	54.30	2.38	10.28	106.32	8.94	11.78	84.85	3.16
X ₁₄	0.07	319.99	3.72	0.59	1176.82	12.85	0.43	1124.52	18.86
X ₁₅	20.38	13.56	1.66	19.80	24.28	0.37	19.45	47.20	0.65

Source: authors' own calculations.

Table 2.

Selected descriptive parameters for indicators at various aggregation levels in 2019

Feature	Voivodeships			Poviats			Communes		
	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As
X ₁	77.72	13.42	-0.89	88.30	8.40	-1.26	91.62	6.65	-1.44
X ₂	44.72	42.80	0.53	38.86	24.16	0.74	37.91	31.76	0.56
X ₃	17.78	25.14	0.21	8.71	46.37	0.99	8.21	52.01	1.03
X ₄	38.91	24.85	1.07	17.36	49.56	0.75	16.00	51.90	0.73
X ₅	28.36	13.83	-0.93	62.31	10.10	-1.08	37.89	10.54	-0.58
X ₆	18.14	25.24	0.07	9.06	44.45	1.02	9.08	48.51	1.36
X ₇	106.44	14.29	0.55	142.21	67.83	5.97	130.09	92.91	9.55
X ₈	173.31	42.76	-0.29	692.88	29.15	0.32	2952.62	19.60	0.21
X ₉	88.31	29.44	1.64	105.32	43.12	0.55	449.84	94.56	19.83
X ₁₀	163.28	40.82	1.27	273.28	70.24	1.84	1201.67	71.02	1.72
X ₁₁	33.40	42.84	0.93	21.83	67.39	2.08	22.53	64.31	0.79
X ₁₂	5.52	49.03	0.84	3.96	140.79	5.98	4.26	91.21	5.46
X ₁₃	14.43	75.91	2.59	10.88	149.74	5.95	12.49	100.06	4.54
X ₁₄	0.02	280.87	3.03	0.71	1124.62	12.26	0.58	1142.40	14.23
X ₁₅	18.23	14.28	1.84	15.97	27.98	0.94	15.80	52.76	0.75

Source: authors' own calculations.

Table 3.*Selected descriptive parameters for indicators at various aggregation levels in 2020*

Feature	Voivodeships			Poviats			Communes		
	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As
X ₁	78.69	9.76	-0.08	86.19	9.46	-0.80	89.40	7.28	-1.28
X ₂	44.16	35.13	1.09	39.18	23.80	0.81	39.65	27.23	0.55
X ₃	19.89	24.31	0.08	7.79	50.25	1.25	7.81	50.91	0.98
X ₄	36.97	19.76	-0.12	16.08	54.25	0.79	14.13	53.46	1.00
X ₅	26.92	15.67	-0.54	63.38	10.30	-1.19	36.62	10.86	-0.61
X ₆	20.35	23.07	0.06	8.38	51.73	1.85	8.74	46.66	1.34
X ₇	122.69	20.22	1.26	170.25	53.04	2.58	190.40	222.82	20.30
X ₈	216.57	39.51	-0.36	795.82	29.10	0.24	3254.44	17.90	0.20
X ₉	110.49	24.14	0.08	106.76	52.84	2.89	468.55	70.17	7.06
X ₁₀	167.31	40.70	0.88	271.13	73.58	1.64	1240.00	73.47	1.65
X ₁₁	30.17	43.32	1.49	19.13	70.45	1.82	20.98	67.51	0.95
X ₁₂	4.68	62.26	1.33	2.87	98.21	6.18	3.53	92.83	8.08
X ₁₃	11.94	80.79	2.06	7.84	109.79	6.23	9.61	107.71	10.52
X ₁₄	0.02	280.87	3.03	0.42	1351.94	17.02	0.45	1316.43	16.12
X ₁₅	16.16	12.87	0.87	14.08	28.54	0.74	13.93	54.11	1.01

Source: authors' own calculations.

The analysis of parameter values shows the following regularities:

- for four indicators: share of current income in total income (X_{1S}), current transfers per capita (X_{8S}), operating surplus per capita (X_{9S}), total liabilities per capita (X_{10D}) – their average level increased when the level of aggregation was lower. As for the share of investment expenditure in total expenditure (X_{15S}), it was possible to notice decreasing values on lower levels of aggregation;
- as for the share of investment expenditure in total expenditure (X_{15S}), it was possible to notice decreasing values on lower levels of aggregation, as well as its decrease year-to-year: in 2018, the values of this indicator for the voivodship, poviats and commune, were 20.4, 19.8 and 19.5 respectively, while in 2020 it was 16.2, 14.1 and 13.9;
- diversification of the values of the majority of indicators (except X_{1S} , X_{5S}) at various levels of aggregation was above 20%; the highest value of most of the characteristics was for poviats;
- the lowest diversification was found in voivodeships, poviats and communes in terms of the share of current income in total income (X_{1S}), and the highest – in terms of the share of due liabilities in total liabilities (X_{14D});
- the distribution of the majority of indicators at all levels of aggregation was characterized by a strong or very strong right-sided asymmetry, which is unfavorable from the point of view of stimulant indicators, as it means the predominance of objects whose level of indicators is below average;

- only the distribution of the share of current income in total income X_{1S} was characterized by a strong left-sided asymmetry, which means that for most poviats and communes (the distribution for voivodships in 2020 was close to symmetrical), the share of current income in total income was above average;
- the situation was different for destimulant indicators ($X_{10D} - X_{14D}$), where the distribution of indicators with right-hand asymmetry is desirable;
- an exception was noted: the burden of salaries and remuneration-derivatives on current expenditure X_{5D} was characterized by at least moderate (for voivodships and communes) and strong (for poviats) left-sided asymmetry, which means that for the majority of the objects the burden of salaries and remuneration-derivatives on current expenditure was above the average.

Using the fifteen diagnostic features presented in the sub-chapter above, TOPSIS synthetic measures (equal weights of $w_j = \frac{1}{15}$ were used) were determined, which characterized the financial situation in individual LGUs in 2018-2020; based on these values, four typological groups were distinguished (Tab. 4-6). Based on these groups, it may be seen that some voivodeships in the analyzed period changed their typological group, e.g. Podlasie Voivodeship from Group 4 in 2018 transferred to Group 2 in 2020. Meanwhile, the Greater Poland Voivodeship shifted from Group 2 in 2018 to Group 4 in 2020.

There were also certain changes in the structure of groups of poviats; the share of poviats belonging to Group 1 and 2 increased, i.e. their financial situation was above the average for all poviats. Only in two voivodships (Kuyavia-Pomerania and West Pomerania) there was a decrease in share in the best groups (Group 1 and 2) and an increase in the worst groups (Group 3 and 4).

During 2018-2020, the share of communes from Groups 3 and 4 in the total number of communes remained the same and amounted to approx. 48%. However, the number of communes in these groups slightly changed: the share of communes in the third group in 2020 increased by 1.1 percentage point, as compared to 2018, while the share of communes belonging to Group 4 in that period remained at the same level. The situation varied among voivodships. In 2020, (Table 6) in nine voivodeships there was a predominance of communes from Groups 3 and 4, in which the level of synthetic measures was below the average. This applied in particular to communes in the following voivodeships: Lower Silesia (62.2%), Warmia-Masuria (57%), Lesser Poland (57%), Lubusz (56.3%), Pomeranian (54.6%), West Pomeranien (53.6%), and Greater Poland (51.8%). In previous years, the communes classified in Groups 3 and 4 were present in seven voivodeships.

Table 4.
Typological groups of LGUs in 2018

LGU	Voivodeships		Poviats				Communes			
	R_i	Group	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
Lower Silesia	0.6601	3	0	13	10	3	4	65	90	6
Kuyavia-Pomerania	0.6936	2	1	12	5	1	2	75	59	4
Lublin	0.5887	3	0	13	7	0	1	117	86	5
Lubusz	0.6116	3	0	6	5	1	1	37	41	1
Łódź	0.6765	2	0	13	8	0	3	96	75	0
Lesser Poland	0.6715	3	0	9	10	0	0	78	99	2
Masovia	0.7429	2	0	25	12	0	5	185	117	2
Opole	0.7310	2	0	4	7	0	1	30	39	0
Subcarpathia	0.8202	1	0	17	4	0	3	85	64	4
Podlasie	0.3710	4	0	13	1	0	2	72	40	1
Pomerania	0.7203	2	0	10	6	0	0	56	62	1
Silesia	0.6788	2	0	15	1	1	2	88	54	4
Świętokrzyskie	0.7483	2	0	9	4	0	0	39	61	1
Warmia-Masuria	0.6556	3	0	14	5	0	3	33	74	4
Greater Poland	0.7017	2	1	13	16	1	1	119	99	3
West Pomerania	0.7125	2	2	11	5	0	9	54	43	4

Source: authors' own calculations.

Table 5.
Typological groups of LGUs in 2019

LGU	Voivodeships		Poviats				Communes			
	R_i	Group	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
Lower Silesia	0.6468	3	1	14	9	2	8	48	97	12
Kuyavia-Pomerania	0.5309	4	0	12	7	0	1	76	59	4
Lublin	0.6086	3	0	11	8	1	3	106	94	6
Lubusz	0.2889	4	0	5	5	2	2	36	36	6
Łódź	0.6357	3	0	10	11	0	8	104	61	1
Lesser Poland	0.7233	2	1	8	9	1	1	80	93	5
Masovia	0.7266	2	3	19	14	1	12	177	116	4
Opole	0.7762	2	0	3	7	1	0	30	38	2
Subcarpathia	0.8178	1	0	18	3	0	4	81	64	7
Podlasie	0.7623	2	0	10	3	1	6	69	33	7
Pomerania	0.7621	2	0	5	10	1	6	55	55	3
Silesia	0.6791	3	0	7	9	1	7	79	60	2
Świętokrzyskie	0.8103	1	0	11	2	0	0	49	49	3
Warmia-Masuria	0.6643	3	0	8	11	0	3	42	61	8
Greater Poland	0.7227	2	4	14	12	1	8	111	102	1
West Pomerania	0.7284	2	1	11	6	0	9	35	62	4

Source: authors' own calculations.

Table 6.
Typological groups of LGUs in 2020

LGU	Voivodeships		Poviats				Communes			
	R_i	Group	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
Lower Silesia	0.6728	3	1	10	14	1	5	57	97	6
Kuyavia-Pomerania	0.7799	2	0	15	3	1	2	80	57	1
Lublin	0.5804	3	0	10	10	0	2	108	97	2
Lubusz	0.3254	4	0	4	6	2	2	33	41	4
Łódź	0.6742	3	0	8	12	1	3	98	71	2
Lesser Poland	0.7604	2	0	9	10	0	1	76	95	7
Masovia	0.7458	2	1	20	15	1	1	184	119	5
Opole	0.8567	1	1	3	6	1	0	35	34	1
Subcarpathia	0.8093	2	4	11	6	0	1	79	72	4
Podlasie	0.7614	2	0	11	2	1	3	74	37	1
Pomerania	0.7461	2	2	8	5	1	2	52	64	1
Silesia	0.6665	3	1	6	10	0	1	83	62	2
Świętokrzyskie	0.8388	1	1	8	4	0	2	48	49	2
Warmia-Masuria	0.6771	3	0	10	9	0	2	47	63	2
Greater Poland	0.5605	4	0	12	18	1	2	105	115	0
West Pomerania	0.8237	2	0	9	9	0	1	50	57	2

Source: authors' own calculations.

5. Conclusions

Based on the completed study, the following conclusions may be drawn:

- the lower the level of local government, the greater the share of current income in total income, current transfers per capita, operating surplus per capita and total liabilities per capita,
- the improvement in the self-financing indicator may suggest a low level of implemented investments, which was confirmed by the relatively low values of the share of investment expenditure in total expenditure,
- a negative trend was observed: the share of investment expenditures in total expenditures decreased at all levels of local government units, especially in communes and poviats.

The pandemic period did not clearly affect the financial situation of LGUs – it was rather a time of continued trends of changes of the indicators used in the study. Luckily, despite the pandemic, a decrease in the share of debt in total income was recorded at all levels of LGUs, despite a slight decrease in the share of the operating surplus in total income in poviats and communes. Based on the analysis of voivodeships, it may be concluded that in 2020 (in comparison to previous years), the financial situation of the Greater Poland voivodship deteriorated the most, while the financial situation of the Podlasie voivodship improved the most.

References

1. Bieniasz, A., Gołaś, Z., Łuczak, A. (2013). Zastosowanie metody TOPSIS do oceny kondycji finansowej gmin w Polsce w 2010 roku. *Zesz. Teoretyczne Rachun.*, 25-42. <https://doi.org/10.5604/16414381.1046236>
2. Bień, W. (2011). *Zarządzanie finansami przedsiębiorstwa*. Difin.
3. Čámská, D. (2013). Financial Situation of Municipalities Supported by EU Funds. *Int. Adv. Econ. Res.*, 19, 315-316. <https://doi.org/10.1007/s11294-013-9405-4>.
4. Dziekański, P., Leśna-Wierszołowicz, E. (2019). *The spatial differentiation of development and the level of the financial situation of rural communes of the Swietokrzyskie Voivodeship*. Presented at the 20th International Scientific Conference “Economic Science for Rural Development 2019”, pp. 248-255. <https://doi.org/10.22616/ESRD.2019.129>.
5. Filipiak, B. (2010). Utrzymanie płynności finansowej przez jednostki samorządu terytorialnego w warunkach kryzysu – zarys problemu pomiaru. *Probl. Zarządzania Finans. Mark.*, 159-167.
6. Ghose, P.S. (2021). Selection of Plant Location for a Steel Project by TOPSIS. *World J. Appl. Chem.*, 6, 1-5. <https://doi.org/10.11648/j.wjac.20210601.11>.
7. Hruža, F., Novotná, S. (2017). Municipal bankruptcies in the Czech and Slovak Republic (Case study). *Sci. Pap. Univ. Pardubice, D 13*.
8. Karatova, N. (2020). The impact of the Covid-19 crisis on the activities of the municipalities in the Republic of Bulgaria. *Trakia J. Sci.*, 18, 522-528. <https://doi.org/10.15547/tjs.2020.s.01.084>.
9. Lampe, H.W., Hilgers, D., Ihl, C. (2015). Does accrual accounting improve municipalities' efficiency? Evidence from Germany. *Appl. Econ.*, 47, 4349-4363. <https://doi.org/10.1080/00036846.2015.1030562>.
10. Malinowska-Misiąg, E. (2022). Finanse jednostek samorządu terytorialnego w Polsce w pierwszym roku pandemii. *Optim. Econ. Stud. Kol. Zarządzania Finans. Szk. Gł. Handlowa w Warszawie, 1*, 48-63. <https://doi.org/10.15290/oes.2022.01.107.04>.
11. Ministerstwo Finansów (2021). *Wskaźniki do oceny sytuacji finansowej jednostek samorządu terytorialnego w latach 2018-2020*. Retrieved from: <https://www.gov.pl/web/finanse/wskazniki-do-oceny-sytuacji-finansowej-jednostek-samorzadu-terytorialnego-w-latach-2018-2020>, 30.06.2022.
12. Mrówczyńska-Kamińska, A., Średzińska, J., Kucharczyk, A. (2011). Analiza finansowa w jednostkach samorządu terytorialnego na przykładzie Miasta i Gminy Środa Wlkp. *Zesz. Nauk. Szk. Gł. Gospod. Wiej. Ekon. Organ. Gospod. Żywn.*, 175-185.
13. Parida, P., Sahoo, S. (2013). Multiple Attribute Decision Making Approach by TOPSIS technique. *Int. J. Eng. Res. Technol.*, 2, 907-912.

14. Parlińska, A. (2014). Zadłużenie samorządów gminnych w Polsce w latach 2005-2012. *Nierówności Społeczne a Wzrost Gospod.*, 4, 191-200.
15. Permanasari, V.Y., Nadjib, M., Sjaaf, A.C., Besral, Anjani, A.A. (2022). The Response of Local Governments in Financing Related to the Covid-19 Pandemic: A Literature Review. *J. Public Health Res.*, 11, jphr.2021.2620. <https://doi.org/10.4081/jphr.2021.2620>.
16. Poniatowicz, M. (2015). Determinanty autonomii dochodowej samorządu terytorialnego w Polsce. *Financ. Sci.* <https://doi.org/10.15611/nof.2015.1.01>.
17. Roszkowska, E. (2011). Multi-criteria decision making models by applying the Topsis method to crisp and interval data. *Mult. Criteria Decis. Mak.*, 200-230.
18. Standar, A. (2017). Ocena kondycji finansowej gmin oraz jej wybranych uwarunkowań na przykładzie województwa wielkopolskiego przy wykorzystaniu metody TOPSIS. *Więś Rol.*, 69-92. <https://doi.org/10.53098/wir022017/04>.
19. Ślebocka, M. (2017). Wykorzystanie analizy finansowej w jednostkach samorządu terytorialnego dla potrzeb przedsięwzięć rewitalizacyjnych na przykładzie miasta Łodzi. *Ekonomiczne Problemy Usług*, 4. Wydaw. Nauk. Uniw. Szczec., 257-268.
20. Tomal, M., Nalepka, A. (2018). Badanie wpływu poziomu rozwoju gmin na ich skłonność do inwestowania na przykładzie gmin województwa małopolskiego. *World Real Estate J. Świat Nieruchom.*, 105, 7. <https://doi.org/10.14659/worej.2018.105.007>.
21. Yoon, K., Kim, W. (2017). The behavioral TOPSIS. *Expert Syst. Appl.*, 266-272.
22. Ziolo, M. (2011). Zadłużenie gmin województwa zachodniopomorskiego w latach 2006-2009 w świetle tendencji ogólnopolskich - analiza komparatywna. *Zesz. Nauk. Wyższej Szk. Bank. we Wrocławiu*, 391-409.
23. Zulqarnain, R.M., Saeed, M., Ahmad, N., Dayan, F., Ahmad, B. (2020). Application of TOPSIS Method for Decision Making. *Int. J. Sci. Res. Math. Stat. Sci.*, 76-81.

PROMOTING AND PROTECTING HEALTH AS A PRIORITY ON THE ROAD TO SUSTAINABLE DEVELOPMENT

Iwona BĄK¹, Beata SZCZECIŃSKA^{2*}

¹ Department of Applied Mathematics in Economics, Faculty of Economics, West Pomeranian University of Technology, Szczecin, Poland; iwona.bak@zut.edu.pl, ORCID: 0000-0001-8959-7269

² Department of System Analysis and Marketing, Faculty of Economics, West Pomeranian University of Technology, Szczecin, Poland; beata.szczecinska@zut.edu.pl, ORCID: 0000-0002-7718-777X

* Correspondence author

Purpose: The article aims to assess the situation of the European Union countries regarding health promotion and protection. The study has adopted indicators related to Sustainable Development Goal 3 (SDG3) in 27 EU countries in two research periods (2014 and 2020) so that it will be possible to assess the situation of the studied countries and indicate which countries have improved or not their situation related to the studied phenomenon.

Design/methodology/approach: A taxonomic measure of development based on Weber's median vector was used to assess the implementation of SDG3 in EU countries. Upon its basis, rankings of EU countries were constructed, and typological groups of similar levels were determined due to the studied phenomenon.

Findings: The study results showed that the older EU member states are characterised by a better situation in health protection and promotion compared to the newer, mostly post-communist countries. The best-rated countries in the first research period were Sweden, the Netherlands and Denmark, while in the second one, it was again Sweden, the Netherlands and Ireland.

Social implications: The results of the studies presented in this paper can be useful for the diagnosis of the results achieved so far and for the revision of the health policy of the whole European Union as well as of the individual countries in the future.

Originality/value: This article is part of the debate on combining health promotion and protection, emphasising a balanced diet and physical activity, and sustainable development. Health promotion, a process that enables people to increase control and improve their health, is expected to play an important (and transformative) role in achieving the sustainable development of Goal 3 (ensuring health for all and at all ages).

Keywords: sustainable development; health promotion and protection; Weber's median.

Category of the paper: Research paper.

1. Introduction

Public health is one of the key challenges of sustainable development. According to the World Health Organization (WHO), health is a state of complete physical, mental and social well-being, not just a lack of disease or infirmity (Sartorius, 2006). Two concepts are closely related to health: its protection and promotion. Health care is an activity aimed at preventing and treating diseases, maintaining mental, physical and social development of a person, extending life, and ensuring healthy development for the next generations. On the other hand, health promotion means creating conditions that facilitate and encourage a healthy lifestyle. Apart from prophylaxis and health education, it is one of the basic elements of public health.

Health protection and promotion are designed to improve the health of the population by preventing disease, controlling risks, improving fitness and well-being and increasing the ability of workers to work and function in society. Health promotion activities take different forms but generally focus on exercise and activity, diet, cancer prevention, smoking cessation and treating chronic diseases through wellness programs (Mendes, Dias, 2011).

There is a close relationship between health and other elements of sustainable development (Adshead, Thorpe, Ruter, 2006; Acharya, Lin, Dhingra, 2018). Indeed, health depends on environmental (e.g., climate change and energy, sustainable transportation, sustainable production and consumption, natural resource management), economic (e.g., population wealth, unemployment) and social (e.g., demographic factors, social exclusion) issues. Therefore, public health is not only a significant outcome but also a prerequisite for sustainable development. A similar view is taken by Fortune et al. (2018), who emphasise the direct or indirect links between health and all the Sustainable Development Goals. They also highlight the importance of health promotion in achieving equality, strengthening communities and protecting human rights. Ayres and Agius (2004) also wrote on health protection in the light of sustainable development, pointing to the need for an interdisciplinary approach to develop an integrated and comprehensive strategy. According to Porritt (2005), sustainable development concerns improving the physical, social and personal quality of life of individuals in a way that does not hinder future generations.

In May 2018, World Health Organization (WHO) member states approved a new WHO General Program of Work for 2019-2023. It is based on sustainable development objectives and is intended to help countries stay on track to meet SDG3 and other health-related goals. Its three strategic priorities are universal health coverage, health security, and improving health and well-being (WHO, 2018). According to Mohammed and Ghebreyesus (2018), universal health insurance can help reduce poverty (Goal 1) by protecting the population from financial hardship, and good health can drive employment and economic growth (Goal 8). Well-organised health systems can also provide support against the social and economic consequences of epidemics and other health emergencies.

In recent decades, significant progress has been made in extending overall and healthy life expectancy, reducing maternal and child mortality, managing national and global health risks and reducing the burden of communicable and non-communicable diseases (Menne et al., 2020). The implementation of the 2030 Agenda is progressing in all European WHO member states, but current projections indicate that no country is fully on track to achieve the health-related goals and that there is room for further strengthening and accelerating implementation at a faster pace. Some health goals in SDG3 and other health objectives will only be achieved if actions are accelerated across society. It includes halving the number of deaths and injuries worldwide from traffic accidents, reducing tuberculosis and new HIV infections, increasing vaccination rates, tackling risk factors such as obesity, alcohol, smoking and air pollution, combating mental health disorders and reducing interpersonal violence (WHO, 2019). A healthy lifestyle is an important condition for sustainable development (Bozkurt, Ergen, 2015; Farhud, 2017). Therefore, studying society for its health habits and promoting a healthy lifestyle that supports sustainable development is necessary.

The article aims to assess the situation of the European Union countries regarding health promotion and protection. The study has adopted indicators related to Sustainable Development Goal 3 (SDG3) in 27 EU countries in two research periods (2014 and 2020) so that it will be possible to assess the situation of the studied countries and indicate which countries have improved or not their situation related to the studied phenomenon. This article is part of the debate on combining health promotion and protection, emphasising a balanced diet and physical activity, and sustainable development. Health promotion, a process that enables people to increase control and improve their health, is expected to play an important (and transformative) role in achieving the sustainable development of Goal 3 (ensuring health for all and at all ages).

The layout of this article includes an introduction that outlines the paper's main purpose and explains the authors' key motivations for conducting research on health promotion and protection in EU countries. In addition, a review of the literature concerning the phenomenon under study is included. The following section discusses the statistical data used in the article and describes the research procedure. Finally, the results of the study, discussion, and conclusions of the study are presented.

2. Literature review

The growing challenges in promoting public health include, on the one hand, workplace activities, local, national and international health programs, and the possibility of opening up pathways for non-medical professionals. These challenges are related to, among other things: the limited number of centres offering health promotion and infection control education, the focus on hospitals and clinics, the emergence of resurgent as well as new infections,

globalisation and the movement of people, bacterial resistance, and vaccination coverage (Ansari, Privett, 2005). Developing a unified program in this area is a current challenge in the modern world.

Swerissen and Crisp (2004) stress that interventions applied at the wrong social system level are unlikely to be effective, not to mention sustainable development. Interventions that isolate individual action from the social context are unlikely to yield a sustainable health benefit without changes in the organisational, social and institutional conditions that make up the social context. Health promotion programs are more likely to produce lasting effects if they are adapted to the appropriate levels of social organisation in order to achieve better health outcomes.

Enterprises are an excellent place to promote health and make changes in this area at the organisational level for the benefit of society as a whole. Finding ways to promote the health and well-being of employees, who often spend more than half of their lives in the workplace, should become one of the priorities for enterprise managers. According to Chen et al. (2015), well-functioning health programs will improve individual and collective labour productivity and increase the efficiency of the entire organisation.

Occupational health is most often associated with protecting workers from occupational injuries and diseases, and measures taken by workplaces include health and safety training, guaranteeing protective clothing and organising work in such a way as to guarantee workers' safety as much as possible. How to protect workers from all kinds of hazards encountered in the workplace was presented by Liu (2020), comparing five legal systems (European Union, Netherlands, United Kingdom, Sweden and China) on occupational health and safety. On the other hand, the study of Jonathan and Mbogo (2016) on the operation of health and safety systems in secondary schools showed that most teaching staff were not involved in training programs that would equip them with safety skills in the workplace. It significantly affected their preparation in matters of health risks and thus their overall performance. Similar conclusions were reached by Allender, Colquhoun and Kelley (2011), who attempted to evaluate the effectiveness of workplace health programs at a multinational IT company.

Health promotion usually includes activities that maintain or improve employees' health, ranging from health risk assessments to health initiatives and immunisations (Hymel et al., 2011). An increasing number of companies are undertaking "new" protection and health promotion in the workplace, improving workers' overall well-being. Dugdill (2000) considers that health promotion strategies should address both psychosocial issues and create bridges between the home and work environments if the health of the working population is to improve. Indeed, there are very few comprehensive workplace health programs, and it would be good for programs to be designed by a health "expert" rather than developed by the workforce. Behavioural changes that improve health have been described by Sorensen et al. (1998), among others. They have attempted to assess the impact of two-year integrated interventions on workplace health and promoting changes in eating habits and quitting smoking. The study was

conducted at 24 manufacturing plants in Massachusetts, with between 250 and 2,500 employees at each plant. The results of the introduced intervention resulted in changes in nutrition (a reduction in caloric intake), but no significant changes in quitting cigarette smoking were noted. The authors emphasise that even small-scale interventions can raise awareness and have an impact on reducing coronary heart disease. The impact of improving the quality of food in employee cafeterias as a factor in increasing awareness of healthy meal choices outside of work as well, contributing to a reduction in overweight and obesity was written about by Lassen et al. (2014). Studies conducted in workplaces show that blue-collar workers are less likely to participate in health promotion programs (Sorensen et al., 1996). The implication is that top-down management-imposed changes in nutrition and smoking reduction have more supporters among white-collar workers.

Reflection on the broad application of corporate strategies to promote physical activity among employees and their families through employer-sponsored initiatives was described by Pronk and Kottke (2009). They believe that the benefits of physical activity are manifold, including primarily improved health and well-being and increased productivity. According to them, the promotion of physical activity in the workplace should be an integrated initiative that measurably improves employee health and, consequently, the company's financial performance.

The improvement of physical activity using workplace pedometers was evaluated by Chan, Ryan and Tudor-Locke (2004) and Backholer, Freak-Poli and Peeters (2012). They assessed the effect of controlling the number of steps on changes in body mass index (BMI), waist circumference, resting heart rate and blood pressure. They found that sedentary workers obtained health benefits, and pedometers' use contributed to increased physical activity.

The way to create a sustainable health culture at work is to strategically and systematically integrate various environmental, health and safety policies and programs that improve workers' overall health and well-being and prevent work-related injuries and illnesses. As a result, employees believe that the organisation cares about them and can transfer good practices to their personal lives. It will, to a large extent, contribute to strengthening the overall national health system and overall better health outcomes for the entire population.

While much attention has been paid to protecting and promoting health among workers, it should be noted that the workplace environment can be used successfully to promote healthy lifestyles. It is a perfect place to introduce activities that, on the one hand, teach and, on the other, perpetuate the application of health-promoting principles by employees and, indirectly, by their families. In addition, employers represent a powerful stakeholder group that should influence health policy initiatives aimed at creating supportive environments in the workplace, as well as in the broader community.

3. Research methodology

3.1. Stages of the applied research procedure

In this study, a 3-stage research procedure was used to assess the situation of the European Union countries relating to SDG3 implementation, the successive stages of which are shown in Figure 1. The first stage included the collection of statistical data on SDG3 implementation indicators in 27 EU countries in two years: 2014 and 2020. After a detailed description of the indicators adopted for the study with the use of the selected measures of descriptive statistics, the distributions of the indicators adopted for the study were analysed.

The second step included the selection and design of the synthetic measure. Given the high variation and asymmetry of most indicators, it was decided to use a positional taxonomic measure based on Weber's median. Based on this measurement, the three medians method was used to determine typological groups with similar levels of the phenomenon under study.

The final step is to analyse and interpret the results obtained. On the basis of the created rankings and designated typological groups, the situation of the studied countries was evaluated in terms of the implementation of SDG3. In addition, using Kendall's tau measure, it was examined whether there was a relationship between the obtained rankings of countries in the years under consideration.

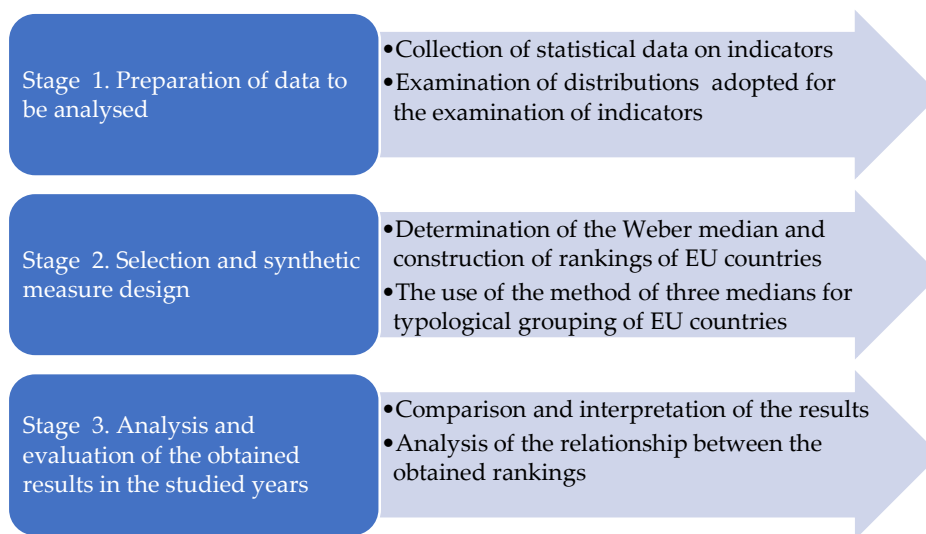


Figure 1. Research procedure chart.

Source: own elaboration.

3.2. Statistical materials

The indicators proposed by Eurostat help in measuring the level of goals' achievement. According to Eurostat, the indicators prepared by them were organized in accordance with the goals of sustainable development and have universal in nature, i.e. they can be used to monitor more than one goal of sustainable development. All indicators are grouped into sub-topics to emphasize the interrelationship and highlight different aspects of each SDG.

The baseline data for this study's attempt to compare European Union countries in terms of health protection and promotion came from the Eurostat (2022) database and was for the years 2014 and 2020 (in a few cases, due to lack of data, the previous year was chosen). A great difficulty in carrying out this type of analysis is the collection of reliable and comparable statistical data. It turns out that the databases of the statistical offices of the EU countries do not always provide complete and up-to-date information. In this study, due to the availability of data, it was decided to compare the years 2014 and 2020, due to the fact that these two periods were characterized by complete data for all indicators and EU countries. For example, the smoking prevalence indicator included in the Eurostat database was fully available for the years 2014, 2017 and 2020. The remaining indicators were available for a greater number of years, but due to the desire to use as many indicators as possible, and in order to fully compare the EU countries, the above periods were taken to comparison.

This study uses the available indicators that have been assigned by Eurostat to SDG 3 group of sustainable development indicators. Moreover, two indicators were added which, in the Authors' opinion, are in line with the implementation of the tasks related to SDG3. The first of these indicators (Y_{12D} - Frequency of alcohol consumption every day) relates to the achievement of the target 3.5: Prevent and treat substance abuse. The second (Y_{13D} - Time (zero minutes) spent on health-enhancing (non-work-related) aerobic physical activity by sex and educational attainment level) was linked to goal 3.4: Reduce mortality from non-communicable diseases and promote mental health, taking into account the recommendations of specialists in the field of medicine that physical effort and exercise are an excellent prevention of many civilization diseases. Regular physical activity, are health-enhancing behaviours that contribute to health improvement and social development (Macassa, 2022).

Table 1 presents a list of diagnostic features used in the study. These relate to indicators describing the implementation of SDG3. The availability of data determined the choice of features. The influence of each characteristic on the analysed phenomenon was also shown by classifying it into a set of characteristics stimulating development in the area (symbol S) or destimulating this development (symbol D). It is worth noting that the destimulants are strongly predominant; only two indicators (Y_{1S} and Y_{2S}) are classified in the set of stimulants.

Table 1.
Base of indicators

Symbol	Indicator	Name of the indicator	Indicator description
Y_{1S}	SDG_03_10	Healthy life years at birth	The indicator of healthy life years measures the number of remaining years that a person of specific age is expected to live without any severe or moderate health problems.
Y_{2S}	SDG_03_20	Share of people with good or very good perceived health	The indicator is a subjective measure on how people judge their health in general on a scale from "very good" to "very bad". It is expressed as the share of the population aged 16 or over perceiving itself to be in "good" or "very good" health.
Y_{3D}	SDG_03_30	Smoking prevalence (every day)	The indicator measures the share of the population aged 15 years and over who report that they currently smoke boxed cigarettes, cigars, cigarillos or a pipe.
Y_{4D}	SDG_03_40	Standardised death rate due to tuberculosis, HIV and hepatitis by type of disease	The rate is calculated by dividing the number of people dying due to selected communicable diseases by the total population.
Y_{5D}	SDG_03_42	Standardised preventable and treatable mortality	Preventable mortality refers to mortality that can mainly be avoided through effective public health and primary prevention interventions (i.e. before the onset of diseases/injuries, to reduce incidence).
Y_{6D}	SDG_03_60	Self-reported unmet need for medical examination and care	The indicator measures the share of the population aged 16 and over reporting unmet needs for medical care due to one of the following reasons: 'Financial reasons', 'Waiting list' and 'Too far to travel' (all three categories are cumulated).
Y_{7D}	SDG_02_10	Obesity rate by body mass index (BMI)	The indicator measures the share of obese people based on their body mass index (BMI). BMI is defined as the weight in kilos divided by the square of the height in meters. People aged 18 years or over are considered obese with a BMI equal or greater than 30. Other categories are: underweight (BMI less than 18.5), normal weight (BMI between 18.5 and less than 25), and pre-obese (BMI between 25 and less than 30). The category overweight (BMI equal or greater than 25) combines the two categories pre-obese and obese.
Y_{8D}	SDG_08_60	Fatal accidents at work per 100 000 workers	The indicator measures the number of fatal accidents that occur during the course of work and lead to the death of the victim within one year of the accident. The incidence rate refers to the number of fatal accidents per 100 000 persons in employment.
Y_{9D}	SDG_11_20	Population living in households considering that they suffer from noise, by poverty status	The indicator measures the proportion of the population who declare that they are affected either by noise from neighbours or from the street.
Y_{10D}	SDG_11_40	Road traffic deaths, by type of roads	The indicator measures the number of fatalities caused by road accidents, including drivers and passengers of motorised vehicles and pedal cycles as well as pedestrians. The average population of the reference year (calculated as the arithmetic mean of the population on 1st January of two consecutive years) is used as denominator (per 100 000 persons).

Cont. table 1.

Y_{11D}	SDG_11_50	Years of life lost due to PM2.5 exposure	The indicator measures the years of life lost (YLL) due to exposure to particulate matter (PM2.5). PM2.5 are particulates whose diameter is less than 2.5 micrometres and which can be carried deep into the lungs where they can cause inflammation and exacerbate the condition of people suffering heart and lung diseases. YLL is defined as the years of potential life lost as a result of premature death. It is an estimate of the average number of years that a person would have lived if they had not died prematurely.
Y_{12D}	Goal 3.5.	Frequency of alcohol consumption every day	This indicator measures the share of people in the population who consume alcohol daily. According to the WHO, alcohol abuse is one of the most important factors affecting the health of people around the world.
Y_{13D}	Goal 3.4.	Time (zero minutes) spent on health-enhancing (non-work-related) aerobic physical activity by sex and educational attainment level	Physical activity should be done every day to reduce the risk of disease, according to World Health Organization recommendations. Nutritional errors and the lack of exercise are the most common cause-and-effect relationships of overweight and obesity.

Source: own elaboration.

In the next step, the indicators adopted for the study were characterised by determining their selected descriptive characteristics (Table 2). The preliminary analysis of the diagnostic characteristics shows that there are large disparities between countries due to the indicators studied. The coefficients of variation in 2020 ranged from 7.19% (Y_{1S} – healthy life years at birth) to 117.65% (Y_{6D} – the self-reported unmet need for medical examination and care), with variation exceeding 30% for most features. The diversity of indicators in 2014 looks similar. The consequence of the high dispersion of features is also their high asymmetry. It should be noted that right-sided asymmetry dominates, indicating the predominance of EU countries with index values below the average value, which is positive for features that are destimulants. It is evident in the case of the indicator with the highest level of variation (Y_{6D}), which is also characterised by a very high measure of asymmetry. In 2014, the average value of this indicator was 3.9%, and for only eight countries, it was above the average, with Latvia having the highest value (12.5%). Among the countries where the index was below 0.5%, there were only: Austria (0.1%) and Slovenia (0.2%). In 2020, the average value of this indicator for the EU-27 decreased to 2.3%, with the highest value for Estonia (13.0%), and the lowest (below 0.5%), countries such as: Malta (0%), Luxembourg (0.1%), Germany (0.1%), Austria (0.1%), Netherlands (0.2%), Spain (0.4%), Cyprus (0.4%).

Noteworthy is the Y_{2S} (the share of people with good or very good perceived health) indicator, which is characterised by strong left-sided asymmetry, which means that in most EU countries, the population aged 16 or older rated their health above the EU average, which in 2014 was 66.16% and 68.1% in 2020. The lowest rating of this indicator was given by the residents of Lithuania (44.3% in 2020 compared to 45% in 2014), and the highest by the residents of Ireland (83.7% in 2020 compared to 82.7% in 2014).

Table 2.

Selected descriptive characteristics of the indicators adopted for the study in the years 2014 and 2020

Symbol	2014			2020		
	\bar{x}	Vs (%)	As	\bar{x}	Vs (%)	As
Y_{1S}	61.63	7.75	0.69	62.38	7.19	0.21
Y_{2S}	66.16	15.34	-0.71	68.12	13.55	-0.87
Y_{3D}	25.96	21.57	-0.22	24.59	30.87	0.03
Y_{4D}	3.24	82.82	1.47	2.20	103.15	2.19
Y_{5D}	307.07	39.81	0.90	280.09	39.97	0.85
Y_{6D}	3.93	90.63	1.17	2.31	117.65	2.50
Y_{7D}	52.95	7.36	-0.28	55.25	8.84	-0.06
Y_{8D}	2.47	50.96	0.78	1.97	43.59	0.10
Y_{9D}	16.79	31.01	0.84	16.04	35.10	0.69
Y_{10D}	5.83	36.31	0.40	4.54	34.34	0.63
Y_{11D}	904.78	44.37	0.99	749.33	44.63	0.67
Y_{12D}	7.53	69.21	1.19	6.78	65.73	0.97
Y_{13D}	48.93	35.43	0.10	49.66	35.17	-0.06

Source: own elaboration.

3.3. Method

In the article, a taxonomic measure of development based on Weber's (Weber, 1971) median vector was used to assess the implementation of SDG3 in EU countries. This method is used to linearly order multivariate objects due to the development of a distinguished phenomenon. Weber's median allows the construction of a synthetic measure, which considers not only the high resistance to outlier observations, but also the relationships between the studied characteristics. There are many examples in the literature of the application of this method (Pulido, Sanchez-Soriano, 2009; Bąk, 2014; Młodak, 2014; Pechersky, 2015; Adam, Kroupa, 2017). The indisputable advantage of this method is its resistance to outliers, which in the case of very mixed results of European Union countries in the analysed areas, is an essential factor influencing its choice in the presented study. The Weber median was calculated in *R program: l1median* of package: *pcaPP*. The determination of the taxonomic meter proceeds in the following stages (Cheba, Bąk, 2020):

1. Normalization of the diagnostic features.

The positional option of the linear object assignment takes a different normalization formula, in comparison with the classical approach, based on a quotient of the feature value deviation from the proper coordinate of the Weber median and a weighed absolute median deviation, using the Weber median (Młodak, 2014):

$$z_{ij} = \frac{x_{ij} - \theta_{0j}}{1.4826 \cdot \text{mãd}(X_j)}, \quad (1)$$

where: $\theta_0 = (\theta_{01}, \theta_{02}, \dots, \theta_{0m})$ is the Weber median, $\text{mãd}(X_j)$ is the absolute median deviation, in which the distance from the features to the Weber vector is measured, i.e.: $\text{mãd}(X_j) = \text{med}_{i=1,2,\dots,n} |x_{ij} - \theta_{0j}|$ ($j = 1, 2, \dots, m$).

2. Calculation of taxonomic measure of development.

The synthetic measure μ_i is calculated on the basis of maximum values of normalized features, similarly to the Hellwig (1968) method:

$$\phi_j = \max_{i=1,2,\dots,n} z_{ij}, \quad (2)$$

according to the following formula:

$$\mu_i = 1 - \frac{d_i}{d_-}, \quad (3)$$

where: $d_- = \text{med}(\mathbf{d}) + 2,5\text{mad}(\mathbf{d})$ where $\mathbf{d}=(d_1, d_2, \dots, d_n)$ is a distance vector calculated using the formula: $d_i = \text{med}_{j=1,2,\dots,m} |z_{ij} - \phi_j|$ $i = 1, 2, \dots, n$, ϕ_j – the i -th coordinate of the development pattern vector, which is constituted of the maximum values of the normalized features.

3. The division of objects (countries) into four typological groups.

For this purpose, the three-median method was used, which consists in determining the median coordinates of the vector $\mu = (\mu_1, \mu_2, \dots, \mu_n)$, which is marked with a symbol $\text{med}(\mu)$. The calculated median divides the collection of objects into two groups. The first group includes objects for which the values of the measure are not greater than the median, and the second group includes objects with values exceeding the median level. Subsequently, in the separated groups, the medians are determined again, which divide the first and second groups into two further subgroups. It can be written as follows: $\text{med}_k(\mu) = \text{med}_{i:\Gamma_i \in \Omega_k}(\mu_i)$, where $k = 1, 2$.

This way, four groups of objects with the following values of the development measure are obtained:

I group: $\mu_i > \text{med}_1(\mu)$,

II group: $\text{med}(\mu) < \mu_i \leq \text{med}_1(\mu)$,

III group: $\text{med}_2(\mu) < \mu_i \leq \text{med}(\mu)$,

IV group: $\mu_i \leq \text{med}_2(\mu)$.

In the next step, based on the results obtained between the positions held by countries in each ranking in 2014 and 2020, the correlation coefficient τ Kendall was calculated according to the formula (Sanderson, Soboroff, 2007):

$$\tau = \frac{P-Q}{\sqrt{(P+Q+T) \cdot (P+Q+U)}}, \quad (4)$$

where:

P – the number of correctly-ordered pairs,

Q – the number of incorrectly ordered pairs,

T – the number of ties in 1st ranking,

U – the number of ties in 2nd ranking.

Kendall's τ measure is used when there are rankings from different sources (in different years) and for several facilities, and it is important to assess the consistency of these rankings. This coefficient takes values from the range of $\langle -1, 1 \rangle$; it indicates not only the strength but

also the direction of dependence. It is an excellent tool for describing the similarity of the ordering of a data set (Okazaki, Yutaka, Mitsuru, 2004; Lapata, 2006).

4. Results of the research

Table 3 shows the results of the rankings and typological groups of EU countries obtained using the taxonomic measure of development calculated for the implementation of SDG3 in 2014 and 2020. The positions of individual countries in the obtained rankings tended to vary, except for six countries whose positions did not change in the years under study. Sweden invariably remained the leader, and the positions of the countries occupying the last positions in the table, i.e. Latvia (27th position) and Romania (26th position), did not change. The following also remained in the same places: Germany (6th position), Belgium (8th position) and France (15th position).

Eight countries moved no further than one place, and two countries (Austria and Portugal) moved two places. The implementation of SDG3 in 2020, compared to 2014, worsened in 10 countries – Croatia (down from 17th to 24th place) and Slovakia (down from 12th to 18th place) were the most affected. Eleven member countries showed improvement, with the highest noted in Italy (from 18th to 12th position), Greece (from 21st to 16th position) and Cyprus (from 9th to 5th position).

Since the positions of individual EU countries in the years of the study are not the same (in some cases, the changes in the ranking are significant), Kendall's tau coefficient was determined in order to assess the consistency of the ordering of the studied objects. Its high value (0.778) confirms the consistency of the linear ordering of countries, despite differences in the positions of some objects.

The observation of typological groups in the analysed years shows that the changes in the membership of countries in individual groups concerned 12 countries, six of which advanced by one group higher, and the remaining six also decreased by one group.

Table 3.

Ranking and typological groups of EU countries due to SDG3 implementation in 2014 and 2020

Country	2014			2020		
	μ_i	rank	group	μ_i	rank	group
Belgium	0.637	8	II	0.678	8	II
Bulgaria	0.181	23	IV	0.340	22	IV
Czechia	0.382	19	III	0.401	20	III
Denmark	0.728	3	I	0.685	7	II
Germany	0.676	6	I	0.707	6	I
Estonia	0.356	20	III	0.348	21	IV
Ireland	0.693	5	I	0.801	2	I

Cont. table 3.

Greece	0.347	21	IV	0.481	16	III
Spain	0.539	14	III	0.560	13	II
France	0.531	15	III	0.519	15	III
Croatia	0.403	17	III	0.196	24	IV
Italy	0.393	18	III	0.581	12	II
Cyprus	0.607	9	II	0.726	5	I
Latvia	-0.379	27	IV	0.019	27	IV
Lithuania	0.122	24	IV	0.144	25	IV
Luxembourg	0.567	11	II	0.608	10	II
Hungary	0.435	16	III	0.455	17	III
Malta	0.660	7	II	0.763	4	I
Netherlands	0.888	2	I	0.779	3	I
Austria	0.540	13	II	0.581	11	II
Poland	0.332	22	IV	0.413	19	III
Portugal	0.122	25	IV	0.285	23	IV
Romania	0.018	26	IV	0.130	26	IV
Slovenia	0.587	10	II	0.533	14	III
Slovakia	0.566	12	II	0.447	18	III
Finland	0.714	4	I	0.649	9	II
Sweden	0.912	1	I	0.919	1	I

Source: own elaboration.

Based on a detailed analysis of the values of indicators in the years under study, it is possible to identify those that contribute to the formation of the value of the synthetic measure and thus rank the countries according to the level of the phenomenon under study i.e. the realisation of SDG3.

The best situation due to the implementation of SDG3 occurs in northern and western Europe countries. Sweden and Ireland, which are at the top of the ranking, are characterised by high indicators for Healthy life years at birth (Y_{1S}) and the Share of people with good or very good perceived health (Y_{2S}). The first of these indicators is the highest for Sweden, while the second reaches the maximum value in the case of Ireland. In addition, these countries have low rates related to, for example, the Standardised death rate due to tuberculosis, HIV and hepatitis by type of disease (Y_{4D}), Road traffic deaths by type of roads (Y_{10D}). The high position of the Netherlands in the analysed years is a consequence of low values of destimulant indicators, such as the Standardised death rate due to tuberculosis, HIV and hepatitis by type of disease (Y_{4D}), Self-reported unmet need for medical examination and care (Y_{6D}), Obesity rate by body mass index (BMI) (Y_{7D}), Fatal accidents at work per 100 000 workers (Y_{8D} – the lowest value among EU countries).

Latvia, at the bottom of the ranking in both years under review, has the lowest Healthy life years at birth (Y_{1S}) index and the highest level of the Standardised death rate due to tuberculosis, HIV and hepatitis by type of disease (Y_{4D}) among EU countries. The penultimate in the ranking of Romania has the highest level of destimulant indicators in the member countries, such as Standardised preventable and treatable mortality (Y_{5D}), Road traffic deaths, by type of roads (Y_{10D}), and Time (zero minutes) spent on health-enhancing (non-work-related) aerobic physical activity by sex and educational attainment level (Y_{13D}).

5. Discussion

In this article, based on the 13 indicators related to the implementation of SDG3 adopted for the study, a ranking of EU countries and typological groups with similar levels was constructed in terms of the phenomenon studied. The older EU Member States were better assessed in terms of the indicators adopted for the study than the newer, mostly post-communist countries. The top-ranked countries in the first study period (2014) were Sweden, the Netherlands and Denmark, while in the second one (2020), they were again Sweden, the Netherlands and Ireland, which in 2020 advanced to the second position compared to the fifth in 2014. However, Latvia and Romania were at the end of the ranking in both surveyed years. It is significant that the fourth worst typological group in 2020 included countries (except Portugal) that joined the EU in 2004 or later. They stand out negatively in terms of the high mortality rates due to diseases (Y_{4D} – Standardised death rate due to tuberculosis, HIV and hepatitis by type of disease, Y_{5D} – Standardised preventable and treatable mortality) and higher mortality rates at work (Y_{8D}) and due to road accidents (Y_{10D}). In order to improve the above indicators, these countries should improve their health care systems so that they can detect and treat diseases more effectively, especially preventable ones. That may affect the increase in the Y_{1S} (Healthy life years at birth) index, which assumed the lowest value for Latvia and was the most positive for Sweden. On the other hand, higher rates of road fatalities in less developed EU countries may be associated with lower road quality, lower quality of used vehicles and the lack of motorway networks. Hence, investment in road infrastructure is needed in these Member States.

In former post-communist countries, the exposure to particulate air pollution (Y_{11D}) was also higher. The highest value of the indicator concerned Bulgaria (1,606), followed by Romania (1,261), which joined the community in 2007. For Sweden, ranked first, the indicator was several times lower in 2020 and reached the level 258. The implication is that countries classified in group IV need to focus more on improving air quality and the environment, which will reduce exposure to particulate air pollution and could lead to a reduction in pollution-related mortality. Countries that have been in the EU since 2004 have lower levels of Y_{9D} (Population living in households considering that they suffer from noise, by poverty status) compared to other countries. In this case, southern European countries are leading the way: Malta (30.8%) and Portugal (25.1%) and northern (the Netherlands – 25.5%). High noise and air pollution with dust significantly impact public health, especially on the appearance or exacerbation of many diseases, and thus may cause serious problems that may prevent further professional work (Strzelecka, 2021).

People's health also depends on themselves. Sometimes it is enough just to take care of one's physical activity, maintain a healthy weight, not abuse alcohol and not smoke cigarettes. All these factors contribute to the lifestyle of individuals and society as a whole. The analysis

of indicators related to the care of one's health also shows significant negligence of the new Member States in this respect. Countries at the end of the ranking (see Table 3) are often characterised by poor health indicators. Lack of physical activity outside of work affects as much as 84% of the Romanian population regardless of the study period, with the share of the country's population rating their health as good or very good exceeding the EU average. In comparison, in Sweden, which ranks first, the share of the population that does not spend time on physical activity was 23.8% in 2020 (0.8 p.p. less than in 2014), and a rating of their health as good or very good was marked by 76.5% of the population. According to Gavurova, Rigelsky and Ivankova (2020), the perception of health by individuals is very important. If people feel sick, their work efficiency is not optimal, the consumption of medicines increases and their quality of life decreases. In addition, the negative perception of health as a whole has an impact on the productivity of workers and, consequently, on the economic situation of countries.

Health is also influenced by diet and the associated weight of a person. Poor eating habits can lead to overeating and obesity, which can be treated as a chronic disease. The highest obesity rate (Y_{7D}) was for Croatia, located in typological group IV (64.8%), with other countries in this group also exceeding the EU average of 55.3%.

A study similar to the one included in this paper was conducted by Seke et al. (2013). They analysed 31 European countries and the statistical data (from Eurostat) related to 2011. According to the results, Norway and Iceland are the top two European countries in terms of public health sustainability, while Romania, Lithuania and Latvia, some of the newest EU member states, ranked the lowest. The results also show that the most important variables in the evaluated countries are: “years of healthy life at birth, women” ($r^2 = 0.880$), “years of healthy life at birth, men” ($r^2 = 0.864$), “rate of death due to chronic diseases, men” ($r^2 = 0.850$) and “years of healthy life of women aged 65 years” ($r^2 = 0.844$).

Similar conclusions are drawn by the research of Konarzewska (2020), who constructed a ranking for 28 EU countries using multi-criteria statistical analysis. The research results indicate that Sweden, the Netherlands, Ireland and Denmark are the closest to the implementation of SDG3. The worst situation is in Romania, Latvia, Lithuania and Bulgaria.

Verra et al. (2019) attempted to demonstrate differences in the implemented health and safety regulations of workplaces in the countries of the European Union. However, they did not limit themselves to health protection but also included health promotion measures. The data came from 40,584 companies in 2014. For the purposes of the survey, eight indicators were selected for analysis: the first three measured the more “traditional” health and safety system measures that are necessary to prevent physical harm, and the following three measured indicators that prevent broader psychosocial health problems in terms of addiction prevention (cigarettes, alcohol, drugs, among others), and two indicators focused on health promotion (promoting exercise at work, raising awareness of healthy eating). Each indicator determined how often employers introduced these occupational health and safety measures in their

companies. The study results showed that all Member States addressed the basic principles of occupational health and safety. The most significant differences were noted in the field of prevention of psychosocial problems and health promotion. It appears that psychosocial risks and health promotion are often included in national policies but are not consistently implemented by employers. EU countries must find ways to stimulate establishments to improve safety, health and well-being actively.

The assessment of the correlation between the promotion of human rights and health protection in 161 countries was conducted by Akgungor et al. (2019). A regression model showed that economic, social and cultural rights variables explained differences in health results. They classified countries using cluster analysis and found that those with high respect for economic, social and cultural rights had better health results.

Research and evaluation of health-related interventions usually end with external funding, regardless of whether the research tests the effectiveness of a new health promotion intervention or evaluates the effectiveness of a more comprehensive community-oriented programme (Scheirer, Dearing, 2011). Walugembe et al. (2019) consider how to support the sustainability of beneficial interventions to maximise limited resources, realise long-term public health outcomes, and not lose community support in a sustainable development setting.

The article by De Neve and Sachs (2020) examines the empirical links between achieving the Sustainable Development Goals (SDGs) and subjective well-being, which is one component of human health. Representative data for the whole world for the years 2016-2018 came from the Gallup World Poll survey, which is constantly surveyed by 160 countries representing about 98% of the adult world population. In the survey questionnaire, respondents were asked to evaluate their current life on a scale of 0-10, where 0 is the worst possible life, and 10 is the best. Research has shown that the overall correlation between SDGs and well-being is much lower in regions where the majority are developing countries. It turned out that only in Europe, Asia and the Americas there is a strong, statistically significant correlation between SDGs and well-being. The analysis of the world's regions in terms of their focus on achieving sustainable development goals has shown that in both Americas, health goals play the most important role in driving regional differences in well-being, whereas, for example, for Europe, these are economic goals and for sub-Saharan Africa social goals.

Governments in individual European countries have different approaches to health issues. Some countries have focused on solving problems with smoking (Joossens, Raw, 2006), while others prioritise preventive actions in reducing the incidence of certain diseases, e.g. cancer (Arbyn et al., 2010). Some governments have invested considerable resources to make their roads safe, while others have not (WHO, 2009). Mackenbach and McKee (2013) assessed the extent to which 43 European countries differed in the implementation of health policy in 10 different areas and used these differences to examine the role of political, economic and social determinants of health policy. They developed a set of 27 indicators in the field of smoking, alcohol consumption, nutrition, fertility, pregnancy and childbirth, child health,

infectious diseases, detection and treatment of hypertension, screening for cancer, road safety and air pollution. In exploratory regression analyses, they linked these indicators to the following six factors: national income, survival/self-expression values, democracy, government effectiveness, left-wing participation in government, and ethnic fractionation. Their findings show significant differences among European countries regarding health policy processes and indicators. Overall, Sweden, Norway and Iceland perform best and Ukraine, the Russian Federation, and Armenia perform worst. In Western Europe, some countries, such as Denmark and Belgium, are far worse off than their neighbours.

6. Conclusions

Sustainable development is now a priority issue for the lives and health of future generations. According to a study commissioned by the World Economic Forum, three out of four adults (74%) worldwide are aware of the United Nations Sustainable Development Goals (Tedeneke, 2019). The survey, conducted by the Ipsos Group, asked nearly 20,000 people aged 16-74 from 28 countries how well they know the SDGs and which SDGs they consider to be the most important. The following goals were rated highest: SDG2 – zero hunger, SDG6 – clean water and sanitation, SDG3 – good health and well-being, SDG7 – affordable and clean energy, and SDG14 – life below water. As one can see, the first three include the objective that is the subject of this publication.

In view of the significant and urgent challenges of sustainable development, there is growing interest among researchers, politicians and individuals in the issues of health protection and promotion in light of the SDG3 of the 2030 Agenda. Public and scientific debates in this area show that the threats of the modern world are being seriously addressed. An interdisciplinary approach is necessary, as this is the only way to succeed.

There is a global acceptance that health and social well-being are determined by many factors outside the health system, which include socioeconomic conditions, food and communication consumption patterns, demographic patterns, learning environments, family patterns, cultural factors and global environmental changes. In such a situation, efforts to promote and protect health should include strengthening the health system and action at the individual and community level. The negative effects of global climate change, a sedentary lifestyle, the increasing frequency of natural disasters, the financial crisis, threats to security, are increasing the challenges currently facing public health (Kumar, Preetha, 2012).

Following its values, the EU should strive to promote the prosperity, security and interests of all citizens, and sustainable development will have to constantly inspire the political decision-making process of the European Commission and guide the development of the post-EU2020 growth strategy (Molero et al., 2021).

Our research aimed to compare the situation in European Union countries from the point of view of how far they are from the targets of the 2030 Agenda for Sustainable Development formulated for Goal 3 – Ensure healthy lives and promote well-being for all at all ages. In both research periods (2014 and 2020), the best situation in terms of implementation of SDG3 was in the countries of Northern and Western Europe, with Sweden invariably leading the ranking. This country is characterized by a high level of stimulant indicators adopted for the study and a low level of indicators adversely affecting the studied phenomenon (destimulant). Over 76% of Sweden's residents rate their health as good or very good. The positions of the countries occupying the last positions in the table, i.e. Latvia (27th position) and Romania (26th position), did not change in the analyzed periods. These countries are characterized primarily by a low level of healthy life years at birth (Y_{1S}) and a high level of indicators related to mortality (Y_{4D} – standardized death rate due to tuberculosis, HIV and hepatitis by type of disease and Y_{5D} – standardized preventable and treatable mortality). The perception of health by the inhabitants of Latvia is associated with the unfavorable levels of most of the indicators adopted for the study, moreover, less than 50% of the country's population assesses their health as good or very good. In the case of Romania, the situation is quite different – the country, which takes a very unfavorable position due to the implementation of SDG3, due to the level of the Y_{2S} indicator (share of people with good or very good perceived health) was rated above the average for all Member States. It should be noted that the inhabitants of this country, among the EU countries, spend the least time on health-promoting physical activity, as evidenced by the highest level of the Y_{13D} indicator among the member states. This confirms that the perception of one's own health and lifestyle depends on many factors, e.g. environmental, cultural and socio-economic.

The research presented in this paper can serve as a starting point for further research on sustainable development indicators in the area of health promotion and protection. SDG3 should also be linked to other SDGs, especially those related to environmental risks and the fight against poverty.

References

1. Acharya, S., Lin, V., Dhingra, N. (2018). The role of health in achieving the sustainable development goals. *Bulletin of the World Health Organization*, Vol. 96, No. 9, pp. 591-591A, doi: 10.2471/BLT.18.221432.
2. Adam, L., Kroupa, T. (2017). The intermediate set and limiting super differential for coalitional games: between the core and the Weber set. *International Journal of Game Theory*, Vol. 46, No. 4, pp. 891-918, <https://doi.org/10.1007/s00182-016-0557-3>.

3. Adshead, F., Thorpe, A., Ruter, J. (2006). Sustainable development and public health: A national perspective. *Public Health, Vol. 120, No. 12*, pp. 1102-1105, <https://doi.org/10.1016/j.puhe.2006.10.003>.
4. Akgungor, S., Alaei, K., Chao, W.F., Harrington, A., Alaei, A. (2019). Correlation between human rights promotion and health protection: a cross country analysis. *International Journal of Human Rights in Healthcare, Vol. 13, No. 1*, pp. 72-92, <https://doi.org/10.1108/IJHRH-07-2018-0050>.
5. Allender, S., Colquhoun, D., Kelley, P. (2011). Competing discourses of workplace health. *Journal for the Social Study of Health, Illness and Medicine, Vol. 10, Iss. 1*, pp. 75-93, <https://doi.org/10.1177/1363459306058989>.
6. Ansari, W.E., Privett, S. (2005). Health protection: Communicable disease, public health and infection control educational programmes – a case study from the UK. *Public Health, Vol. 119, No. 4*, pp. 328-340, <https://doi.org/10.1016/j.puhe.2004.06.004>.
7. Arbyn, M., Anttila, A., Jordan, J., Ronco, G., Schenck, U., Segnan, N., Wiener, H., Herbert, A., von Karsa, L. (2010). European Guidelines for Quality Assurance in Cervical Cancer Screening. Second Edition – Summary Document. *Annals of Oncology, Vol. 21, No. 3*, pp. 448-458, <https://doi.org/10.1093/annonc/mdp471>.
8. Ayres, J.G., Agius, R. (2004). Health protection and sustainable development. *The BMJ, Vol. 328, No. 7454*, pp. 1450-1451, <https://doi.org/10.1136/bmj.328.7454.1450>.
9. Backholer, K., Freak-Poli, R., Peeters, A. (2012). Daily step-count and change in waist circumference during a workplace pedometer program. *Open Journal of Preventive Medicine, Vol. 2, No. 2*, pp. 249-256, <https://doi.org/10.4236/ojpm.2012.22036>.
10. Bąk, I. (2014). Influence of feature selection methods on classification sensitivity based on the example of a study of Polish voivodship tourist attractiveness. *Folia Oeconomica Stetinensia, Vol. 13, No. 2*, pp. 134-145, doi: 10.2478/fofi-2013-0017.
11. Bozkurt, F., Ergen, A. (2015). Promoting Healthy Lifestyle for Sustainable Development. In: U. Akkucuk (Ed.), *Handbook of Research on Developing Sustainable Value in Economics, Finance, and Marketing* (pp. 110-123). United States: IGI Global.
12. Chan, C.B., Ryan, D.A., Tudor-Locke, C. (2004). Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Preventive Medicine, Vol. 39, No. 6*, pp. 1215-1222, <https://doi.org/10.1016/j.jpmed.2004.04.053>.
13. Cheba, K., Bąk, I. (2020). Sustainable Development and Green Economy in the European Union Countries – Statistical Analysis. In: K. Jajuga, J. Batóg, M. Walesiak (Eds.), *Classification and Data Analysis. Theory and Applications* (pp. 163-185). Springer: Cham, https://doi.org/10.1007/978-3-030-52348-0_11.
14. Chen, L., Hannon, P.A., Laing, S.S., Kohn, M.J., Clark, K., Pritchard, S., Harris, J.R. (2015). Perceived workplace health support is associated with employee productivity. *American Journal of Health Promotion, Vol. 29, No. 3*, pp. 139-146.

15. De Neve, J.E., Sachs, J.D. (2020). The SDGs and human well-being: a global analysis of synergies, trade-offs, and regional differences. *Scientific Reports*, Vol. 10, No. 15113, <https://doi.org/10.1038/s41598-020-71916-9>.
16. Dugdill, L. (2000). Developing a holistic understanding of workplace health: the case of bank workers. *Ergonomics*, Vol. 43, No. 10, pp. 1738-1749, <https://doi.org/10.1080/001401300750004140>.
17. Eurostat (2022). Sustainable Development Goals – Overview. Retrieved from: <https://ec.europa.eu/eurostat/web/sdi>, 07.08.2022.
18. Farhud, D. (2017). Life Style and Sustainable Development. *Iranian Journal of Public Health*, Vol. 46, No. 1, pp. 1-3.
19. Fortune, K., Becerra-Posada, F., Buss, P.C., Galvão, L.A., Contreras, A., Murphy, M., Rogger, C., Keahon, G.E., de Francisco, A. (2018). Health promotion and the agenda for sustainable development, WHO Region of the Americas. *Bulletin of the World Health Organization*, Vol. 96, pp. 621-626, <http://dx.doi.org/10.2471/BLT.17.204404>.
20. Gavurova, B., Rigelsky, M., Ivankova, V. (2020). Perceived health status and economic growth in terms of gender-oriented inequalities in the OECD countries. *Journal of Scientific Papers Economics & Sociology*, Vol. 13, No. 2, pp. 245-257, doi: 10.14254/2071-789X.2020/13-2/16.
21. Hellwig, Z. (1968). Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju oraz zasoby strukturę wykwalifikowanych kadr. *Przegląd Statystyczny*, Vol. 15, No. 4, pp. 307-327.
22. Hymel, P.A., Loeppke, R.R., Baase, C.M., Burton, W.N., Hartenbaum, N.P., Hudson, T.W., McLellan, R.K., Mueller, K.L., Roberts, M.A., Yarborough, C.M., Konicki, D.L., Larson, P.W. (2011). Workplace Health Protection and Promotion: A New Pathway for a Healthier- and Safer-Workforce. *Journal of Occupational and Environmental Medicine*, Vol. 53, No. 6, pp. 695-702, <https://doi.org/10.1097/JOM.0b013e31822005d0>.
23. Jonathan, G.K., Mbogo, R.W. (2016). Maintaining Health and Safety at Workplace: Employee and Employer's Role in Ensuring a Safe Working Environment. *Journal of Education and Practice*, Vol. 7, No. 29, pp. 1-7. Retrieved from: <https://files.eric.ed.gov/fulltext/EJ1118861.pdf>, 23.06.2022.
24. Joossens, L., Raw, M. (2006). The Tobacco Control Scale: a new scale to measure country activity. *Tobacco Control*, Vol. 15, pp. 247-253, doi: 10.1136/tc.2005.015347.
25. Konarzewska, I. (2020). Meeting the Sustainable Development Goal of Good Health and Well-Being by European Union Countries in 2017. *Comparative Economic Research*, Vol. 23, No. 2, pp. 53-68, <http://dx.doi.org/10.18778/1508-2008.23.12>.
26. Lapata, M. (2006). Automatic Evaluation of Information Ordering: Kendall's Tau. *Computational Linguistics*, Vol. 32, pp. 471-484.
27. Lassen, A.D., Beck, A., Leedo, E., Andersen, E.W., Christensen, T., Mejborn, H., Thorsen, A.V., Tetens, I. (2014). Effectiveness of offering healthy labelled meals in improving the

- nutritional quality of lunch meals eaten in a worksite canteen. *Appetite*, Vol. 75, pp. 128-134, <https://doi.org/10.1016/j.appet.2013.12.005>.
28. Liu, K. (2020). *Protection of Health and Safety at the Workplace. A Comparative Legal Study of the European Union and China*. Singapore: Springer, <https://doi.org/10.1007/978-981-15-6450-5>.
29. Macassa, G. (2022). Can Sustainable Health Behaviour Contribute to Ensure Healthy Lives and Wellbeing for All at All Ages (SDG 3)? A Viewpoint. *Journal of Public Health Research*, Vol. 10, Iss. 3, No. 2051, <https://doi.org/10.4081/jphr.2021.2051>.
30. Mackenbach, J.P., McKee, M. (2013). A comparative analysis of health policy performance in 43 European countries. *European Journal of Public Health*, Vol. 23, No. 2, pp. 195-201, <https://doi.org/10.1093/eurpub/cks192>.
31. Mendes, R., Dias, E.C. (2011). Health Protection, Health Promotion, and Disease Prevention at the Workplace. In: T.L. Guidotti (Ed.), *Global Occupational Health*. New York: Oxford University Press, doi: 10.1093/acprof:oso/9780195380002.003.0018.
32. Menne, B., Aragon de Leon, E., Bekker, M., Mirzikashvili, N., Morton, S., Shriwise, A., Tomson, G., Vracko, P., Wippel, C. (2020). Health and well-being for all: an approach to accelerating progress to achieve the Sustainable Development Goals (SDGs) in countries in the WHO European Region. *European Journal of Public Health*, Vol. 30, Iss. 1, pp. i3-i9, <https://doi.org/10.1093/eurpub/ckaa026>.
33. Młodak, A. (2014). On the construction of an aggregated measure of the development of interval data. *Computational Statistics*, Vol. 29, Iss. 5, pp. 895-929, doi: 10.1007/s00180-013-0469-7.
34. Mohammed, A.J., Ghebreyesus, T.A. (2018). Healthy living, well-being and the sustainable development goals. *Bulletin of the World Health Organization*, Vol. 96, Iss. 9, pp. 590-590A, <https://doi.org/10.2471/BLT.18.222042>.
35. Molero, A., Calabro, M., Vignes, M., Gouget, B., Gruson, D. (2021). Sustainability in Healthcare: Perspectives and Reflections Regarding Laboratory Medicine. *Annals of Laboratory Medicine*, Vol. 41, Iss. 2, pp. 139-144, <https://doi.org/10.3343/alm.2021.41.2.139>.
36. Okazaki, N., Yutaka, M., Mitsuru, I. (2004). *Improving chronological sentence ordering by precedence relation*. Proceedings of the 20th International Conference on Computational Linguistics, Geneva, Switzerland (23-27 August), pp. 750-756.
37. Pechersky, S. (2015). A note on external angles of the core of convex TU games, marginal worth vectors and the Weber set. *International Journal of Game Theory*, Vol. 44, Iss. 2, pp. 487-498, <https://doi.org/10.1007/s00182-014-0441-y>.
38. Porritt, J. (2005). Healthy environment – healthy people: The links between sustainable development and health. *Public Health*, Vol. 119, Iss. 11, pp. 952-953, <https://doi.org/10.1016/j.puhe.2005.08.004>.

39. Pronk, N.P., Kottke, T.E. (2009). Physical activity promotion as a strategic corporate priority to improve worker health and business performance. *Preventive Medicine, Vol. 49, Iss. 4*, pp. 316-321.
40. Pulido, M., Sanchez-Soriano, J. (2009). On the core, the Weber set and convexity in games with a priori unions. *European Journal of Operational Research, Vol. 193, Iss. 2*, pp. 468-475, doi: 10.1016/j.ejor.2007.11.037.
41. Sanderson, M., Soboroff, I. (2007). *Problems with Kendall's Tau*. Proceedings of the SIGIR '07. 30th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval, Amsterdam, The Netherlands (23-27 July), pp. 839-840, <https://doi.org/10.1145/1277741.1277935>.
42. Sartorius, N. (2006). The Meanings of Health and its Promotion. *Croatian Medical Journal, Vol. 47, Iss. 4*, pp. 662-664.
43. Scheirer, M.A., Dearing, J.W. (2011). An Agenda for Research on the Sustainability of Public Health Programs. *American Journal of Public Health, Vol. 101, Iss. 11*, pp. 2059-2067, <https://doi.org/10.2105/AJPH.2011.300193>.
44. Seke, K., Petrovic, N., Jeremic, V., Vukmirovic, J., Kilibarda, B., Martic, M. (2013). Sustainable development and public health: rating European countries. *BMC Public Health, Vol. 13, Iss. 77*, pp. 1-7, doi: 10.1186/1471-2458-13-77.
45. Sorensen, G., Stoddard, A., Hunt, M.K., Hebert, J.R., Ockene, J.K., Avrunin, J.S., Himmelstein, J., Hammond, S.K. (1998). The effects of a health promotion-health protection intervention on behavior change: the WellWorks Study. *American Journal of Public Health, Vol. 88, Iss. 11*, pp. 1685-1690.
46. Sorensen, G., Stoddard, A., Ockene, J.K., Hunt, M.K., Youngstrom, R. (1996). Worker Participation in an Integrated Health Promotion/Health Protection Program: Results from the WellWorks Project. *Health Education Quarterly, Vol. 23, Iss. 2*, pp. 191-203, <https://doi.org/10.1177/109019819602300205>.
47. Strzelecka, A. (2021). The Field of “Public Health” as a Component of Sustainable Development – Poland Compared to the European Union. *Sustainability, Vol. 13, Iss. 18, No. 10351*, <https://doi.org/10.3390/su131810351>.
48. Swerissen, H., Crisp, B.R. (2004). The sustainability of health promotion interventions for different levels of social organization. *Health Promotion International, Vol. 19, Iss. 1*, pp. 123-130, <https://doi.org/10.1093/heapro/dah113>.
49. Tedeneke, A. (2019). *Global Survey Shows 74% Are Aware of the Sustainable Development Goals*. World Economic Forum. Retrieved from: <https://www.weforum.org/press/2019/09/global-survey-shows-74-are-aware-of-the-sustainable-development-goals>, 20.06.2022.
50. Verra, S.E., Benzerger, A., Jiao, B., Ruggeri, K. (2019). Health Promotion at Work: A Comparison of Policy and Practice Across Europe. *Safety and Health at Work, Vol. 10, Iss. 1*, pp. 21-29, <https://doi.org/10.1016/j.shaw.2018.07.003>.

51. Walugembe, D.R., Sibbald, S., Le Ber, M.J., Kothari, A. (2019). Sustainability of public health interventions: where are the gaps? *Health Research Policy and Systems, Vol. 17, No. 8*, pp. 1-7, <https://doi.org/10.1186/s12961-018-0405-y>.
52. Weber, A. (1971). *Theory of Location of Industries*. New York: Russel & Russel.
53. WHO (2009). European status report on road safety. Towards safer roads and healthier transport choices. Retrieved from: <https://apps.who.int/iris/bitstream/handle/10665/107266/9789289041768-eng.pdf?sequence=1&isAllowed=y>, 21.06.2022.
54. WHO (2018). Draft thirteenth general programme of work, 2019–2023. Report by the Director-General. Retrieved from: https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_4-en.pdf?ua=1or, 18.06.2022.
55. WHO (2019). Progress report on the roadmap to implement the 2030 Agenda for Sustainable Development, building on Health 2020, the European policy for health and well-being. Retrieved from: https://www.euro.who.int/__data/assets/pdf_file/0011/410006/69wd08e_E_RoadmapImplementation2030Agenda_190380.pdf, 24.06.2022.

REGIONAL DIVERSITY OF THE ENVIRONMENTAL QUALITY OF LIFE IN POLAND

Iwona BAŁ

Department of Applied Mathematics in Economics, Faculty of Economics, West Pomeranian University of Technology; iwona.bak@zut.edu.pl, ORCID: 0000-0001-8959-7269

Purpose: The paper aims to assess the variation in the environmental quality of life in Poland's voivodships in 2021. The study uses indicators to monitor the links between the natural environment and society. They indicate how environmental conditions affect the quality of life and well-being of the population.

Design/methodology/approach: The study used one of the taxonomic methods - the TOPSIS method, based on which the voivodships were divided into four classes characterised by similar levels of environmental quality of life.

Findings: The study results showed that Podkarpackie, Lubuskie, Małopolskie and Warmińsko-Mazurskie voivodships, characterised by high natural values and relatively low environmental impact ratios compared to other voivodships and the national average, were in the best group due to the environmental quality of life. The last places belonged to the Pomorskie, Opolskie, Łódzkie and Śląskie Voivodships. Most of them are industrial, which means that the indicators of environmental impact, especially air pollution and collected waste, are relatively high and exceed the national average.

Social implications: The research results presented in the article may be useful for the diagnosis of current results and the revision of the environmental policy of the entire country as well as their individual regions in the future.

Originality/value: The article fits into contemporary debates on the effectiveness of implementing the concept of green economy as a tool for sustainable development.

Keywords: environmental quality of life, sustainable development; green economy; TOPSIS method.

Category of the paper: Scientific paper.

1. Introduction

An important determinant of socioeconomic development and quality of life is the natural environment, whose resources are the foundation of economic activity and the integrity of societies (Kryk, 2015). Increasingly, the societies of many countries, including highly

developed ones, are experiencing the effects of growing crises (ecological and energy) and the consequences of global warming in the form of extreme climatic events (Łącka, 2022). The deterioration of living conditions and food production is unfolding in many countries (Carayannis, Barth, Campbell, 2012). The negative effects of unsustainable consumption of natural resources and emissions are being felt in virtually every country (Hall, Mynick, Williams, 1991; Kumar et al., 2020). Therefore, society should consciously manage the resources of the natural environment, maintaining their high biodiversity, landscape, aesthetics, "health", and cultural values to maintain balance in ecosystems. In this way, it is possible to use the natural environment and thus meet human needs, resulting in a reasonable quality of life.

The growing awareness of the human impact on the environment and the irreversibility of climate change, as well as the responsibility of present societies for the living conditions of future generations, resulted in the concept of sustainable development and the green economy. The use of the adjective "green" in relation to economic phenomena signifies symbolic attention to the importance and need to protect the natural factor in the economy (Adamowicz, 2022).

The term "green economy" was popularised due to the economic crisis experienced from 2008 to 2010. It happened mainly as a result of the involvement of countries that, through the adopted recovery programmes, initiated projects related to the transformation of economies towards environmentally friendly solutions. The green economy is believed to best express all three aspects of sustainable development: economic, social and environmental. It aims to improve people's well-being while reducing ecological risk and the scarcity of natural resources (Ryszawska, 2013). Several definitions of the green economy can be found in the literature, all of which incorporate respect for the environment and address environmental costs in economic activity. It is most often monitored by indicators, which can be classified into four thematic areas, i.e. (Daniek, 2020; Bąk, Cheba, 2020):

1. natural capital, including indicators describing the state of the natural environment,
2. environmental and resource productivity of the economy – indicators showing the links between the natural environment and the economy have been included in this group,
3. the environmental dimension of quality of life of the population – presenting indicators to monitor the links between the natural environment and society,
4. economic opportunities and policy responses – including indicators that characterise economic and social impact instruments, creating the desired development directions to greening the economy.

In terms of the considerations presented in this article, the attention is drawn to the third group, which includes indicators related to air pollution, municipal waste, land management, population access to essential water and wastewater services, and natural values.

This study aims to assess the diversity of environmental quality of life in Polish voivodships. The research presented in this article contributes to contemporary debates on the effectiveness of implementing the green economy concept as a tool for sustainable development. The analysis was conducted on the voivodships of Poland in 2021. The statistical

data were taken from the Local Data Bank of the Central Statistical Office (GUS) in Poland (www.stat.gov.pl). One of the taxonomic methods - the TOPSIS method – was used to achieve the research objective.

The layout of this article includes an introduction, which outlines the main purpose of the paper and explains the authors' main motivations for researching the environmental dimension of quality of life in Poland's voivodships. In addition, a review of the literature concerning the issue under study is included. The following section discusses the statistical data used in the article and describes the research procedure. Finally, the results of the research and the conclusions of the research are presented.

2. Quality of life and the environment

Quality of life is a category increasingly present in the studies and research of representatives of many sciences: economics, sociology, psychology, medicine, and pedagogy, but also in the statements of politicians and social development strategy documents. This issue goes beyond the material dimension, and it is a relative and complex concept (Keles, 2012) that addresses many aspects of human existence, including the environment (Baran, 2018). It is also recognised as the essence of sustainable development. According to Kusterka-Jefmańska (2010), the essence of sustainable development is to permanently improve the quality of human life by forming the right proportions using three strengths of capital: ecological, economic and social. Extreme environmental events such as natural disasters (earthquakes, cyclones, floods, droughts and volcanic eruptions) and epidemics can cause increased death, injury and disease levels. In the long term, drastic environmental changes can also worsen human health through climate change (Streimikiene, 2015). The conflict between human needs and environmental sustainability has led many governments to introduce the concept of sustainable development in planning future development activities (Jusoff, 2020). Improving the quality of life has become the main goal of sustainable development and is assessed using various factors and indicators (Streimikiene, 2015).

It cannot be denied that, in material terms, the quality of life has improved over the last 50 years. Nowadays, we have access to many amenities, purchase more luxury goods and live longer. However, other areas of life have deteriorated; for example, there has been a significant increase in the number of people suffering from allergic and civilisation-related lifestyle diseases, including cardiovascular diseases caused by being overweight, the lack of exercise or stress. The quality of the local environment directly impacts people's health and well-being. An unpolluted environment gives satisfaction, improves mental well-being, and allows people to unwind from the stresses of daily life and be physically active. Access to resources such as green areas, forests and rivers is an important aspect of the quality of life.

Air pollution is also vital for public health (Ryńska, 2011; Han, 2020). Exposure to PM 2.5 concentration is associated with increased respiratory symptoms (Pirozzi et al., 2018) and has a harmful effect on mental health (Genc et al., 2012). It has also been confirmed that exposure to air pollution reduces enthusiasm for participation in outdoor physical activity (Roberts, Voss, Knight, 2014).

Intensive development generates many environmental requirements. According to Jusoff (2020), development is often cited as one of the major agents that have led to the transformation of the four main components of the natural environment - land, water, air and biological aspects. The ecological crisis made people aware of the scale of threats that concerned both the objective and subjective quality of life. For this reason, in evaluating the quality of life, attention is paid to protecting the environment and conducting economic activities following the principles of sustainable development. The positive aspects of the environmental impact on the general well-being of the population are often cited. Studies by many authors clearly indicate a positive relationship between the number of green spaces and health (De Sousa, 2006; Van Dillen et al., 2012; Dadvand et al., 2016; Van Den Berg et al., 2016). Chang et al. (2020) identify access to nature and scenic beauty as an important factor influencing health, which affects both physical and mental health. According to De Sousa (2006), brownfield redevelopment and creating green spaces in cities are two initiatives gaining support in the U.S. because they are seen as important elements in fostering urban revitalisation and more sustainable development.

The main factor affecting the quality of environmental services provided (Osbaldiston, Sheldon, 2003) is environmental responsibility implemented through activities such as energy saving, the use of renewable resources (Bąk, Cheba, 2023) and sustainable consumption. To help offset the progressive degradation of the environment in the 21st century, people will need to significantly change their habits (Howard, 2000; Winter, 2000) to move towards environmentally oriented behaviour. Environmentally friendly behaviour involves saving natural resources and energy, using renewable energy sources instead of fossil fuels, recycling waste, and properly managing and disposing wastewater. It will be beneficial to societies that also directly use environmental resources and services, such as water, clean air, land, forests and the previously mentioned access to green spaces, which allow for the satisfaction of basic needs and influence the meaningful use of leisure time (Balestra, Dottori, 2012).

3. Statistical material and method

Table 1 presents a list of diagnostic features used in the study. They concern indicators describing aspects related to the environmental quality of life. The influence of each feature on the analysed phenomenon was also indicated by classifying it into a set of characteristics

stimulating development in the area (symbol S) or destimulating this development (symbol D). It should be noted that over 56% of the indicators adopted for the study are stimulants.

Table 1.
Base of indicators

Symbol	Name	\bar{x}	V_s (%)	As
X_{1D}	Emissions of particulate pollutants from plants which are particularly onerous on air purity in tons per 1 km ²	0.08	91.26	3.00
X_{2D}	Emission of gaseous air pollutants (without carbon dioxide) from plants of particular concern to air purity in tonnes per 1 km ²	785.39	103.95	1.48
X_{3D}	Municipal waste collected per capita in kg	212.98	17.57	-0.49
X_{4D}	Industrial and municipal wastewater in % of wastewater requiring treatment	96.86	4.97	-2.18
X_{5D}	Wastewater discharged to waters or land containing substances particularly harmful to the aquatic environment hm ³ per 1 km ²	0.08	144.87	2.24
X_{6S}	Share of treated wastewater in wastewater requiring treatment (%)	91.84	12.78	-1.86
X_{7S}	Population using wastewater treatment plants as % of the total population	74.85	9.08	-0.77
X_{8S}	Urban population using water supply as % of the total population	96.84	1.56	-0.39
X_{9S}	Urban population using sewers as % of the total population	90.91	2.50	0.25
X_{10S}	Urban population using mains gas as % of the total population	71.84	12.94	-1.23
X_{11S}	Share of legally protected areas in the total area %	33.46	37.77	1.09
X_{12S}	Area of parks, greens and neighbourhood green areas as % of the total area	0.21	70.83	2.82
X_{13S}	Forest cover (%)	30.34	22.68	1.24
X_{14S}	Share of green areas in % of the total area	0.63	71.51	1.73
X_{15D}	Agricultural and forestry land excluded from agricultural production in ha per 1 km ²	2.11	53.14	0.47
X_{16D}	Share of devastated and degraded land requiring redevelopment as % of the total area	0.21	45.31	0.54

Source: own elaboration.

The preliminary analysis of the diagnostic characteristics shows significant disparities between surveyed voivodships in terms of the environmental quality of life. These are indicated by high values of the coefficient of variation (V_s) and the asymmetry coefficient (A_s). The coefficient of variation ranges from 1.56% ($X_{1.8S}$ – urban population using the water supply in % of the total population) to 144.87% ($X_{1.5D}$ – wastewater discharged to waters or land containing substances particularly harmful to the aquatic environment hm³ per 1 km²), with values exceeding 30% for most features (Table 1). Most destimulant indicators show moderate to high right-sided asymmetry. It means that the indicators adopted for the study for most voivodships assume values below the average, which is a favourable situation. Only the decomposition of two destimulant features is characterised by moderate and strong left-sided asymmetry. It means that for most voivodships, municipal waste collected per capita in kg (X_{3D}) and industrial and municipal wastewater in % of wastewater requiring treatment (X_{4D}) are above the national average.

The distributions of most stimulant indicators are also unfavourable, with as many as five of them having a distribution with right-sided asymmetry. It follows that in the case of most voivodships, their values were below the average. High right-hand asymmetry is particularly relevant to environmental indicators. These include the share of legally protected areas in % of the total area (X_{11S}), the area of parks, greenery and green areas in % of the total area (X_{12S}), forest cover (X_{13S}) and the share of green areas in the total area (X_{14S}).

The paper uses one of the methods of multivariate statistical analysis - the TOPSIS method - to classify Poland's voivodships in terms of environmental quality of life.

The TOPSIS method, i.e. Technique for Order Preference by Similarity to an Ideal Solution, proposed and described by Hwang and Yoon in 1981, is one of the multi-criteria methods of decision-making (Yoon, Kim 2017; Parida Sahoo, 2013; Roszkowska, 2019; Zulqarnain et al., 2020), it is often used for the linear ordering of multivariate objects (Dmytrów, 2018; Galik et al., 2022). The procedure of TOPSIS method proceeds in the following steps:

Stage 1. Determination of the matrix:

$$X = [x_{ij}] \quad (1)$$

where:

i – the number of the object ($i = 1, 2, \dots, n$),

j – the number of the diagnostic feature ($j = 1, 2, \dots, m$),

x_{ij} – the value of the j th feature diagnostic for the i -th object.

Stage 2. Normalisation (ensuring comparability) of diagnostic feature values based on the formula:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}} \quad (2)$$

where:

z_{ij} – the value of j -th of normalised feature diagnostically for the i -th object.

Stage 3. For each standardised diagnostic feature, the determination of two reference points that determine the coordinates of the Positive Ideal Solution and the Negative Ideal Solution, respectively – a pattern and an antipattern:

$$v_j^+ = \begin{cases} \max_i v_{ij} & \text{for stimulant} \\ \min_i v_{ij} & \text{for destimulant} \end{cases} \quad (3)$$

$$v_j^- = \begin{cases} \min_i v_{ij} & \text{for stimulant} \\ \max_i v_{ij} & \text{for destimulant} \end{cases} \quad (4)$$

where:

v_j^+ – the j -th coordinate of the Positive Ideal Solution,

v_j^- – the j -th coordinate of the Negative Ideal Solution.

Stage 4. For all objects, the calculation of Euclidean distances from the pattern and the antipattern, respectively:

$$d_i^+ = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^+)^2} \quad (5)$$

$$d_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^-)^2} \quad (6)$$

where:

d_i^+ – Euclidean distance of the i th object from the Positive Ideal Solution,

Stage 5. Determination of the value of the aggregate variable denoting the relative proximity of the i th object to the Positive Ideal Solution according to the formula:

$$R_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (7)$$

where:

$$0 \leq R_i \leq 1.$$

The preferred object has the smallest distance from the pattern and, at the same time, the largest distance from the antipattern, i.e. it assumes the largest value of the coefficient R_i .

Stage 6. Linear ordering of objects due to the non-increasing value of the aggregate variable (7).

Stage 7. The three-median method divides objects (voivodships) into four classes characterised by a similar environmental quality of life (class I has the highest level, class IV – has the lowest). This method consists in determining the median coordinates of the vector $R = (R_1, R_2, \dots, R_n)$, which is denoted by $\text{med}(R)$, and then dividing the group of objects into two groups: those for which the values of the meter exceed the median and those with values not exceeding it. Subsequently, the intermediate medians are defined as $\text{med}_k(R) = \underset{i: R_i \in \Omega_k}{\text{med}}(R_i)$, where $k = 1, 2$.

As a result following object groups are created:

$$\text{Class I: } R_i > \text{med}_1(R) \quad (8)$$

$$\text{Class II: } \text{med}(R) < R_i \leq \text{med}_1(R) \quad (9)$$

$$\text{Class III: } \text{med}_2(R) < R_i \leq \text{med}(R) \quad (10)$$

$$\text{Class IV: } R_i \leq \text{med}_2(R) \quad (11)$$

4. Results

The values of the aggregate variable determined using the TOPSIS method were ordered in non-increasing order, and on their basis, the ranking of voivodships in Poland by the environmental quality of life was created. The results are presented in Table 2 and Figure 2.

Table 2.

Ranking and typological classes of voivodships due to the environmental quality of life

Rank	Voivodships	R_i	Class
1	Podkarpackie	0,7074	I
2	Lubuskie	0,6351	
3	Małopolskie	0,6241	
4	Warmińsko-mazurskie	0,6126	
5	Dolnośląskie	0,6092	II
6	Lubelskie	0,5952	
7	Wielkopolskie	0,5951	
8	Podlaskie	0,5951	
9	Mazowieckie	0,5839	III
10	Świętokrzyskie	0,5506	
11	Kujawsko-pomorskie	0,5495	
12	Zachodniopomorskie	0,5491	
13	Pomorskie	0,5425	IV
14	Opolskie	0,5196	
15	Łódzkie	0,5063	
16	Śląskie	0,3612	

Source: own elaboration.

Upon analysing the information in Table 2, it can be noted that the division of voivodships using the three-median method results in separating four equal classes. The first of these includes two voivodships in the south of the country and one in the west and the north-east part. These provinces can be evaluated positively for most of the indicators adopted for the study. Podkarpackie Voivodship had the highest environmental quality of life in 2021. It was decided by low values (below the average) of indicators related to environmental pollution, the share of devastated and degraded land in need of redevelopment in % of total area (the lowest indicator in the country), as well as high values of indicators related to natural attractiveness, including the highest indicator of the share of green areas in the total area among voivodships (X_{14s}).

Another group relates to voivodships located in different parts of the country and with a varying surface areas. They are characterised by good air quality (the indicators for particulate and gaseous pollutants are below the average in the country), low indicators related to wastewater management, and a low share of devastated and degraded land in need of redevelopment in % of total area, except for Dolnośląskie Voivodeship.

The voivodships belonging to the third class can be assessed positively, mainly due to the below-average indicators of particulate and gaseous pollutants (except for Świętokrzyskie) and the share of agricultural and forest land excluded from agricultural production in the total area (the lowest level of this indicator in the country applies to the Kujawsko-Pomorskie

Voivodship). However, indicators related to the share of legally protected areas in the total area are unfavourable, apart from Świętokrzyskie, in which this share is the highest in the country.

The fourth group included voivodships, which should be assessed negatively in the case of most of the indicators adopted for the study. Śląskie Voivodship occupied the last position in the ranking as a result of the highest indicators among the voivodships regarding particulate and gaseous pollutants from particularly onerous plants, the share of devastated and degraded land, and wastewater discharged into waters or land containing substances, particularly harmful to the aquatic environment. In addition, in this voivodship, the share of legally protected areas in the total area is below the average (X_{11s}), but there is a good situation due to another indicator related to natural attractiveness. These include the share of parks, green areas and community green areas in the total area (X_{12s}), which in the Śląskie Voivodship is the highest among the studied voivodships.

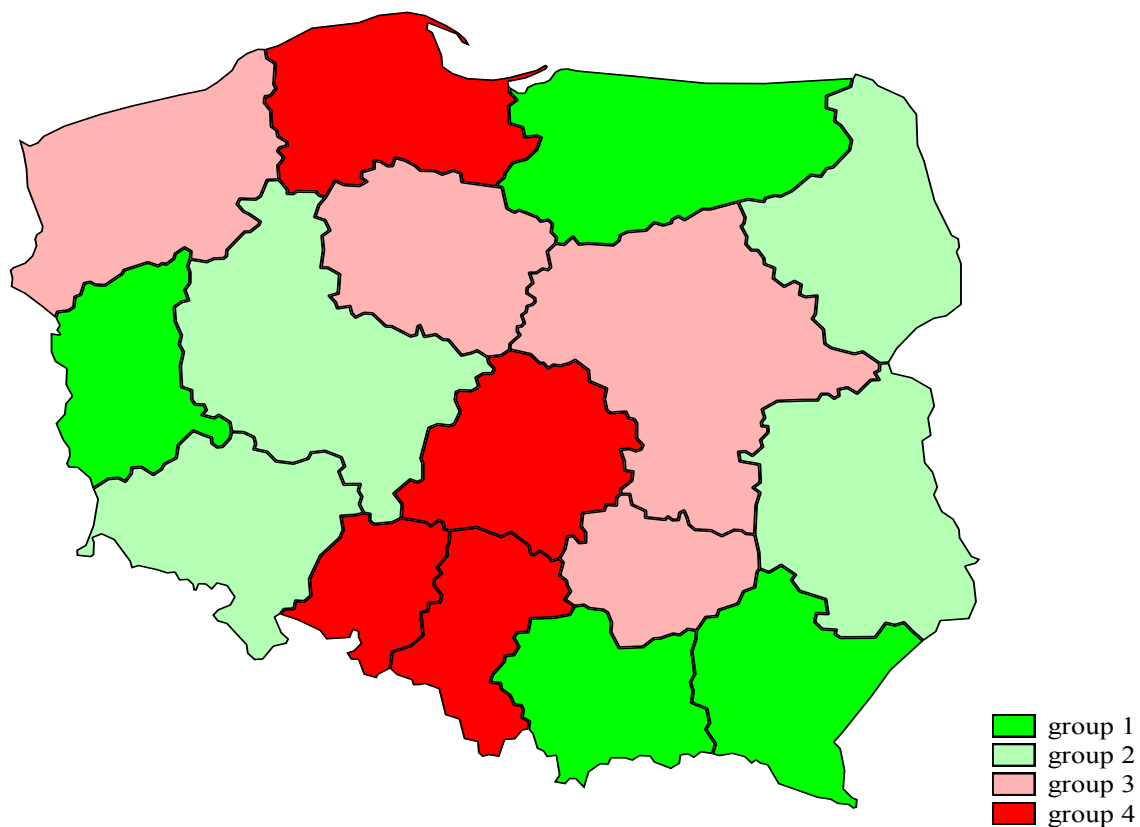


Figure 1. Spatial distribution of Polish voivodeships by topological groups.

Source: own elaboration.

5. Conclusions

Protecting the environment and natural resources is one of the most critical factors in ensuring sustainable well-being. However, measuring environmental indicators is difficult: first, the magnitude of the impact of current environmental factors on future well-being is uncertain, and second, few comparable indicators meet agreed-upon standards. However, it should be remembered that high quality of life as the ultimate goal of the concept of sustainable development should be the result of conducting development policy at all levels of governance, i.e. national, regional and local. The standard of living depends not only on income and possession of material things; it is also determined by external conditions, including the qualities of the natural environment in the immediate or distant surroundings of a man. The quantitative and qualitative state of the environment should be considered not only as a tourist asset (affecting, among other things, leisure activities), an element of national wealth, but also a factor necessary to maintain good physical health and mental well-being (Malinowski, Wasiuta, 2021). All this is of great importance for the implementation of the idea of sustainable development.

The socioeconomic development of the country is not uniform throughout its territory. Individual parts and regions differ, for example, in location, geographical and natural conditions, state of economic development, and the way of organisation and functioning of the area's community. The practical implementation of the concept of sustainable development, the essence of which is, among others, a lasting improvement in the quality of life of residents, is of particular importance in local, territorial systems.

Upon analysing the ranking of voivodships presented in this study, it can be noted that the best group due to the environmental quality of life included: Podkarpackie, Lubuskie, Małopolskie and Warmińsko-Mazurskie. These voivodships were characterised by high natural values and relatively low environmental impact indicators compared to other voivodships and the national average. The last places belonged to the Pomorskie, Opolskie, Łódzkie and Śląskie voivodships. Most of them are industrial, which means that the indicators of environmental impact, especially air pollution and collected waste, are relatively high and exceed the national average.

When analysing the indicators calculated for individual voivodships, it should be remembered that they give only an "averaged" picture of a given voivodship without providing information about its internal diversity. These differences, as in the entire country, run, among others, on the urban-rural line or central areas – peripheral areas.

The results of research on the quality of life in its objective dimension are a valuable source of information on the most important problems that should be considered when defining the goals and objectives of development policy in all its dimensions: social, economic and environmental. This type of research seems to be particularly justified in relation to local, territorial systems.

References

1. Adamowicz, M. (2022). A Green Concept of Economic Growth and Development. *Economic and Regional Studies*, 15(2), pp. 158-180.
2. Bąk, I., Cheba, K. (2020). *Zielona gospodarka jako narzędzie zrównoważonego rozwoju*. Warszawa: CeDeWu.
3. Bąk, I., Cheba, K. (eds.) (2022). *Green Energy. Meta-analysis of the Research Results*. Springer.
4. Balestra, C., Dottori, D. (2011). Aging society, health and the environment. *Journal of Population Economics, Springer; European Society for Population Economics*, 25(3), 1045-1076, DOI: 10.1007/s00148-011-0380-x.
5. Baran, B. (2018). Globalizacja a środowiskowe uwarunkowania jakości życia. *Współczesne problemy Ekonomiczne*, 1(16), pp. 7-15.
6. Carayannis, E.G., Barth, T.D., Campbell, D.F. (2012). The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship*, 1, pp. 1-12. doi: <https://doi.org/10.1186/2192-5372-1-2>.
7. Chang, K.K.P., Wong, F.K.Y., Chan, K.L., Wong, F., Ho, H.C., Wong, M.S., Ho, Y.S., Yuen, J.W.M., Siu, J.Y., Yang, L. (2020). The Impact of the Environment on the Quality of Life and the Mediating Effects of Sleep and Stress. *Int. J. Environ. Res. Public Health*, 17(22), 8529. doi: 10.3390/ijerph17228529.
8. Dadvand, P., Bartoll, X., Basagana, X., Dalmau-Bueno, A., Martinez, D., Ambros, A., Cirach, M., Triguero-Mas, M., Gascon, M., Borrell, C., Nieuwenhuijsen, M.J. (2016). Green spaces and General Health: Roles of mental health status, social support, and physical activity. *Environ. Int.*, 91, pp. 161-167. doi: <https://doi.org/10.1016/j.envint.2016.02.029>.
9. Daniek, K. (2020). Green economy indicators as a method of monitoring development in the economic, social and environmental dimensions. *Social Inequalities and Economic Growth*, 62(2), pp. 150-173. doi: 10.15584/nsawg.2020.2.10.
10. De Sousa, C.A. (2006). Unearthing the benefits of brownfield to green space projects: An examination of project use and quality of life impacts. *Local Environ.*, 11, pp. 577-600. doi: <https://doi.org/10.1080/13549830600853510>.
11. Dmytrów, K. (2018). Comparison of Several Linear Ordering Methods for Selection of Locations in Order picking by Means of the Simulation Methods. *Acta Univ. Lodziensis Folia Oecon.*, 5, pp. 81-96. <https://doi.org/10.18778/0208-6018.338.05>.
12. Galik, A., Bąk, M., Baładynowicz-Panfil, K., Cirella, G.T. (2022). Evaluating Labour Market Flexibility Using the TOPSIS Method: Sustainable Industrial Relations. *Sustainability*, 14, 526. doi: <https://doi.org/10.3390/su14010526>.
13. Genc, S., Zadeoglulari, Z., Fuss, S.H., Genc, K. (2012). The adverse effects of air pollution on the nervous system. *Journal of toxicology*. doi: <https://doi.org/10.1155/2012/782462>.

14. Hall, D.O., Mynick, H.E., Williams, R.H. (1991). Cooling the greenhouse with bioenergy. *Nature*, 353, pp. 11-2.
15. Han, B. (2020). Associations between perceived environmental pollution and health-related quality of life in a Chinese adult population. *Health and Quality of Life Outcomes*, 18(198). doi: <https://doi.org/10.1186/s12955-020-01442-9>.
16. Howard, G.S. (2000). Adapting human lifestyles for the 21st Century. *American Psychologist*, 55, pp. 509-515.
17. Jusoff, M.M. (2020). Improving the quality of life for sustainable development. *IOP Conf. Series: Earth and Environmental Science*, 561, 012020. doi: 10.1088/1755-1315/561/1/012020.
18. Keles, R. (2012). The Quality of Life and the Environment. *Procedia - Social and Behavioral Sciences*, 35, pp. 23-32. doi: <https://doi.org/10.1016/j.sbspro.2012.02.059>.
19. Kryk, B. (2015). Środowiskowe uwarunkowania jakości życia w województwie zachodniopomorskim na tle Polski. *Ekonomia i Środowisko*, 3(54), pp. 170-181.
20. Kumar, A.K., Bhattacharya, T., Hasnain, S.M.M., Nayak, A.K. (2020) Applications of biomass-derived materials for energy production, conversion, and storage. *Materials Science for Energy Technologies*, 3, pp. 905-920. doi: <https://doi.org/10.1016/j.mset.2020.10.012>.
21. Kusterka-Jefmańska, M. (2010). Wysoka jakość życia jako cel nadrzędny lokalnych strategii zrównoważonego rozwoju. *Zeszyty Naukowe Instytutu Spraw Publicznych Uniwersytetu Jagiellońskiego seria: Zarządzanie Publiczne*, 4(12), pp. 115-123.
22. Łącka, I. (2023). The Role of Green Energy in the Economic Growth of the World. In: I. Bąk, K. Cheba (eds.), *Green Energy. Meta-analysis of the Research Results* (pp. 41-57). Spiringer.
23. Malinowski, M., Wasiuta, A. (2021). *Stan środowiska a poziom życia ludności w Polsce*. Poznań: Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu.
24. Osbaldiston, R., Sheldon, K.M. (2003). Promoting internalized motivation for environmentally responsible behavior: A prospective study of environmental goals. *Journal of Environmental Psychology*, 23(4), pp. 349-357. doi: [https://doi.org/10.1016/S0272-4944\(03\)00035-5](https://doi.org/10.1016/S0272-4944(03)00035-5).
25. Parida, P., Sahoo, S. (2013). Multiple Attribute Decision Making Approach by TOPSIS technique. *International Journal of Engineering Research & Technology*, 2(11), pp. 907-912. doi: 10.17577/IJERTV2IS110272.
26. Pirozzi, C.S., Mendoza, D.L., Yizhe, X., Yue, Z., Scholand, M.B., Baughman, R.P. (2018). Short-Term Particulate Air Pollution Exposure is Associated with Increased Severity of Respiratory and Quality of Life Symptoms in Patients with Fibrotic Sarcoidosis. *International Journal of Environmental Research and Public Health*, 15, 1077. doi: <https://doi.org/10.3390/ijerph15061077>.

27. Roberts, J.D., Voss, J.D., Knight, B. (2014). The Association of Ambient Air Pollution and Physical Inactivity in the United States. *PLoS ONE*, 9(3), e90143. doi: <https://doi.org/10.1371/journal.pone.0090143>.
28. Roszkowska, E. (2019). Multi-criteria decision making models by applying the Topsis method to crisp and interval data. *Multiple Criteria Decision Making*, 6, pp. 200-230.
29. Ryńska, E. (2011). Zapewnienie jakości życia w przestrzeni zurbanizowanej. *Problemy Rozwoju Miast*, 3-4, pp. 55-64.
30. Ryszawska, B. (2013). Koncepcja zielonej gospodarki jako odpowiedź na kryzys gospodarczy i środowiskowy. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 318, pp. 47-56. doi: 10.15611/pn.2013.318.04.
31. Streimikiene, D. (2015). Environmental indicators for the assessment of quality of life. *Intellectual Economics*, 9(1), pp. 67-79. doi: <https://doi.org/10.1016/j.intele.2015.10.001>.
32. Van Den Berg, M., van Poppel, M., van Kamp, I., Andrusaityte, S., Balseviciene, B., Cirach, M., Danileviciute, A., Ellis, N., Hurst, G., Masterson, D., Smith, G., Triguero-Mas, M., Uzdanaviciute, I., de Wit P., van Mechelen, W., Gidlow, Ch., Grazuleviciene, R., Nieuwenhuijsen, M.J., Kruize, H., Maas, J. (2016). Visiting green space is associated with mental health and vitality: A cross-sectional study in four European cities. *Health Place*, 38, pp. 8-15. doi: 10.1016/j.healthplace.2016.01.003.
33. Van Dillen, S., De Vries, S., Groenewegen, P., Spreeuwenberg, P. (2012). Greenspace in urban neighbourhoods and residents' health: Adding quality to quantity. *J. Epidemiol. Community*, 66(6), e8. doi: 10.1136/jech.2009.104695.
34. Winter, D.D. (2000). Some big ideas for some big problems. *American Psychologist*, 55, pp. 516-522.
35. Yoon, K., Kim, W. (2017). The behavioral TOPSIS. *Expert Systems with Applications*, 89, pp. 266-272. doi: <https://doi.org/10.1016/j.eswa.2017.07.045>.
36. Zulqarnain, R.M., Saeed, M., Ahmad, N., Dayan, F., Ahmad, B. (2020). Application of TOPSIS Method for Decision Making. *Int. J. Sci. Res. Math. Stat. Sci.*, 7, pp. 76-81.

DIAGNOSIS OF THE STATE AND FUNCTIONING OF THE ENVIRONMENT IN THE ZACHODNIOPOMORSKIE VOIVODESHIP

Milena BERA^{1*}, Natalia OLESZCZYK^{2*}

¹ Department of European and Regional Studies, Faculty of Economics, West Pomeranian University of Technology in Szczecin; mbera@zut.edu.pl, ORCID: 0000-0002-1997-349X

² Institute of Economics and Finance, Faculty of Economics, Finance and Management. University of Szczecin; noleszczyk@zut.edu.pl, ORCID: 0000-0002-8441-8054

* Correspondence author

Purpose: The research in the article was conducted to diagnose the state of environmental protection in the West Pomeranian region, that is, to get an answer to the question in which districts the state of environmental protection was at the best level in which the situation was worse.

Design/methodology/approach: The article classifies 21 counties of the West Pomeranian region in terms of the state of environmental protection in 2020. The counties were divided based on the taxonomic development measure as a tool for classifying socio-economic objects.

Findings: The study showed that the best state of environmental protection was characterized by the districts of Sławieński, Choszczeński, Police, and the city of Koszalin. The worst state of environmental protection was characterized by the districts of Pyrzyce, Kamiński, and the city of Szczecin.

Research limitations/implications: A taxonomic study conducted based on a set of variables that do not contain the most relevant characteristics (due to lack of statistical data) of the studied phenomenon may lead to an erroneous assessment of reality is the most significant limitation of this article.

Practical implications: The presented study can be used at the regional level to assess environmental problems and determine corrective and counteracting actions to the current situation.

Social implications: The results of the study make it possible to revise the actions of environmental policy realized in the West Pomeranian Voivodeship.

Originality/value: This study is an independent and comprehensive analysis of the state of environmental protection in the West Pomeranian province.

Keywords: environmental protection, county, zachodniopomorskie province.

Category of the paper: Research paper.

1. Introduction

The socio-economic development of any country and region is primarily related to the way and volume of production of material goods, population, and natural conditions, that is, the surrounding nature, i.e., the geographic environment (Mazur, 2000). Thus, this development occurs in a specific territory (geographic space with particular climatic conditions, water relations, and other natural resources (fossil resources, soils, forests)). Thus, the geographic (natural) environment includes both inorganic (abiotic) elements, such as the bedrock (lithosphere), surface relief, i.e., natural relief (morphology), waters (hydrosphere), the air layer surrounding the Earth (atmosphere) together with climatic phenomena, and organic (biotic) elements, i.e., the natural world of plants (flora) and animals (fauna). A specific element of the geographic environment is space, i.e., the surface of the Earth with specific and unchanging dimensions - it is the component that connects all natural components (Malachowski, 2007, p. 7). Thus, the geographic environment is a set of all natural factors (nature) found in a given area in which people live and which they use as their skills improve to satisfy their material and other needs, that is, recreational, aesthetic (for example, the beauty of the landscape), creative (for example, literature, poetry, art) and scientific. Thus, it can be said that the geographic environment, like nature surrounding humans, is a necessary and permanent condition for the existence and development of human society. However, it is not primarily original but transformed to varying degrees. The geographic environment also contains anthropogenic elements - houses, settlements, roads, airports, ports, artificial bodies of water, etc., the so-called technosphere (technical environment) (Malachowski, 2007, p. 10).

In economic science, it is essential to understand and describe the relationship between the natural environment and the economy. The economic importance of the environment is indisputable. It is a direct source of energy, some means, and objects of labor and means of consumption, a receiver of production and consumption waste, and determines agricultural, forestry, and fishing production. It also determines the possibilities for the development of transportation, influences human health, and shapes the residential and recreational space necessary for the proper development of the individual and society (Żylicz, 1989).

The relationships between elements of the environment and the changes in these elements themselves are complex. Man is an element of the environment while simultaneously introducing quantitative and qualitative changes in it. The extent of human interference with the natural environment depends mainly on technical and economic possibilities (Bernaciak, 2002).

Due to the intensity of nature's transformation measured by the degree of its saturation with anthropogenic elements, three types of environment are distinguished: natural, transformed (transformed), and artificial.

The concept of environmental protection is interpreted in many ways. In a very general sense, it is activities aimed at preserving or restoring rare, valuable living and inanimate creations of nature and natural resources and ensuring the permanence of their use; it includes, among others, landscape protection (landscape parks and others), reserve protection (reserves, national parks), species protection, nature monuments (Popular Encyclopedia, 1996).

In a broader sense, the depletion of natural resources includes the protection of all natural resources. On the other hand, in the broadest sense, nature conservation is almost synonymous with environmental protection (Mazur, 2004).

According to the PWN Popular Encyclopedia, environmental protection is an activity aimed at protecting all elements of the environment from the adverse impact of human activity and such shaping of human activity that it provides optimal conditions for physical and mental development, also preserving intact natural elements of a natural nature (Popular Encyclopedia, 1996). Nature conservation and environmental protection are two separate though complementary streams. In nature protection, nature itself and its resources are in the foreground, to be protected from destruction, devastation, and irrational management. In contrast, in environmental protection, the protection of humans, their lives and health, and the quality of life came to the fore.

Environmental protection differs from nature conservation in that actions to protect nature can, to some extent, be considered manifestations of altruism. We protect nature for nature's sake, not only for nature's sake, because everyone wants to benefit from nature. Environmental protection is the protection of human beings and their living conditions. Environmental protection is also a necessary condition for the effectiveness of nature (Uminski, 1996). Current efforts to protect the natural environment take place, among other things, on the economic, legal, technical, and organizational levels and use various methods (effective and efficient) to ensure maximum protection of natural elements and their rational use by people (Mayer, 2000).

Economic measures are intended to generate adequate motivation to undertake projects to prevent environmental deterioration and remove existing damage and deformation. The overexploitation of nature's resources by various countries, which do not include costs and inputs in their calculations, has led to a rapid deterioration of the anthroposphere. Some natural resources, primarily water and air, were previously considered free goods both in their inexhaustible abundance and non-deteriorating quality have caused a sharp increase in expenditures for their acquisition. Water and air have thus become economic goods, for the use of which payment is due (Gorczyca, 1976).

Economic instruments for the protection of the natural environment provide an indirect form of influence on economic agents while affecting their financial condition. These instruments are presented as an alternative to directly regulating environmental degradation activities. The purpose of using instruments in the field of environmental policy is to achieve the assumed level of environmental quality or to realize balanced but sustainable socio-economic development (Bernaciak, Gaczek, 1996). The essence of economic and

environmental instruments is to influence the price-setting process to consider the costs of environmental pollution when economic agents and consumers make decisions.

2. Characteristics of the study area

In this article, a study was conducted to diagnose the state of environmental protection in the West Pomeranian Voivodeship. Zachodniopomorskie Voivodeship is located in the northwestern part of Poland, by the Baltic Sea and the Szczecin Lagoon. From the west, it borders Germany (with the states of Mecklenburg-Vorpommern and Brandenburg). The total length of the province's borders is 982.9 km, including the western state border with Germany, and the sea border in the north has a similar length of 188.9 km. The province's capital is Szczecin, with a population of nearly 400,000 in 2020 (according to CSO data). The voivodeship covers an area of 22,897 square kilometers, 7.3% of Poland's area (the fifth largest in the country).

The West Pomeranian region has an agricultural and industrial character. The area of agricultural land in 2018 was 1,129.9 thousand hectares (according to the Central Statistical Office), accounting for about 49.3% of the province's total area. The main branches of the economy are agriculture and the food industry. Timber, metal, chemical, and electricity production are also important industries. Also of great importance to the region are the four commercial seaports located within the region: Szczecin, Swinoujście, Kołobrzeg, and Police, as well as a dozen smaller seaports and fishing harbors (Report, 2019). The entire area of the province is a special economic zone. Numerous investment areas are located in the province, including 19 special economic zones, eight industrial parks, and two science and technology parks. In addition, the region has natural minerals: natural gas, oil, ores of iron, limestone, marls, peat, peat bogs, thermal waters, and brine. The solid development of organic agriculture characterizes the province. Two central geographic-physical regions can be distinguished in the province: South Baltic Coast and Pomeranian Lake District. The voivodeship's climate is moderate, predominately westerly, northwesterly, and northern winds. The abundance of water bodies and a large area of forests determine the high air humidity. The average annual temperature is 9.3°C, and the average annual precipitation of 550-700 mm.

Surface waters occupy about 5.2% of the province's area. In addition to the Szczecin Lagoon and the Kamiński Lagoon, they consist of numerous lakes and a rich river network. Lakes mainly occur in the Lake District: Wałęckie, Choszczno, Insko, Mysliborski, and Drawskie. Lakes with an area of more than 50 hectares there are 178, and the largest lakes in the province include Dąbie and Miedwie. The more important rivers of the province are Odra (with tributaries: Tywa, Rurzyca, Drawa, Mysia, Plonia, and Ina, as well as rivers flowing

directly into the Baltic Sea: Rega, Parsęta, and Wieprza (Report of the Chief Inspectorate for Environmental Protection, 2020).

The essential document defining the directions of the development policy of the West Pomeranian region West Pomeranian Voivodeship and the goals that should be achieved on the horizon until the year 2030 is the Development Strategy of the West Pomeranian Voivodeship until 2030. The vision of the region's development formulated therein aims to achieve the perspective of the year 2030 development goals ensuring a higher quality of life for the region's residents based on the potential of a modern economy. The most critical assets identified in the Strategy assets at the disposal of West Pomerania, and at the same time, the challenges facing the region, including facing the region include demographic changes, socio-public activity, education, blue economy, and tourism. The objectives and tasks of the ecological policy of the West Pomeranian Voivodeship in individual areas of intervention in perspective until 2024 are formulated in the Program for Environmental Protection of the West Pomeranian Voivodeship for 2016-2020 with an outlook until 2024. The main objective of the Program is to strive to improve the state of the environment in the voivodeship, reduce the negative impact of pollution on the environment, as well as to protect and develop the values of the environment and rational management of its resources. The achievement of the above objective will be served by implementing the environmental priorities identified in the document (areas of intervention).

3. Methodology

The following potential diagnostic variables were proposed to measure the quality of the environment in the counties of the West Pomeranian region in the year under study. The selection of variables was made arbitrarily.

X1 - total treated wastewater discharged in dm^3 per km^2 ,

X2 - total treated wastewater in % of the total,

X3 - population served by treatment plants in % of the total population,

X4 - water consumption for the industry in dm^3 per 1 km^2 ,

X5 - dust pollution emissions in tons per 1 km^2 ,

X6 - emission of gaseous pollutants in tons per 1 km^2 ,

X7 - particulate pollutants retained or neutralized in abatement facilities in % of total pollutants generated; this indicator is expressed as a percentage ratio of the amount of pollution retained to the amount of pollution generated, i.e., retained and emitted,

X8 - gaseous pollutants retained or neutralized in abatement facilities in % of total pollutants generated; this indicator is expressed by the percentage ratio of the amount of pollutant retained to the amount of pollutant generated, i.e., retained and emitted (Environmental Protection, 2020),

X9 - total waste generated during the year in a thousand tons per km²,

X10 - total waste disposed of during the year in % of total waste,

X11 - legally protected areas in % of total area,

X12 - nature monuments per 1 km²,

X13 - total municipal and industrial wastewater treatment plants per 1 km²,

X14 - expenditures on municipal management and environmental protection in PLN per person.

The values of the variables are shown in Table 1.

Table 1.

Potential environmental diagnostic variables in Poviats of West Pomeranian Voivodeship in 2020

	Total wastewater discharged	Wastewater treated together	Population served by wastewater treatment plants	Water consumption for industry	Dust emissions	Gaseous emissions	Particulate pollutants retained or neutralized in reduction facilities	Gaseous pollutants retained or neutralized in reduction facilities	Total waste generated during the year	Total waste disposed of during the year	Total legally protected areas	Natural monuments	Total municipal and industrial wastewater treatment plants I	Expenses for municipal management and environmental protection
	dam ³ /km ²	%	%	dam ³ /km ²	ton/km ²	ton/km ²	%	%	tys. t/km ²	%	%	per 1 km ²	per 1 km ²	zł/per person
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
Powiat białogardzki	1,65	97,58	76,79	0,68	0,14	66,46	95,44	0,07	0,02	12,56	0,00	0,09	0,01	25,84
Powiat drawski	0,98	88,43	70,15	0,20	0,03	7,79	18,18	0,00	0,00	0,00	0,43	0,14	0,01	31,13
Powiat kołobrzeski	6,26	99,91	86,61	0,56	0,13	119,85	94,83	0,00	0,06	14,51	0,07	0,32	0,02	23,24
Powiat koszaliński	1,14	89,25	55,05	0,11	0,12	5,47	72,47	0,00	0,00	0,00	0,20	0,10	0,02	154,60
Powiat sławieński	1,76	98,90	71,37	0,05	0,01	8,12	52,17	0,00	0,06	5,77	0,14	0,16	0,01	136,11
Powiat szczecinecki	1,31	97,80	77,12	0,64	0,59	204,13	95,30	0,00	0,13	0,04	0,28	0,08	0,01	7,20
Powiat świdwiński	1,15	97,81	67,35	0,54	0,02	10,80	41,03	0,00	0,00	35,29	0,14	0,20	0,02	32,78
Powiat walecki	1,16	97,49	74,10	0,41	0,06	24,19	82,65	0,00	0,01	1,94	0,52	0,07	0,01	24,62
Powiat m.Koszalin	75,02	100,00	98,72	2,51	1,30	1 663,87	92,49	0,00	0,55	5,46	0,45	0,71	0,01	20,54
Powiat choszczeński	1,01	97,97	74,82	0,07	0,04	9,04	83,78	0,00	0,01	1,79	0,54	0,08	0,02	195,96
Powiat gryficki	2,74	102,26	72,17	0,22	0,02	4,81	14,29	0,00	0,00	0,00	0,00	0,07	0,02	84,68
Powiat myśliborski	1,77	90,28	65,87	0,24	0,06	71,39	97,83	0,00	0,19	3,87	0,44	0,09	0,01	15,75
Powiat pyrzycki	1,31	100,76	72,71	0,09	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,03	0,02	3,56
Powiat stargardzki	2,58	101,75	78,36	0,55	0,10	84,98	81,51	0,00	0,33	0,14	0,08	0,07	0,02	15,88
Powiat łobeski	0,83	98,68	51,83	0,27	0,07	16,33	82,81	0,02	0,00	0,00	0,03	0,02	0,01	107,40

Cont. table 1.

Powiat m. Szczecin	69,92	31,31	14,96	448,90	3,17	3 823,17	98,54	0,06	0,80	20,12	0,06	0,09	0,23	11,42
Powiat goleniowski	1,81	99,05	67,71	0,38	0,13	21,09	61,40	0,26	0,06	1,10	0,08	0,05	0,01	106,26
Powiat gryfiński	1,31	99,93	64,82	683,25	0,67	3 030,27	99,66	0,44	0,38	39,28	0,25	0,14	0,02	26,88
Powiat kamieński	2,14	97,98	69,44	0,02	0,00	0,28	0,00	0,00	0,00	0,00	0,10	0,13	0,02	30,51
Powiat policki	3,81	99,85	78,91	262,26	1,20	2 174,10	95,75	0,52	6,95	87,47	0,03	0,01	0,01	119,32
Powiat m. Świnoujście	16,47	68,14	99,84	1,37	4,04	7 338,98	95,75	0,52	0,06	0,00	0,18	0,13	0,04	0,66

Source: own calculations based on statistics from www.stat.gov.pl

Using statistical data for 2020, a matrix of correlation coefficients R was created to identify the final set of diagnostic variables. Two levels of r^* values were established:

1. $r^* > 0.4329$, which was calculated based on the formula proposed by S. Bartosiewicz (Bartosiewicz, 1976).

$$r^* = \sqrt{\frac{t_\alpha^2}{t_\alpha^2 + n - 2}} = \sqrt{\frac{2,093^2}{2,093^2 + 21 - 2}} = 0,4329$$

where:

t_α - critical value read from Student's t - distribution tables for $n - 2$ degrees of freedom

and for a predetermined level of significance α , $t_{\alpha=0,05,ss=19} = 2,093$,

2. $r > 0.5$, a level often used in taxonomic studies (Nowak, 1990).

Table 2 presents the results of the selection of diagnostic variables using Hellwig's method for 2020.

Table 2.

First stage of selection of diagnostic variables for $r^* > 0.4329$ for 2020

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1,0000	0,5916	0,1681	0,2672	0,6114	0,4471	0,2871	0,0229	0,0588	0,0263	0,1009	0,6330	0,6494	0,2687
X2	0,5916	1,0000	0,5736	0,3711	0,7720	0,6235	0,2457	0,1426	0,0134	0,0032	0,0489	0,0833	0,9189	0,2315
X3	0,1681	0,5736	1,0000	0,4383	0,0400	0,0744	0,0270	0,2025	0,0558	0,0470	0,2167	0,4153	0,7035	0,1336
X4	0,2672	0,3711	0,4383	1,0000	0,3620	0,4700	0,3314	0,5251	0,3337	0,5788	0,0977	0,0774	0,4752	0,1137
X5	0,6114	0,7720	0,0400	0,3620	1,0000	0,9473	0,4078	0,5605	0,2069	0,1693	0,0638	0,1263	0,6213	0,2982
X6	0,4471	0,6235	0,0744	0,4700	0,9473	1,0000	0,3972	0,7287	0,2190	0,2504	0,0465	0,0956	0,4512	0,2836
X7	0,2871	0,2457	0,0270	0,3314	0,4078	0,3972	1,0000	0,3443	0,2382	0,2754	0,2210	0,1396	0,1725	0,0186
X8	0,0229	0,1426	0,2025	0,5251	0,5605	0,7287	0,3443	1,0000	0,5591	0,5916	0,1771	0,1702	0,0119	0,0048
X9	0,0588	0,0134	0,0558	0,3337	0,2069	0,2190	0,2382	0,5591	1,0000	0,8556	0,1917	0,1336	0,0182	0,2024
X10	0,0263	0,0032	0,0470	0,5788	0,1693	0,2504	0,2754	0,5916	0,8556	1,0000	0,2259	0,0596	0,0790	0,0910
X11	0,1009	0,0489	0,2167	0,0977	0,0638	0,0465	0,2210	0,1771	0,1917	0,2259	1,0000	0,3080	0,2005	0,0451
X12	0,6330	0,0833	0,4153	0,0774	0,1263	0,0956	0,1396	0,1702	0,1336	0,0596	0,3080	1,0000	0,0600	0,2276
X13	0,6494	0,9189	0,7035	0,4752	0,6213	0,4512	0,1725	0,0119	0,0182	0,0790	0,2005	0,0600	1,0000	0,1984
X14	0,2687	0,2315	0,1336	0,1137	0,2982	0,2836	0,0186	0,0048	0,2024	0,0910	0,0451	0,2276	0,1984	1,0000
Σ	4,1326	4,6195	3,0957	4,4416	5,1869	5,0345	3,1057	4,0415	3,0865	3,2531	1,9437	2,5294	4,5601	2,1172

Source: own calculations using EXCEL spreadsheet.

Table 2 shows that in the first stage of calculations, the central variable X5 qualified for the study, while the following satellite variables did not qualify: X1; X2; X6; X8; X13.

Table 3.

Second stage of selection of diagnostic variables for $r^ > 0.4329$ for 2020*

	X ₃	X ₄	X ₇	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₄
X ₃	1	0,43826	0,02701	0,05581	0,04699	0,21666	0,41525	0,13363
X ₄	0,43826	1	0,33135	0,33371	0,57880	0,09772	0,07737	0,11367
X ₇	0,02701	0,33135	1	0,23817	0,2754	0,22100	0,13956	0,01859
X ₉	0,05581	0,33371	0,23817	1	0,85559	0,19174	0,13361	0,20240
X ₁₀	0,04699	0,57880	0,2754	0,85559	1	0,22586	0,05962	0,09097
X ₁₁	0,21666	0,09772	0,22100	0,19174	0,22586	1	0,30802	0,04505
X ₁₂	0,41525	0,07737	0,13950	0,13361	0,05962	0,30802	1	0,22760
X ₁₄	0,13363	0,11367	0,01859	0,20240	0,09097	0,04505	0,22760	1
Σ	2,33363	2,97092	2,25110	3,01104	3,13325	2,30609	2,36105	1,83192

Source: own calculations using EXCEL spreadsheet.

Table 3 shows that in the second stage of calculations the central variable X10 qualified for the study, while the following satellite variables X4, X9 did not qualify. The remaining variables: X3, X7, X11, X12, X14 are isolated variables, since the values of their correlation coefficients are not greater than the r^* value (see Table 4).

Table 4.

Isolated variables for $r^ > 0.4329$ for 2020*

	X ₃	X ₇	X ₁₁	X ₁₂	X ₁₄
X ₃	1	0,027013	0,216668	0,415251	0,133631
X ₇	0,027013	1	0,221006	0,13956	0,018592
X ₁₁	0,216668	0,221006	1	0,308023	0,045053
X ₁₂	0,415251	0,13956	0,308023	1	0,227602
X ₁₄	0,133631	0,018592	0,045053	0,227602	1
Σ	1,792563	1,406172	1,79075	2,090435	1,424878

Source: own calculations using EXCEL spreadsheet.

From the research conducted and the determination of the correlation matrix of variables, it follows that the final set of diagnostic variables will include the following variables:

X3 - population served by treatment plants in % of the total population,

X5 - dust pollution emissions in tons per km²,

X7 - particulate pollutants retained or neutralized in reduction facilities in % of total pollutants generated,

X10 - total waste disposed of during the year in % of total waste,

X12 - natural monuments per 1 km²,

X14 - expenditures on municipal management and environmental protection in PLN per person.

4. Discussion and Conclusions

To rank the counties of the West Pomeranian Voivodeship by the state of environmental protection in 2020, a taxonomic measure of development was calculated. According to the stages of determining the taxonomic measure of development, the nature of the diagnostic variables was first determined.

It turned out that in the set of diagnostic variables [X3, X5, X7, X10, X12, X14], which will be the basis for carrying out the classification of poviats of the West Pomeranian region in terms of the state of environmental protection, five stimulants X3, X7, X10, X12, X14, and one destimulant X5 can be distinguished. The destimulant was transformed into a stimulant.

Then all variables (stimulants) were brought to comparability, using two ways of transforming variables:

- 1) standardization,
- 2) zeroed unitarization.

These two methods are aimed at comparing the classification results depending on the transformation formula adopted. The normalization formulas provide the normalized values with differentiated variability and, simultaneously, a constant spread for all variables. Classical standardization, on the other hand, results in standardizing the values of all variables in terms of variability measured by the standard deviation, eliminating variability as a basis for differentiating objects (Gatnar, Walesiak, 2004). Standardization of variables was carried out according to a formula using STATISTICA 8.

Using the standardized variables, a synthetic variable (Z_i'') was determined for each county. The values were then normalized to the interval [0,1]). The values of the variable were used to create a ranking of the counties of West Pomeranian Voivodeship in terms of the state of environmental protection and to determine the belonging of the counties to typological groups.

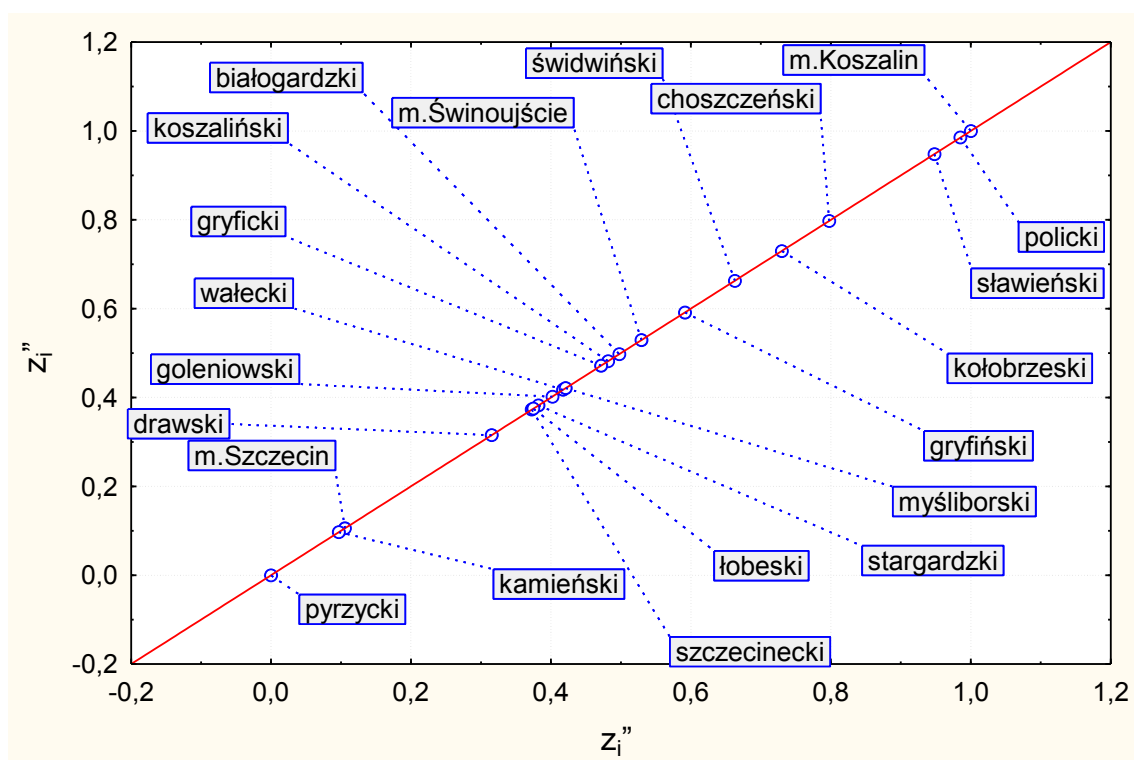


Figure 1. Ranking of Poviats of Western Pomeranian Voivodeship regarding the state of environmental protection in 2020 (standardized variables).

Source: own elaboration using tools of STATISTICA 8 package.

The survey shows that the best state of environmental protection in the West Pomeranian Voivodeship was characterized by the poviats of Sławieński, Choszczeński, Police and the city of Koszalin. In the second typological group were Poviats: białogardzki, kołobrzeski, koszaliński, świdwiński, gryfiński and Świnoujście. The poor state of environmental protection was characterized by the following poviats: drawski, szczecinecki, wałecki, gryficki, myśliborski, stargardzki, łobeski, goleniowski. The worst state of environmental protection was characterized by the following poviats: pyrzycki, kamiński and the city of Szczecin.

In summary, the West Pomeranian province has average natural resources. Varying pressures on the natural environment characterize it. High differentiation is characterized by indicators occurring in infrastructure. However, with a high degree of sewerage in the province and a relatively small disproportion between the length of the sewerage and water supply networks, the overall assessment of the level of environmental infrastructure is relatively low, which is mainly due to the low level of industrial waste utilization on a national scale.

References

1. Bartosiewicz, S. (1976). *Econometrics*. Warsaw: PWE, p. 259.
2. Bernaciak, A., Gaczek, W.M. (2002). *Economic aspects of environmental protection*. Poznań: AE, p. 10.
3. Central Statistical Office (2020). *Environmental Protection*. Warsaw, p. 220.
4. *Development Strategy of the Western Pomeranian Voivodeship until 2030* (2019). Szczecin: Marshal's Office of the Western Pomeranian Voivodeship.
5. Gatnar, E., Walesiak, M. (2004). *Methods of statistical multivariate analysis in marketing research*. Wrocław: Publisher of the Academy of Economics in Wrocław, p. 36.
6. Gorczyca, M. (1976). Measures of environmental protection. In: *Economic aspects of environmental protection*. Warsaw: Arkady, p. 38.
7. Local Data Bank, www.stat.gov.pl, 12.05.2022.
8. Małachowski, K. (2007). *Economy and the environment and ecology*. Warsaw: Cedewu, pp. 7, 10.
9. Mazur, E. (2000). *Threats to the natural environment and the economic and legal aspects of its protection*. Szczecin: Publishing University of Szczecin, p. 13.
10. Mazur, E. (2004). *Natural environment. Threat, protection and shaping*. Szczecin: Publishing University of Szczecin, p. 118.
11. Meyer, B. (2000). *Environmental Protection. Guide*. Szczecin: Publishing University of Szczecin, p. 72.
12. Nowak, E. (1990). *Taxonomic methods in the classification of socio-economic objects*. Warsaw: National Economic Publishing House, p. 31.

13. Popular Encyclopedia (1996). Warsaw: PWN, p. 580.
14. *Program for Environmental Protection of the Western Pomeranian Voivodeship for 2016-2020 with perspective until 2024* (2016). Szczecin: West Pomeranian Regional Parliament, resolution nr XVI/298/16.
15. *Report on the activities of the WFOŚiGW in Szczecin - 2018* (2019). Szczecin: Provincial Fund for Environmental Protection and Water Management in Szczecin.
16. *State of the Environment in the Western Pomeranian Voivodeship report* (2020). Szczecin: Chief Inspectorate for Environmental Protection.
17. *Statistical Vademecum for Local Governments - zachodniopomorskie province* (2020). Statistical Office in Szczecin, www.szczecin.stat.gov.pl.
18. Umiński, T. (1996). *Ecology, environment, nature*. Warsaw: School and Pedagogical Publishing House, p. 204.
19. Żylicz, T. (1989). *Economics in the face of environmental problems*. Warsaw: PWN, pp. 14-16.

PARKING CONDITIONS IN TRANSPORT DEMAND MANAGEMENT

Leszek BYLINKO

University of Bielsko-Biala; lbylinko@ath.bielsko.pl, ORCID: 0000-0001-8047-801X

Purpose: In today's urban mobility landscape, the increasing number of cars trying to park in the city center is one of the most burdensome problems facing urban transport. Knowing about the impact that individual parking space management strategies and methods - including parking solutions and pricing systems - can have on the efficiency of the urban transport system, may be of key importance for the selection of solutions in this area. This knowledge is the main goal of my research.

Design/methodology/approach: The observations and research presented in this article took place in Bielsko-Biala. As part of the research, the effectiveness of actions implementing the city's parking policy was analyzed. The scope of these activities included, first of all, parking fees and the organization of the so-called parking zones in the city. In the case of parking fees, the effectiveness of parking fees was analyzed. The research was mainly a case study. It also had elements of quantitative research - a questionnaire. The effectiveness of parking fees was assessed on the basis of official and up-to-date data on parking fees and the analysis of the ability (ATP) and readiness (WTP) to pay parking fees by their users.

Findings: This article presents the way in which regulations, including parking fees in the center and suburbs of Bielsko-Biala, influenced the demand for parking space and thus the mobility of the city's inhabitants.

Practical implications: The results presented in the article are the basis for making practical decisions regarding the necessary regulations - in the perspective of the increase in demand for transport in downtown areas - related to parking space. This, in turn, may increase the share of public transport in the transport structure.

Originality/value: The available results of empirical research on the relationship between the parking strategy and transport congestion and its consequences are very poor, while the research itself is often hampered by the lack of data systematically collected before and after the introduction of new tools or changes to the already used parking space management tools. The publication analyzes the data collected at the time when new or modified functioning elements of the municipal transport policy were implemented in the city. Indirectly, the author of the article presents evidence for the thesis that negative actions, such as raising parking fees, only allow for limited in time and space effects of actions related to reducing the demand for transport.

Keywords: transport demand management, mobility management, parking policy.

Category of the paper: research paper.

1. Introduction and current knowledge on the impact of transport policy on urban mobility

The mature transport system of Bielsko-Biala is to potentially enable drivers to reach most destinations in a comfortable, safe and affordable manner. The city's road infrastructure would effectively meet the above criteria in the conditions of traffic intensity recorded in the 1970s or 1980s. The main transport problems faced by most urban communities today are road and parking congestion, low mobility of travelers, as well as high economic, social and environmental costs of car transport. All these problems can be prevented by effectively applying the principles of transport demand management.

Most conventional urban transport management strategies address selected individual travel problems. Moreover, individual ones may, as in the case of induced demand, stimulate an increase in demand for journeys and highlight existing problems (Zhang, Loo, 2021). An example is the widening of roads, which reduces congestion in the short term, but may generate additional vehicle traffic over time. As a rule, such action results in even greater problems resulting from the intensity of transport traffic (Bylinko, 2021).

Given that the main goal of demand management is to influence the individual behavior of urban travelers, the challenge for urban transport policy makers is to find the right mix of incentives and disincentives that will bring about a change in routine travel choices (Meyer, 1999). Urban population growth and the rapidly growing number of vehicles are changing travel patterns in a way that makes demand management strategies more effective at solving transport problems than strategies to increase capacity (Farahmand, Konstantinos, Geurs, 2021). In addition, the inability of transport infrastructure to respond rapidly to changing travel needs, coupled with an increase in the number of travelers, forces more emphasis on demand-side management techniques, rather than solving problems by increasing supply.

Most transport demand management strategies are economically sound, but the magnitude of the effects of single tools is too small to significantly affect overall travel patterns. Many city organizations implement single individual demand management strategies, but virtually none has yet implemented a complete transport demand management toolkit that is technically feasible and economically viable (Mahmood, Bashar, Akhter, 2009).

The methods of managing the demand for transport are most often classified according to their direct or indirect impact on the nature of urban transport. This criterion allows us to distinguish five groups of strategies for implementing the concept (Hyllenius et al., 2009):

- Improved transport options.
- Incentives to use alternative modes of transport and to reduce driving.
- Strategies for managing parking space and land development.
- Policy tools and institutional change.
- Transport demand management and support programs.

Most transport demand management strategies are economically sound, but the magnitude of the effects of single tools is too small to significantly affect overall travel patterns (Vanoutrive, 2019). Many city organizations implement single individual demand management strategies, but virtually none has yet implemented a complete transport demand management toolkit that is technically feasible and economically viable. The table below (Table 1) presents the instrumentation of methods related to parking space, which are the indirect subject of research interests in this article.

Table 1.

Instrumentation of parking space management

Tool's name	Description
Parking Cost, Pricing and Revenue Calculator	Excel spreadsheet calculates parking facility costs, prices and revenue
Parking Management	Strategies for more efficient use of parking.
Parking Management: Strategies, Evaluation and Planning - Comprehensive	Development of integrated and coordinated plans for the construction and modernization of parking spaces
Parking Pricing	Charging motorists directly for using parking facilities
Parking Solutions	Comprehensive menu of solutions to parking problems
Parking Evaluation	Guidelines for evaluating parking problems and solutions
Shared Parking	Sharing parking facilities among multiple users
Bicycle Parking	Bicycle racks, lockers and changing facilities

Source: Online TDM Encyclopedia Transportation Demand Management. Improved Transport Options, Victoria Transport Policy Institute, <https://www.vtpi.org/tdm/index.php#improved>.

While most of the individual transport demand management measures contribute to relatively small results that only have an effective impact on a few percent of all urban journeys, their impact is cumulative and synergistic (the total impact is greater than the sum of the individual effects). A comprehensive transport demand management program generally affects a large proportion of all journeys and provides large total benefits (Rowe, 2013).

According to the theory of transport economics, parking fees can have a significant impact on transport demand (transport flexibility). Even small changes in parking fees can affect car travel patterns. The ratio of the use of vehicles for travel to the amount of parking fees varies from -0.1 to -0.3 (a 10% increase in parking fees reduces vehicle journeys by 1-3%), depending on demographic and geographic factors, and means of travel and travel characteristics (Vaca, Kuzmyak, 2005). Parking charges for commuting appear to be particularly effective in reducing travel during peak times. Switching from free parking to parking systems that allow for the reimbursement of parking costs (prices that reflect the full cost of providing parking spaces) usually reduce car journeys by 10-30%, especially if such a change is made from the so-called improved transport options and other complementary transport demand management strategies (Hess, 2001). Experience also shows that setting parking charges in one area only can shift travel to other locations with a slight reduction in the total number of vehicles (Hensher, King, 2001).

This article is based on the considerations presented above. Chapter 2 describes the research methodology and presents changes in the parking policy of Bielsko-Biala in recent years. Chapter 3 reviews the effects of the changes, their analysis and evaluation of activities related to parking regulations and fees and their impact on the mobility of the city's in the future. The last part presents research conclusions related to planning the city's parking policy.

2. Research methodology

The observations and research presented in this article took place in Bielsko-Biala. As part of the research, the effectiveness of actions implementing the city's parking policy was analyzed. The scope of these activities included, first of all, parking fees and the organization of the so-called parking zones in the city. In the case of parking fees, the effectiveness of parking fees was analyzed. The research was mainly a case study. It also had elements of quantitative research - a questionnaire.

The effectiveness of parking fees was assessed on the basis of official and up-to-date data on parking fees and the analysis of the ability (possibilities) and readiness to pay parking fees by their users. The ability to pay (ATP) is the user's ability to pay for the services received based on the income considered optimal, while the willingness to pay (WTP) is the user's willingness to pay fees for issuing rewards for the received services. Ability to pay (ATP) is analyzed on the basis of income, transportation costs, parking fees and parking usage frequency. Meanwhile, willingness to pay (WTP) is the average of the parking fees that users are willing to pay based on their perception of available parking spaces.

In this study, questionnaires were used, which were sent to 240 motorized parking users. They were both car and motorcycle users. The respondents were also user groups, both regularly and irregularly parking on the streets of Bielsko-Biala.

In an attempt to maintain the adequacy of the data included in the study, factors that may affect the willingness to pay (WTP) were taken into account, namely: understanding the need to manage the mobility of city residents, perceiving the benefits of efficient parking space management, determining the proportion of total expenses to expenses related to parking and the method of payment for parking.

The method will be used to assess the public's willingness to pay, namely: the contingent valuation method. Contingent valuation method is a survey technique that attempts to obtain information about the preferences of the individual/household for a product or service (Raffel et al., 2015). These methods fall into the category of direct method, a method that directly ask how much the price that the user wants to pay for the product used. Respondents in this survey were given several questions about how much they value a good or services.

3. Analysis and evaluation of changes in the parking policy in Bielsko-Biala

Pursuant to Resolution No. VIII / 101/2015 of the City Council of May 26, 2015, a Paid Parking Zone (PPZ) was established in Bielsko-Biala, where a fee is charged for parking vehicles on public roads. The above-mentioned zone was designated in the city due to the significant deficit of parking spaces in the city center, in order to, among others, increasing the rotation of parking vehicles. The compact development of the downtown makes it impossible to designate new parking spaces, while the number of vehicles continues to increase, which in turn leads to an increased demand for a limited number of parking spaces.

The functioning of Paid Parking Zones theoretically shortens the parking time in the areas with a shortage of parking spaces to the necessary minimum, improves parking conditions for downtown residents, reduces the traffic of vehicles looking for parking spaces, reducing noise and exhaust emissions, which directly improves the living conditions of residents.

In the first shape, the Paid Parking Zone and its area were delimited by streets and squares, which were presented in comparison with the zone area enlarged in 2022 in the Figure 1. It should also be added that originally the fee for parking vehicles in the zone was collected on business days, from Monday to Friday, from 8:00 to 16:00.

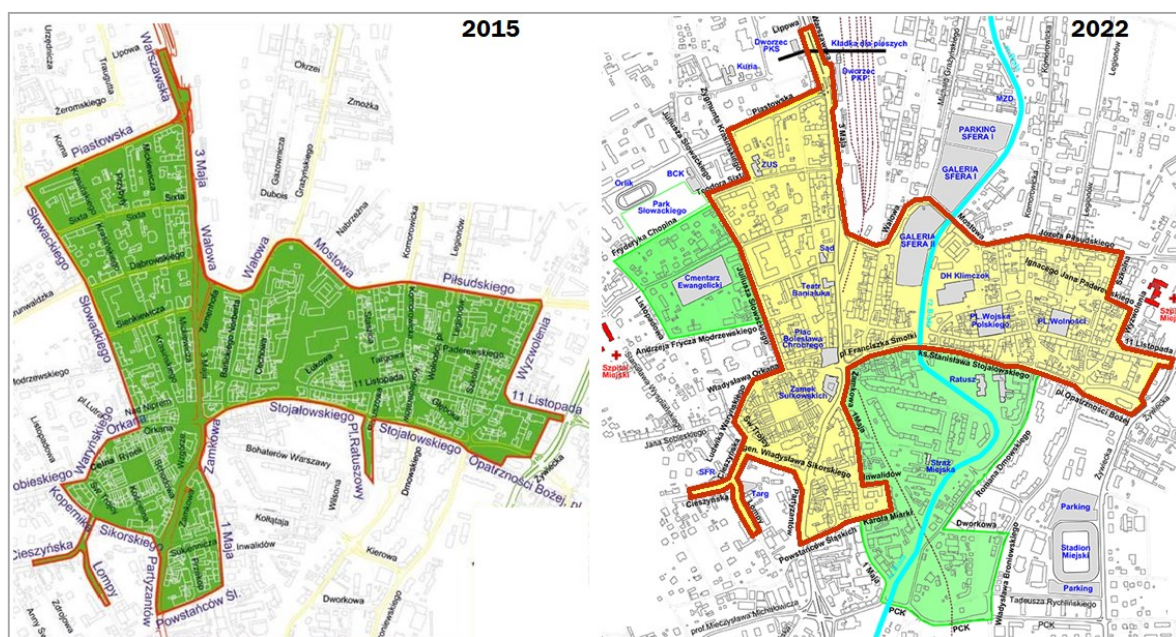


Figure 1. The range of the Paid Parking Zone in Bielsko-Biala in 2015 (left) and in 2022.

Source: Miejski Zarząd Dróg w Bielsku-Białej, <https://mzd.bielsko.pl/o-strefie-platnego-parkowania/>.

The Table 2 presents a summary of the number of parking spaces in car parks in the Paid Parking Zone and on streets in Bielsko-Biala in 2015 and 2022. The number of parking spaces intended for disabled people has also been taken into account.

Table 2.

List of parking spaces in the Paid Parking Zone (PPZ) in 2015 and 2022

Type of parking spaces	Year 2015	Year 2022	Change 2015-2022 [%]
Ordinary parking spaces	1001	1337	+34%
Parking spaces for disabled people	87	101	+28%

Source: Miejski Zarząd Dróg w Bielsku-Białej, <https://mzd.bielsko.pl/o-strefie-platnego-parkowania/>.

The payment of parking fees on public roads results directly from the Act of March 21, 1985 on public roads (Journal of Laws of March 31, 2015, item 460), according to which the City Council, at the request of the Mayor of roads, may introduce Paid Parking Zones in areas with a shortage of parking spaces.

From January 1, 2022, there were, inter alia, extending the payment hours for parking and increasing the fee for using the zone. Parking in the zone is paid for an hour longer - until 17.00. It was a tribute to the drivers living in the zone - the extension of paid time was to make it easier for residents returning by car from work to find a free place in the afternoon. Basically, the rotation in the zone was to be ensured by the increase in the amount of fees. From January 1, 2022, you have to pay PLN 3.50 for the first hour of parking, however the minimum fee for the first 30 minutes is PLN 2.00. The rate for the second hour is PLN 4.00, for the third hour - PLN 4.50, and for each subsequent hour - PLN 3.50. Changes in the amount of parking fees are presented in the Table 3.

The amount of the penalty for non-payment has changed, i.e. the additional fee and the method of its calculation. A driver who does not pay for his stoppage in the zone receives an order to pay the additional fee. It amounts to PLN 150. However, if he/she pays the payment himself within 7 days from the date of issuing the order, he/she will receive a 50% discount, i.e. he/she will pay only PLN 75. At this point, it should also be added that in the Paid Parking Zone in Bielsko-Biala, it is possible to make e-payments for parking vehicles based on three mobile applications: mobiParking, SkyCash, moBILET and mPay. The use of mobile applications seems to have a strong impact on the efficiency of fees, including their compliance with the table presented above.

Table 3.

Differences in the amount of basic and additional fees (penalties) for parking in the Paid Parking Zone in Bielsko-Biala between 2015 and 2022

Type of payment	Year 2015	Year 2022	Change 2015-2022 [%]
Initial 0,5 hour	1	2	+100%
Initial full hour	2	3.5	+75%
2nd hour	2.30	4	+74%
3rd hour	2.50	4.5	+80%
Subsequent hour (each)	2	3.5	+75%
Monthly fee for local inhabitants	100	150	+50%
Monthly fee for business	140	200	+43%
Penalty	50	150	+200%

Source: Miejski Zarząd Dróg w Bielsku-Białej, <https://mzd.bielsko.pl/o-strefie-platnego-parkowania/>.

The analysis of data related to parking in the paid parking zone shows (Table 4) that the increase in negative tools did not reduce the load on the parking lots in the zone. A slight increase of 2% was observed here. On the other hand, the number of cars looking for parking spaces in the outskirts of the zone has increased significantly, by as much as 6%. There has also been an increase in vehicles that break the road traffic regulations, including those related to parking fees. On this basis, it can be concluded that the increase in the so-called additional parking fee (penalties) did not affect the number of vehicles violating the parking restrictions.

Table 4.

Changes in selected numbers of parking cars 2021-2022

Year	2021	2022
Use of parking lots in the Paid Parking Zone	82%	83%
Use of parking lots in the close neighborhood of PPZ	85%	91%
Vehicles violating parking regulations	2%	4%

Source: Miejski Zarząd Dróg w Bielsku-Białej, <https://mzd.bielsko.pl/o-strefie-platnego-parkowania/>.

In the context of the parking policy and mobility of the inhabitants of Bielsko-Biala, the analysis of the growing demand for transport is important, which allows to conclude that the increase in demand for transport, caused mainly by the overflow of urbanized areas, also includes medium-sized and small cities. Bielsko-Biala is an administrative unit with approx. 170 thousand residents. The Bielsko-Biala agglomeration, which is made up of the Bielsko County together with the city of Bielsko-Biala, is an area inhabited by 335,000 people. In recent years, a two-track trend, typical of most similar urban structures in Poland, has been maintained: a decrease in public transport passengers (Figure 2) and a rapid increase in the number of private cars (Figure 3).

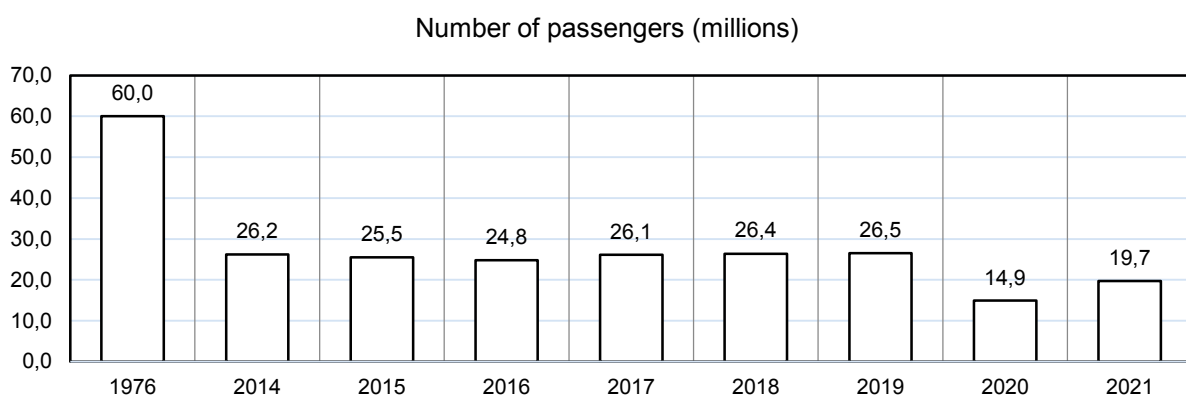


Figure 2. Number of public bus passengers in the years 1976 – 2021 in Bielsko-Biala.

Source: Miejski Zakład Komunikacyjny w Bielsku-Białej, <http://www.mzk.bielsko.pl>.

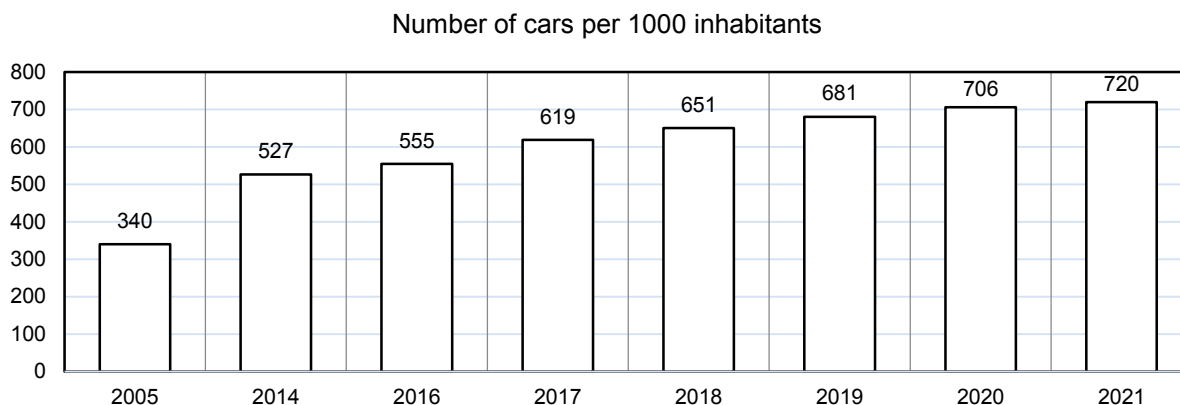


Figure 3. Number of registered cars per 1000 inhabitants in 2005 – 2021 in Bielsko-Biala.

Source: Urząd Miejski w Bielsku-Białej, <http://www.um.bielsko.pl>.

The data on the number of inhabitants of Bielsko-Biala and the Bielsko agglomeration (Table 5) are an indirect evidence of the suburbanization described above. Despite the fact that in the last 22 years, the number of inhabitants of the city of Bielsko-Biala, as shown in Table 4, has decreased by almost 11 thousand. inhabitants, the number of inhabitants of the Bielsko County increased by 22 thousand. residents. Until recently, such a tendency was observed almost exclusively in large and very large cities (with at least 500,000 inhabitants). At the present time, it can be stated that a similar phenomenon is also characteristic of medium-sized cities, which poses a greater risk as it constitutes the basis for the claim that the phenomenon of suburbanization applies to urban centers, regardless of their size or location in the local system.

Table 5.

Population of the city of Bielsko-Biala and Bielsko County in the years 1999-2021. Own study based on data from www.um.bielsko.pl, 20.09.2022

Years	Bielsko-Biala	Bielsko County	Bielsko-Biala and Bielsko County together
1999	178,936	144,922	323,858
2000	178,611	145,772	324,383
2004	176,987	149,361	326,348
2007	175,690	152,695	328,385
2010	174,755	157,119	331,874
2016	172,407	162,495	334,902
2017	171,505	164,003	335,280
2018	171,259	165,000	336,259
2019	170,663	165,960	336,623
2020	169,553	166,348	335,901
2021	168,319	166,498	334,817
<i>difference 1999-2021:</i>	<i>-10,617↓</i>	<i>21,576↑</i>	<i>11,422↑</i>

Source: Own study.

The results of the so-called Ability to Pay (ATP) and readiness to pay fees by residents of various city zones for effective and convenient parking (Willingness to Pay - WTP). The study shows that the fees applied in Bielsko-Biala are not very effective, which means they do not meet the real possibilities and expectations of the inhabitants.

This may be the result of dualism in thinking about cars parked in the center. On the one hand, we want to be able to park easily in our cities, and on the other hand - we would prefer not to have more cars parked there.

Table 6 allows for the comparison official and current fees with ATP and WTP values. It shows that the value based on the user's willingness to pay depends on the place of residence and ranges from PLN 3.14 to PLN 6.62. While the value based on the user's ability to pay is at PLN 1.56 to PLN 4.24.

Table 6.

ATP and WTP values in individual parts of the city of Bielsko-Biala [PLN]

Variable factor	Inhabitants of PPZ	Inhabitants of PPZ vicinity zones	Inhabitants of the suburbs
Willingness to Pay (WTP)	4.24	3.53	1.56
Ability to Pay (ATP)	6.62	5.39	3.14

Source: Own study.

Based on average ATP and WTP value, it finds that the ideal fee should be at PLN 3.11 to PLN 5.05. It is a basic fee - per hour of parking. The official fee is lower than the ideal fee (Figure 4).

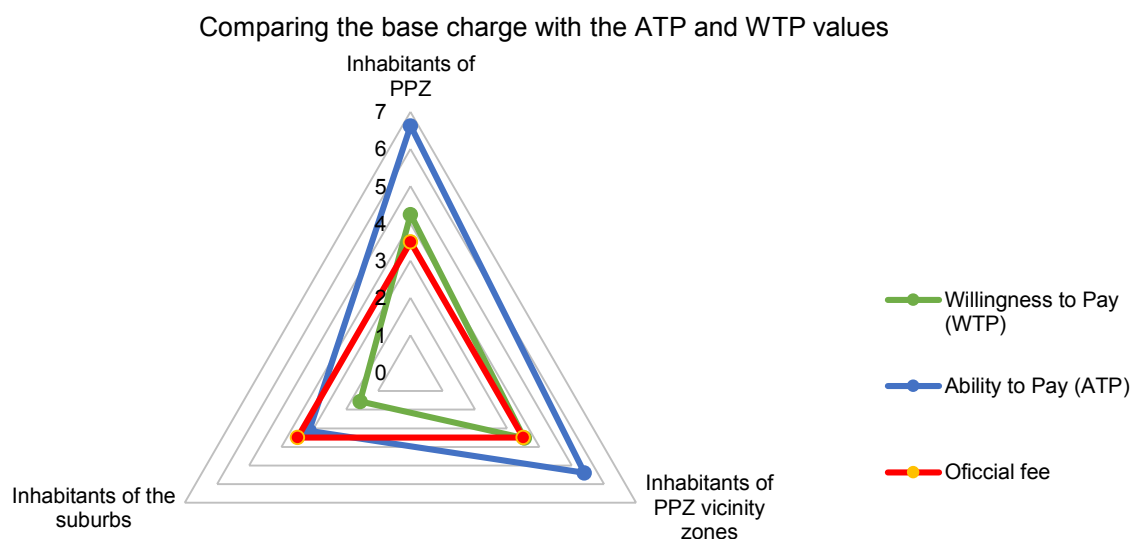


Figure 4. ATP, WTP values [PLN] and official based fee (initial full hour).

Source: Own study.

The results of the estimated values of WTP and ATP can be used as a reference material for determining parking rates. The necessary condition here is to ensure the conditions in which this parking will not be as big a problem as it is today and the parking spaces will simply be more accessible.

The change in the rate of rotation of parking in the paid parking zone is also characteristic of the observed system. Increased rotation at all parking fees suggests that the main driver of this trend is the change in parking fees. Instead of parking in the PPZ, car owners who have been looking for places in the center of Bielsko-Biala often move their vehicles to areas outside the zone, where parking on the street is still free.

4. Conclusions of research

Research and experiences of other cities, such as London, shows that most of the individual measures related to transport demand management contribute to relatively small results, which effectively affect only a few percent of all city commuting. Their proper selection can make their effect cumulative and synergistic (the total effect is greater than the sum of the individual effects). A comprehensive transport demand management program generally affects a large proportion of all journeys and provides large total benefits.

The paid parking system in Bielsko-Biala is not effective and requires thorough changes as part of the overall system of managing the demand for transport in the city.

This article analyzes the impact of the parking policy, including parking fees, on the transport behavior of road users in Bielsko-Biala. A characteristic feature observed during the analysis of the research results is the adaptive behavior of people who want to park in the city center or in its immediate vicinity. The lack of fees for parking in the areas directly adjacent to the paid parking zone means that the effects achieved in the PPZ, consisting not so much in reducing the number of parked vehicles as in greater rotation, extend their negative impact to the outskirts of the PPZ.

References

1. Blainey, S., Preston, J. (2019). Predict or Prophecy? Issues and Trade-Offs in Modelling Long-Term Transport Infrastructure Demand and Capacity. *Transport Policy*, Vol. 74, pp. 165-173, doi: 10.1016/j.tranpol.2018.12.001.
2. Bylinko, L. (2021). *Zarządzanie popytem na transport*. Bielsko-Biała: Wydawnictwo Naukowe Akademii Techniczno-Humanistycznej w Bielsku-Białej.

3. Farahmand, Z.H., Konstantinos, G., Geurs, K.T. (2021). Mobility-as-a-Service as a transport demand management tool: A case study among employees in the Netherlands, *Case Studies on Transport Policy*, Vol. 9, Iss. 4, pp. 1615-1629, doi: 10.1016/j.cstp.2021.09.001.
4. Hensher, D., King, J. (2001), Parking Demand and Response to Supply, Pricing and Location in Sydney Central Business District. *Transportation Research A*, Vol. 35, No. 3, pp. 177-196, doi: 10.1016/S0965-8564(99)00054-3.
5. Hess, D.B. (2001), Effects of Free Parking on Commuter Mode Choice: Evidence from Travel Diary Data. *Transportation Research Record: Journal of the Transportation Research Board*, No. 1753, pp. 35-42. Retrieved from: www.trb.org, 19.09.2022.
6. Hyllenius, P., Smidfelt Rosqvist, L., Haustein, S., Welsch, J., Carreno, M., Rye, T. (2009). *MaxSumo. Przewodnik po metodach planowania, monitorowania i oceny projektów mobilności*. Retrieved from: <http://epomm.eu/>, 21.09.2022.
7. Mahmood, M., Bashar, M.A., Akhter, S. (2009). Traffic Management System and Travel Demand Management (TDM) Strategies: Suggestions for Urban Cities in Bangladesh, *Asian Journal of Management and Humanity Sciences*, Vol. 4, No. 2-3, pp. 161-178. Retrieved from <https://www.researchgate.net/>, 01.09.2022.
8. Meyer, M.D. (1999). Demand management as an element of transportation policy: using carrots and sticks to influence travel behavior, *Transportation Research Part A: Policy and Practice*, No. 33, pp. 575-599, doi: 10.1016/S0965-8564(99)00008-7.
9. *Miejski Zakład Komunikacyjny w Bielsku-Białej*. Retrieved from: <http://www.mzk.bielsko.pl>, 17.09.2022.
10. *Miejski Zarząd Dróg w Bielsku-Białej*. Retrieved from: <https://mzd.bielsko.pl/o-strefie-platnego-parkowania>, 15.09.2022.
11. *Online TDM Encyclopedia Transportation Demand Management. Improved Transport Options*. Retrieved from: <https://www.vtpi.org/tdm/index.php#improved>, 23.08.2022.
12. Parmar, J., Das, P., Sanjaykumar, M.D. (2020). Study on demand and characteristics of parking system in urban areas: A review. *Journal of Traffic and Transportation Engineering (English Edition)*, Vol. 7, Iss. 1, pp. 111-124, doi: 10.1016/j.jtte.2019.09.003.
13. Porru, S., Misso, F.E., Pani, F.E., Repetto, C. (2020). Smart mobility and public transport: Opportunities and challenges in rural and urban areas. *Journal of Traffic and Transportation Engineering (English Edition)*, Vol. 7, Iss. 1, pp. 88-97, doi: 10.1016/j.jtte.2019.10.002.
14. Raffel, A.F., Rachmansyah, A., Soemarno, Kumurur, V.A. (2015). Analysis of Willingness and Ability to Pay (WTP and ATP) On Waste Management in the City Ternate. *Journal of Environmental Science, Toxicology and Food Technology*, Vol. 9, Iss. 5 Ver. II, pp. 39-48, doi: 10.9790/2402-09523948.
15. Rosenfield, A., Attanucci, J.P., Zhao, J. (2020). A randomized controlled trial in travel demand management. *Transportation*, Vol. 47(4), doi: 10.1007/s11116-019-10023-9.

16. Rowe, D. (2013). Do Land Use, Transit and Walk Access Affect Residential Parking Demand? *ITE Journal*, Vol. 83. No. 2, pp. 24-28. Retrieved from: <https://www.researchgate.net/>, 10.09.2022.
17. Uchwała nr VIII/101/2015 Rady Miejskiej w Bielsku-Białej z dnia 26 maja 2015 r. w sprawie ustalenia strefy płatnego parkowania dla pojazdów samochodowych na drogach publicznych na obszarze miasta Bielska-Białej (tekst jednolity). Miejski Zarząd Dróg w Bielsku-Białej (2015).
18. Urząd Miejski w Bielsku-Białej. Retrieved from: <http://www.um.bielsko.pl>, 20.09.2022.
19. Vaca, E., Kuzmyak, J.R. (2005). *Parking Pricing and Fees, Chapter 13, TCRP Report 95*. Transportation Research Board, Federal Transit Administration. Retrieved from: www.trb.org/publications/tcrp/tcrp_rpt_95c13.pdf, 15.09.2022.
20. Vanoutrive, T. (2019). Commuting, spatial mismatch, and Transport Demand Management: The case of gateways. *Case Studies on Transport Policy*, Vol. 7, Iss. 2, pp. 489-496, doi: 10.1016/j.cstp.2018.12.011.
21. Wang, B., Ordonez Medina, S.A., Fourie, P.J. (2019). Comparing Parking Strategies of Autonomous Transit On Demand with Varying Transport Demand. *Procedia Computer Science*, Vol. 151, pp. 814-819, doi: 10.1016/j.procs.2019.04.111.
22. Zhang, F., Loo, B.P.Y. (2021). Transport Demand Management, Editor: Roger Vickerman. *International Encyclopedia of Transportation*, pp. 537-543, doi: 10.1016/B978-0-08-102671-7.10380-X.

STRATEGIC MANAGEMENT IN CONDITIONS OF UNCERTAINTY

Henryk DŹWIGOŁ^{1*}, Mariola DŹWIGOŁ-BAROSZ²

¹ Silesian University of Technology; henryk.dzwigol@poczta.fm, ORCID: 0000-0002-2005-0078

² Silesian University of Technology; mariola.dzwigol-barosz@poczta.fm, ORCID: 0000-0002-5306-3836

* Correspondence author

Purpose: to analyse the variables influencing the construction of a new approach in the strategic management process of an enterprise operating under uncertainty. As a theoretical background for the research, the 'valued' concepts related to business management occurring in the global economy were used, i.e. the concepts of knowledge economy, network organisation, sustainable development, time management and social participation.

Design/methodology/approach: it is necessary to use methods in practice for research in management science based on observation of facts and the classification used in the methodology of inductive sciences such as:

- observation carried out under natural conditions and interaction with the companies under investigation,
- observation-intervention which takes place within the framework of transformation activities in companies, and the researcher has a direct influence on the decisions made in this respect. This implies the need to combine scientific and practical objectives.

Findings: The market has forced a move away from the traditional business management approach to task-focused teams, where today's boss may be his subordinate's subordinate tomorrow, because that is better for the objectives of a particular project. These groups will be interdisciplinary, according to the nature of the task, and their participants will gain a pretty good knowledge of what the other partners are up to and will be prepared enough to replace them with dignity in forced situations. This approach offers an opportunity for the company to adapt more quickly to dynamic changes in the environment.

Research limitations/implications: The research should address the development of a tool to support the selection of methods and approaches for the strategic management process under uncertainty.

Practical implications: The authors have identified only some of the determinants of strategic management under uncertainty, such as the knowledge economy, sustainable development, network structure in the enterprise, time management, soft factors in the management process under uncertainty - emotional intelligence. The research should not only develop new approaches in the process of strategic management, but also identify management methods that should primarily be applied under conditions of uncertainty.

Originality/value: In the conditions of pandemics and wars, it is necessary to develop a flexible approach to the process of strategic corporate management. It is also necessary to develop or modify existing management methods for these difficult times of dynamic change in the environment.

Keywords: strategic management, knowledge economy, sustainability, network structure, emotional intelligence

Category of the paper: The paper is analytical in nature.

1. Introduction

The progressive process of globalisation and permanent changes in the market necessitate companies to develop a different approach to the management process. Today's companies need to open up to new solutions, learn to see problems from different perspectives, become more flexible and responsive to market signals and show a willingness to make changes in the management process. This is related to the fact that nowadays, under conditions of considerable uncertainty, we are more than ever confronted with increasingly complex corporate goals, the evolution of work organisation towards its autonomisation and the creation of flexible forms of work, the reduction of the possibility of achieving results in the company through the use of hierarchical control, greater emphasis on improving the skills of employees and new patterns of so-called 'careers without borders'. These processes include modern managers, whose style of operation should take into account the interests of the enterprise through dynamic management of its resources, i.e.: marketing and sales, production, human resources, financial, organisational, physical and information resources.

In addition, companies are operating in the era of the 4th Industrial Revolution, which is seen as the beginning of a new era in which industry is becoming increasingly 'smart' through intensive data sharing and predictive analytics and the use of Internet of Things technologies (Porter, Heppelmann, 2015; Lenka, Parida, Wincent, 2017). This is forcing companies across industries to develop a new way of doing business, which affects the entire industrial value chain (Iansiti, Lakhani, 2014; Cenamor, Sjödin, Parida, 2017) and which is directly related to their performance (Imran, Waseem, Adnan, 2018; Waschneck et al., 2016). In this context, J. Pieriegud (2019) points out that the digitalisation of the economy and society is one of the most dynamic changes that can be observed in the current environment, which, on the one hand, opens up new opportunities in the creation of business models, while, on the other hand, brings with it uncertainty and various risks related to, inter alia, security in the broadest sense and the social impact of the automation of manufacturing processes. The author sees digitalisation as a continuous process of convergence of the real and virtual worlds, which is becoming a driver of innovation and change in most sectors of the economy.

Taking the above into account, one can conclude that the changes taking place in our environment necessitate the construction of a contemporary strategic management model. However, in order to build such a model, it is first necessary to prepare the assumptions for its construction. Hence, the purpose of this paper is to identify the variables that may influence the construction of a contemporary strategic management model under conditions of uncertainty.

The paper consists of two parts: the first part characterises the variables that can have a key influence on the contemporary market economy model, while the second part of the paper attempts to identify the assumptions for the construction of the contemporary market economy model.

2. Selected variables of the modern market economy model

2.1. Knowledge economy

When analysing the variables of the contemporary market economy model, it is necessary to refer directly to the 'valued' concepts present in the global economy related to business management, which may include:

- knowledge economy,
- sustainability and sustainable organisation,
- network structures,
- public participation,
- time management.

One of the key variables of the contemporary market economy model should be its knowledge-based nature. The essence of a knowledge-based economy is that long-term growth is determined mainly by investment in human capital and innovation (Welfe, 2009). Knowledge here becomes the driving force of the economy and is a resource used in economic transactions. It is the result of specific social, economic and political processes (Krätke, 2012; Ernst, Kim, 2002). As K. Kucznik (2019) points out, the knowledge-based economy comprises four pillars: (1) the institutional-legal environment - factors that may allow the elimination or reduction of legal-administrative-economic market barriers, as well as stimulating entrepreneurship, in other words a system of economic incentives, (2) innovation systems, taking into account the number of people employed in research and development, the number of scientific and technical publications and patents per million inhabitants, (3) education and training, which takes into account the state and effectiveness of lifelong education, and (4) information infrastructure per 10,000 inhabitants.

K.B. Matusiak (2010) points out that the transition from an industrial economy to a knowledge-based economy is evidenced by: (1) dematerialisation (knowledge as a source of competitive advantage), (2) dynamisation (concerning, for example, the technological race and the growing demand for innovation), (3) decentralisation (management by networks and the introduction of flexible business models), (4) uncertainty (corresponding to a turbulent economy), and (5) globalisation (the increase in the reach of markets, while being embedded in local and regional specificities).

Despite the fact that the Knowledge-based Economy has many advantages, one can also point to the risks associated with it, namely: (1) the possibility of a widening of the gap between less-developed countries and the most technologically advanced ones as a result of dynamic technological progress, (2) the additional marginalisation of developing countries as a result of the failure of other countries to absorb dawning technological advances, (3) the widening of inequalities in the level of productivity and the rate of economic development of different countries through variations in the quality of organisation, (4) monopolisation of the market through homogenisation of products and services, (5) increasing disparities in the level of technology use, (6) widening of the gap between highly developed countries supporting themselves in the implementation of modern technology and other countries, and (7) stratification of countries into regions equipped and not equipped with modern infrastructure and adequately qualified human capital (Makulska, 2012).

2.2. Sustainable development

Corporate sustainability is one of the key elements determining the level of competitiveness of an organisation (Koszel, Weinert, 2013). J. Adamczyk (2018) points out that managing an enterprise according to the principles of sustainable development requires balancing economic, social and environmental goals. It involves the process of efficient production of desired products and services, while limiting the consumption of nature's resources and respecting environmental protection, at the same time ensuring that the expectations of stakeholders are met. In accordance with the principles of sustainable development, a company takes into account the interests of customers, employees, suppliers, the local community and other stakeholder groups. A. Misztal (2018a), on the other hand, emphasises that sustainable development in relation to an enterprise is a process of quantitative and qualitative changes aimed at the simultaneous realisation of economic, social and environmental objectives.

Sustainability should be the basis for a long-term approach to organisational management (Misztal, 2018b). The realisation of sustainable development by companies is linked to the need to adapt to the changing environment, to continuously learn and to reorient the company's goals towards increasing value for counterparties (Grudzewski et al., 2010, p. 27).

As emphasised by A. Misztal (2018b), the sustainable development of an enterprise is tantamount to improving the financial and asset situation of the entity, while at the same time improving the conditions and quality of functioning of its employees and taking care to improve standards related to environmental protection. However, the harmonisation of actions towards the implementation of predetermined strategic objectives must take into account not only the current operating conditions, but also expresses the need to take care of the future of the economic entity.

2.3. Network structure in the modern enterprise

The network structure is the structure used in modern organisations that break-up with traditional organisational arrangements and introduce new ways of management. Thus, it can be concluded that this structure is used in such enterprises that base their functioning on network work and management. Furthermore, as Glückler (2012) points out, the concept of network formation and operation is related to guaranteeing and strengthening a competitive position, which is created by means of various forms of interaction between organisations in order to gain access to strategic resources.

A network is a form of organisation that functions to build competitive advantage. Therefore, its element is a kind of relationship between separate entities that is characterised largely by interaction rather than competition (Zentes, Swoboda, Morschett, 2005).

Contemporary network organisations are shaped on the basis of a new approach to competition, which is here identified not only with the individual capabilities of companies, but with the skills resulting from cooperation in a network of shared values. At their core is the shared control of specialised and interconnected resources, which are generally intangible in nature. Network organisations are created when there is a strategic potential among the organisation's partners that creates added value, which at the same time is a factor conditioning the competitiveness of entities creating the network (Mikołajek-Gocejna, 2011).

Working in a networked structure requires managers to have "a high ability to synthesise dispersed information material". Today's managers need to know how to share their expert knowledge with others, how to update this knowledge so that it allows them to shorten the duration of projects, to create informal connections and to control the flow of information within the company and to create and guard the boundaries of the activities of teams or individual employees. Managers operating in a network structure need to make changes in terms of the demands placed on ranks, leadership style, organisational culture and the motivation system.

The advantages of a network organisation include the possibility to achieve high efficiency of operations by eliminating redundant operations, increasing flexibility in operations, introducing new and faster methods of information exchange and fostering competitiveness and learning. In addition, the 'network of relationships' between entities fosters the exchange of resources, facilitates work control and redirection of employee duties (Mikołajek-Gocejna, 2011). Moreover, it allows for the possibility of synergies, the occurrence of a multilateral cooperation effect and a high degree of independence of the partners in the arrangement, which fosters innovation and learning (Sułkowski, Sikorski, 2014). Of course, like any concept, this one too is not free of flaws. The possibility of exploitation by the main organisation, the requirements for professionalism and education of employees, problems when managing the interconnectedness of enterprises, the increase in the number of participants and problems with information management and control are indicated as the main solutions to this approach (Mikołajek-Gocejna, 2011).

2.4. Public participation in the governance process

Participation is understood as the inclusion of employees in the decision-making process concerning the functioning of the organisation and their participation in its management. Participation in the management process enables employees to feel responsible for the fate of the company and for its results, their behaviour and involvement increases their creativity and thus enhances the development potential of the entire organisation. In this context, E. Poutsma (2017) emphasises that in the employee sense, however, participation is not limited to being a member of a team, for the essence of participation is taking an active role in the team, participating in decisions and taking responsibility for joint actions.

As H. Kisilowska (1998) points out, the meaning of employee participation in management is motivational in nature and boils down to activities aimed at triggering bottom-up initiatives and arousing a willingness to assume at least some responsibility in the workplace. Participation implies the empowerment of the employee with all the positive consequences for the formation of desirable attitudes on the part of the employee.

In participatory activities, it is particularly important to involve as diverse a workforce as possible in the decision-making process, as they bring with them unique knowledge of different areas of the company (Przywojska, 2019). At the same time, as I. Rącka and B. Wenerska (2018) it is necessary to conduct the participation process well. This will help to strengthen employees' sense of empowerment (Denhardt, Denhardt, 2007) and increase their confidence. It is also important that social participation allows for real participation in planning and decision-making, as it is unsatisfactory for employees to be listened to, it is necessary to take their opinions into account in company policy (Przywojska, 2019).

2.5. Time management as a new approach to business development

Management in modern companies is most often time-based and focused on innovation (Dźwigoł, Dźwigoł-Barosz, 2018, p. 61).

Temporary management is a concept that has many interpretations and definitions, e.g.: it is the temporary handing over of a company or part of it to management by a selected manager for special tasks in order to make changes in particular or all areas of its business.

Determinants of the emergence of this approach include (Rytka, 2011): (1) increasing competitive pressures resulting from the globalisation of markets while at the same time removing barriers to access - for example in the European Union, (2) the growing influence and role of consumers - access to information through the use of the Internet, (3) the growing uncertainty of tomorrow as a result of increased risks: operational, financial, political, etc. The loss of economic security in business, (4) the growing role of innovation and flexibility in economic processes, and (5) the dynamic changes taking place in the economic and business environment of enterprises.

The new reality requires a highly qualified manager to be hired for a specific purpose and for a specific period of time to solve a complex problem in the company, i.e. the interim manager (Dźwigoł, Dźwigoł, 2018, p. 66).

A manager involved in temporary management should be characterised by a specific approach and achievements (Rytka, 2011), i.e.: (1) have experience, which allows the application of proven methods to the client, (2) boast professional successes, (3) be a person who is stable in life, thus less prone to various types of behaviour, (4) seek challenges, as a temporary manager is hired where the competences of a full-time manager are no longer sufficient, (5) be open to new tasks and goals, which allows for increased effectiveness in their implementation, and (6) feel satisfaction with the result, not only to perform the function for power.

Summarising this concept, it can be pointed out that it focuses on core competences, the increasing demand for efficiency and effectiveness of actions taken, the desire to reduce the risk of profit earned and innovation.

As can be concluded from the analysis, the construction of a new model of market economy (NMME) should be done taking into account such aspects as sustainable development, knowledge-based economy, the use of network structures, social participation in the management process and the use of time management (employment of managers for special tasks). The survival of an enterprise in changing conditions is determined by the ability to anticipate changes and manage them effectively, adapt management methods to new implementation conditions, focus on building effective processes and create effective attitudes and behaviours of employees (Nogalski, Rutka, 2007). It is also becoming necessary to move from a linear approach to process building (so-called linearity) to the creation of processes characterised by a high degree of decision-making autonomy, speed, higher product quality and more effective management (so-called networking).

3. Soft factors in the management process under uncertainty

Emotional quotient or EQ (Mikołajewska, Mikołajewski, 2013, p. 3) (*emotional quotient*, EQ; *emotional intelligence*, EI) - a person's personal competence in terms of the ability to recognise one's own emotional states and those of others, as well as the ability to use one's own emotions and deal with the emotional states of others.

The development of a competence model for managers in a knowledge-based economy is an important element both theoretically and practically (Dźwigoł, Dźwigoł-Barosz, Miśkiewicz, Kwiliński, 2020, p. 2630).

Competences included in emotional intelligence are complementary to general intelligence, understood as purely intellectual, analytical and abstract abilities, measured by the intelligence quotient and expressed by the IQ (*Intelligence Quotient*).

3.1. Three main models of emotional intelligence

According to Daniel Goleman, emotional intelligence includes the ability to understand oneself and one's emotions, to manage and control them, the ability to self-motivate, empathy and skills of a social nature (Matthews, Zeinder, Roberts, 2004).

Jack Mayer and Peter Salovey speak of four areas that make up emotional intelligence: perceiving emotions, supporting thinking with emotions, understanding emotions and managing emotions (Goleman, 1997a).

According to Reuven Bar-On, emotional intelligence consists of five components: intrapersonal intelligence, interpersonal intelligence, stress coping, adaptability and general mood (Goleman, 1997b).

3.2. Typology of emotional competence

Emotional intelligence includes three main groups of competences (Goleman, 1997b; Krokowski, Rydzewski, 2004; Conversation..., 2009):

Psychological competence (relationship with self)

- *Self-awareness*: the ability to recognise one's own emotional states, knowledge of one's own feelings, values, preferences, capacities and intuitive judgements, i.e. emotional awareness.
- *Self-esteem*: self-confidence, awareness of one's abilities, skills and one's limitations; ability to experience oneself independently of other people's judgements.
- *Self-control* or *Self-regulation*: the ability to react consciously to external stimuli and to control one's own emotional states; the ability to cope with stress, to shape one's own emotions in accordance with oneself, one's own norms, principles and professed values.

Social competence (relations with others)

- *Empathy*: the ability to experience the emotional states of others, to be aware of the feelings, needs and values of others, i.e. to understand others, to be sensitive to the feelings of others; an attitude geared to helping and supporting others; the ability to feel and understand social relationships.
- *Assertiveness*: having and expressing one's own opinion and directly, openly expressing emotions, attitudes and professed values within limits that do not violate the rights and psychological territory of others; the ability to defend one's own rights in social situations without violating the rights of others to defend them.
- *Persuasion*: the ability to elicit desired behaviours and reactions in others, i.e. to influence others; the ability to get others to agree, the ability to mitigate conflict.

- *Leadership*: the ability to create a vision and stimulate human motivation to realise it; the ability to win over followers.
- *Collaboration*: the ability to bond and interact with others, the ability to work as a group towards common goals, the ability to perform tasks as a team and solve problems together.

Praxeological competence (a.k.a. action competence - our attitude to tasks, challenges and activities)

- *Motivation*: one's own commitment, the emotional inclinations that lead to or facilitate the achievement of new goals, i.e. the drive for achievement, initiative and optimism.
- *Adaptability*: ability to control one's internal states; ability to cope with a changing environment, flexibility to adapt to changes in the environment, ability to act and make decisions under stress.
- *Conscientiousness*: the ability to take responsibility for tasks and to carry them out; the ability to derive satisfaction from one's duties; consistency in action, in accordance with the standards one has adopted.

3.3. Measuring methods

One of the more popular tools in Anglo-American practice for measuring emotional intelligence is the *Multifactor Emotional Intelligence Scale* (MEIS), on which the *Mayer-Salovey-Caruso Emotional Intelligence Test* (MSCEIT) was based. Jack Mayer, Peter Salovey and David R. Caruso created a tool that examines four levels of emotional intelligence: perceiving emotions, using emotions in cognitive processes, understanding emotions and managing emotions (Conversation..., 2009). In Poland, the *Test of Emotional Intelligence* (TEI) was developed (Śmieja, Orzechowski, Asanowicz, 2013), which is also embedded in Mayer, Salovey and Caruso's theoretical model.

Scholars have raised concerns about the extent to which emotional intelligence measures of self-esteem correlate with personality dimensions that are well established in psychometrics. The predominant view in the scientific literature is that emotional intelligence understood as a trait EI is a reinterpretation of a set of personality traits (Petrides, Pita, Kokkinaki, 2007, pp. 273-289; Mikolajczak et al., 2007, pp. 338-353; Austin, 2009, pp. 381-383).

Ashkanasy et al. also points out that there is currently not enough strong evidence that emotional intelligence predicts leadership competence after excluding personality traits and IQ (Antonakis, Ashkanasy, Dasborough, 2009, pp. 247-261).

Other critical voices argue that tests of emotional intelligence do not measure cognitive ability, only knowledge of and conformity to social norms (APA PsycNet).

Locke argues that the concept of EI is itself a misinterpretation of the construct of intelligence, and proposes an alternative interpretation: it is not another form or type of intelligence, but intelligence - the ability to grasp abstractions - applied to a specific domain of life: the emotions (Locke, 2005, pp. 425-431).

Emotional intelligence also has a moral aspect. Often seen as a moral virtue, it is in fact a skill that can be used instrumentally as a tool to achieve goals by manipulating other people (Wichura, 2017; Grant, 2014).

4. Summary

At present, the key problem of strategic management is to perceive, value and master the growing uncertainty accompanying the activities of enterprises (Koźmiński, 2004). The complexity and dynamics of the environment often create strategic dilemmas as to making sustainable choices of concepts and methods in management processes in the face of this uncertainty.

This paper is an attempt to search for a possible solution to the dilemma between the difficulty of anticipating the future and the choice of concepts related to business management in order to build a contemporary strategic management model. Concepts such as the knowledge economy, network organisation, sustainable development, time management or social participation can significantly influence the construction of an optimal strategic management model under conditions of uncertainty.

5. References

1. Adamczyk, J. (2018). Zrównoważony rozwój jako paradygmat współczesnego zarządzania przedsiębiorstwem. *Przeгляд Organizacji, nr 12*.
2. Antonakis, J., Ashkanasy, N.M., Dasborough, M.T. (2009). Does leadership need emotional intelligence? *The Leadership Quarterly, 20(2)*, pp. 247-261, DOI: 10.1016/j.leaqua.2009.01.006, 22.10.2022.
3. APA PsycNet, doi.apa.org, DOI: 10.1037/1528-3542.1.3.196, 22.10.2022.
4. Austin, E.J. (2009). A reaction time study of responses to trait and ability emotional intelligence test items. *Personality and Individual Differences, 46(3)*, pp. 381-383, DOI: 10.1016/j.paid.2008.10.025, 2020.10.22.
5. Cenamor, J., Sjödin, D.R., Parida, V. (2017). Adopting a platform approach in servitization: Leveraging the value of digitalization. *International Journal of Production Economics, Vol. 192*.
6. Denhardt, J.V., Denhardt, R.B. (2007). *The New Public Service. Serving, Not Steering*. Routledge.

7. Dźwigoł, H., Dźwigoł-Barosz, M., Miśkiewicz, R., Kwiliński, A. (2020). Manager Competency Assessment Model in the Conditions of Industry 4.0, *Entrepreneurship And Sustainability Issues, Vol. 7, No. 4(June)*.
8. Dźwigoł, H., Dźwigoł, D. (2018). Interim manager: identyfikacja kompetencji kierowników do zadań specjalnych. *Zeszyty Naukowe Politechniki Śląskiej Organizacja i Zarządzanie, z. 120*. Gliwice, pp. 65-72.
9. Dźwigoł, H., Dźwigoł-Barosz, M. (2018). Menedżer we współczesnych innowacyjnych przedsiębiorstwach. In: K. Pająk (ed.), *Nowe zarządzanie publiczne. Aspekty teoretyczne i praktyczne*. Warszawa: PWN.
10. Ernst, D., Kim, L. (2002). Global production networks, knowledge diffusion, and local capability formation. *Research Policy, Vol. 31, Iss. 8-9*.
11. Glückler, J. (2012). *Handbook of Research on Entrepreneurship in Professional Services*. Edward Elgar Publishing.
12. Goleman, D. (1997a). *Inteligencja emocjonalna*. Poznań: Media Rodzina. ISBN 978-83-7278-217-5.
13. Goleman, D. (1997b). *Inteligencja emocjonalna w praktyce*. Poznań: Media Rodzina. ISBN 978-83-8559-481-9.
14. Grant, A. (2014). *The Dark Side of Emotional Intelligence, 2 stycznia 2014, 22.10.2022*.
15. Grudzewski, W.M., Hejduk, I.K., Sankowska, A., Wańtuchowicz, M. (2010). W kierunku zarządzania drugiej generacji – model diamentu czterech paradygmatów współczesnego przedsiębiorstwa. *e-mentor, nr 1*.
16. Imran, M., Waseem, H., Adnan, H. (2018). Influence of Industry 4.0 on the Production and Service Sectors in Pakistan: Evidence from Textile and Logistics Industries. *Social Sciences, 7(12)*.
17. Kisilowska, H. (2008). *Partycypacja pracownicza w polskim przedsiębiorstwie w aspekcie integracji europejskiej: zagadnienia prawne*. Oficyna Wydawnicza Politechniki Warszawskiej.
18. Koszel, M., Weinert, A. (2013). Wykorzystanie koncepcji społecznej odpowiedzialności przedsiębiorstw i zrównoważonego rozwoju w kreowaniu innowacyjnego produktu: studia przypadków. *Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania, 32/2*. Uniwersytet Ekonomiczny w Poznaniu.
19. Koźmiński, A. (2004). *Zarządzanie w warunkach niepewności*. PWE.
20. Krätke, S. (2012). *Cities for people, not for profit*. Routledge.
21. Krokowski, M., Rydzewski, P. (2004). *Inteligencja emocjonalna*. Łódź: Imperia S.C.
22. Kucznik, K. (2019). *Gospodarka oparta na wiedzy jako trend stymulujący zarządzanie talentami*. II Konferencja Naukowa "Współczesne problemy ekonomiczne w badaniach młodych naukowców", 24 maja 2018. Polskie Towarzystwo Ekonomiczne.
23. Lansiti, M., Lakhani, K.R. (2014). Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business. *Harvard Business Review, 92*.

24. Lenka, S., Parida, V., Wincent, J. (2017). Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms: Digitalization Capabilities. *Psychology and Marketing*, 34(1).
25. Locke, E.A. (2005). Why emotional intelligence is an invalid concept. *Journal of Organizational Behavior*, 26(4), pp. 425-431, DOI: 10.1002/job.318, 22.10.2022.
26. Makulska, D. (2012). Kluczowe czynniki rozwoju w gospodarce opartej na wiedzy. *Prace i Materiały Instytutu Rozwoju Gospodarczego, nr 88. Pomiędzy polityką stabilizacyjną i polityką rozwoju*. Szkoła Główna Handlowa.
27. Matthews, G., Zeider, M., Roberts, R.D. (2004). *Emotional Intelligence: Science and Myth*. Cambridge: MIT Press.
28. Matusiak, K.B. (2010). *Budowa powiązań nauki z biznesem w gospodarce opartej na wiedzy. Rola i miejsce uniwersytetu w procesach innowacyjnych*. Warszawa: Oficyna Wydawnicza SGH.
29. Mikołajczak, M. et al. (2007). Psychometric Properties of the Trait Emotional Intelligence Questionnaire: Factor Structure, Reliability, Construct, and Incremental Validity in a French-Speaking Population. *Journal of Personality Assessment*, 88(3), pp. 338-353; DOI: 10.1080/00223890701333431, PMID: 17518555.
30. Mikołajek-Gocejna, M. (2011). Wybrane teorie wyjaśniające powstawanie i funkcjonowanie organizacji sieciowych. *Zeszyty Naukowe Szkoły Głównej Handlowej. Kolegium Gospodarki Światowej, nr 32*.
31. Mikołajewska, E., Mikołajewski, D. (2013). Informatyka afektywna w zastosowaniach cywilnych i wojskowych. *Zeszyty Naukowe WSOWL, Nr 2(168)*, p. 3.
32. Misztal, A. (2018a). IT jako element strategii zrównoważonego rozwoju przedsiębiorstwa. *Zeszyty Naukowe Politechniki Śląskiej, Seria: Organizacja i Zarządzanie z. 131*.
33. Misztal, A. (2018b). Zrównoważony rozwój polskich przedsiębiorstw – ewaluacja. *Handel Wewnętrzny, 2(373)*.
34. Nogalski, B., Rutka, R. (2007). *Kluczowe kwestie współczesnego rozwoju nauk o zarządzaniu w Polsce. Współczesne kierunki nauk o zarządzaniu*. Księga jubileuszowa z okazji 50-lecia pracy naukowej i dydaktycznej profesora Jerzego Rokity. Katowice: Górnośląska Wyższa Szkoła Handlowa.
35. Petrides, K.V., Pita, R., Kokkinaki, F. (2007). The location of trait emotional intelligence in personality factor space. *British Journal of Psychology*, 98(2), pp. 273-289, DOI: 10.1348/000712606X120618, 22.10.2020.
36. Pieriegud, J. (2019). The development of digital distribution channels in Poland's retail pharmaceutical market. *Exploring Omnichannel Retailing*.
37. Porter, M.E., Heppelmann, J.E. (2015). How Smart, Connected Products Are Transforming Companies. *Harvard Business Review*, 93.
38. Poutsma, E., Kaarsemaker, E. (2017). *Sharing in the Company: Determinants, Processes and Outcomes of Employee Participation*. Emerald Group Publishing.

39. Przywojska, J. (2019). Współzarządzanie i partycypacja społeczna w rewitalizacji. *Rocznik Lubuski*, 45(2).
40. Rącka, I., Wenerska, B. (2018). Partycypacja społeczna w procesie rewitalizacji. *Przesiębiorczość i Zarządzanie*, 3.
41. Rozmowa Agnieszki Chrzanowskiej z Geraldem Matthews (2009). *Magazyn Psychologiczny Charaktery*, nr 1(144), styczeń.
42. Rytka, E., Buchajska-Wróbel, M., Wendt, R., Gasparski, J., Gajda, K. (2011). *Menedżer do zadań specjalnych. Czasowe zarządzanie przedsiębiorstwem*. Gliwice: Helion.
43. Sułkowski, Ł., Sikorski, C. (eds.) (2014). *Metody zarządzania kultura organizacyjna*. Difin.
44. Śmieja, M., Orzechowski, J., Asanowicz, D. (2013). *Test Inteligencji Emocjonalnej (TIE)*. Podręcznik. Kraków: Wszechnica UJ.
45. Waschneck, B., Bauernhansl, T., Altenmüller, T., Kyek, A. (2016). *Production Scheduling in Complex Job Shops from an Industrie 4.0 Perspective: A Review and Challenges in the Semiconductor Industry*. SamI40 workshop at i-KNOW '16 October 18-19, 2016, Graz, Austria.
46. Wichura, A.J. (2017). Czy inteligencja emocjonalna to pseudo nauka? *Psychologia Racjonalizmu*, 24 września 2017, 22.10.2022.
47. Zentes, J., Swoboda, B., Morschett, D. (2005). *Kooperationen, Allianzen, Netzwerke. Grundlagen Ansätze-Perspektiven*. Wiesbaden: Gabler Verlag.

THE PHENOMENON OF MOBBING AT WORK – INITIAL REPORT FROM THE RESEARCH

Sylwia GOŁĄB^{1*}, Beata BĘDZIK², Zuzanna SIEDLECKA³

¹ West Pomeranian University of Technology in Szczecin, Faculty of Economics; sylwia.golab@zut.edu.pl, ORCID: 0000-0002-6572-9201

² West Pomeranian University of Technology in Szczecin, Faculty of Economics; beata.bedzik@zut.edu.pl, ORCID: 0000-0003-1052-0977

³ SWPS University of Social Sciences and Humanities, Poland; zsiedlecka@st.swps.edu.pl, Student of Psychology

* Correspondence author

Purpose: The article concerns the phenomenon of mobbing in the workplace. Possible causes and consequences of mobbing are described, as well as the specificity of mobbing behavior.

Design/methodology/approach: In order to illustrate the phenomenon of mobbing, terminological arrangements are first made. Mobbing is analyzed through the prism of both its causes and the mechanism of its emergence, as well as the anticipated consequences of its health, social and economic effects. In order to draw a picture of mobbing in Polish companies, an in-house study was conducted. They were of a pilot nature, and only selected results are included in the paper. The survey was conducted in 2021 among employees of West Pomeranian Companies. The research method used to achieve the stated goal was a diagnostic survey, while the research tool used within this method was a standardized interview questionnaire. The study also used secondary data taken from public statistics, thematic reports and academic research.

Findings: Research was conducted to determine the nature of mobbing activities. Primary data indicate that these behaviors tend to increase, while the conducted research indicates that there may be some problems related to the lack of openness in talking about this type of behavior for fear of negative consequences.

Originality/value: Mobbing is a phenomenon that relatively rarely becomes the subject of research. There are many difficulties, both methodological and technical, in assessing this phenomenon. The paper analyzes this phenomenon in the context of behaviors encountered in Polish companies bearing the hallmarks of mobbing. The article is addressed to employees in order to make them aware of the dangers of mobbing at work, but also to managers in order to improve psychosocial factors in organizations.

Keywords: mobbing, unethical behavior in the workplace, causes and consequences of mobbing.

Category of the paper: Research paper.

1. Introduction

The subject of stress in the workplace and its impact on the well-being of employees has been present in the scientific discourse for several dozen years, but it was not until the early 1980s that mobbing was included in the stressors category. This issue was of interest mainly to the Scandinavian countries, and a little later other European countries, as well as the United States, Canada and Australia. This was due to the observation of aggressive behavior in the workplace, which was caused by its inappropriate organization.

2. Review of definitions

Mobbing is most often equated with psychological violence in the workplace, however, the multithreading and complexity of this issue meant that the scope of understanding this category is very wide.

The International Labor Organization describes mobbing as "offensive behavior by vengeful, cruel, malicious or humiliating harm to an individual or group of workers ..." (Ziółkowska, 2015, p. 227). In turn, according to art. 94³ of the Labor Code (LC) "mobbing means actions or behaviors concerning an employee or directed against an employee, consisting in persistent and long-term harassment or intimidation of an employee, causing him to underestimate his professional suitability, causing or aimed at humiliating or ridiculing the employee, isolating or eliminating him. from a team of colleagues" (Labor Code, art. 94).

In management sciences, mobbing is also understood as: "unethical, malicious harassment of one of the team members or a group of employees by a co-worker with a higher position in the group or performing a managerial function; it is the subjecting of an individual or group to humiliation and to limit its defensive abilities" (Bańka, 2007, p. 241).

On the other hand, A. Bechowska-Gebhardt and T. Stalewski define mobbing as "unethical and irrational from the point of view of the organization's goals, activity consisting in long-term, repeated and unjustified harassment of an employee by superiors and colleagues; it is subjecting a victim of economic, psychological and social violence in order to intimidate, humiliate and limit her ability to defend herself" (Bechowska-Gebhardt, Stalewski, 2004, p. 16).

The authors of the definitions also refer to the consequences borne by the victims of mobbing - social isolation, self-depreciation, a sense of harm, helplessness and rejection by colleagues, which may result in severe stress and somatic and mental diseases (Bechowska-Gebhardt, Stalewski, 2004).

The Swedish psychiatrist and professor of psychology - Heinz Leymann is considered to be the precursor of research on mobbing behavior. According to Leymann, mobbing is a form of terror at work, it expresses unethical and hostile communication, which can lead to psychological damage and social alienation. Leymann pointed out that mobbing activities should take place at least once a week, for a minimum of 6 months (Leymann, 1990). Among the criteria describing the phenomenon of mobbing, the most frequently emphasized is the frequency and duration of unethical influences towards the employee, negative consequences for the victim and asymmetry of the relationship between the perpetrator and the victim. Despite the ongoing discussion on terminological arrangements related to mobbing, the following criteria for defining mobbing were adopted (Einarsen et al., 2011):

- regularity and systematicity of unethical behavior,
- duration of the behavior,
- severity of the harassment over time,
- subjecting a person to negative influences, which often results in social exclusion,
- detriment to welfare and health.

In Poland, the best known classification is proposed by Leymann (1996). On the basis of interviews with employees, he distinguished five categories of behavior (Leymann, 1996):

- actions that hinder communication,
- actions that have a negative impact on social relations,
- actions influencing the image of the victim,
- actions detrimental to the professional status of the victim,
- actions against the physical health of the victim.

Although mobbing is defined in various ways, the authors agree on the basic nature of this phenomenon - it is a form of deliberate mental torment that affects communication, social relations, life and work situation and the health of the victims (Kozak, 2009).

3. Causes and consequences of mobbing

In the literature, a lot of space is devoted to the analysis of factors contributing to the occurrence of behaviors or activities that can be considered mobbing. In order to explain the causes of mobbing in the workplace, researchers focus on two factors, i.e. the psychosocial work environment and the individual characteristics of the victims and perpetrators of this phenomenon. They emphasize that the organization plays a key role in the emergence of mobbing at work. Organizations with a lot of conflicts are particularly exposed to this phenomenon (Matthiesen, Einarsen, 2010). Moreover, people working in such environments have a low assessment of both the management style prevailing there and the ability to control

their own work, as well as transparency in the scope of roles in the organization (Einarsen, 2000).

The reasons for mobbing can also be found in rigid social structures, which are favored by the directive style of management. Typical negative features of the organization where the phenomenon of psychological violence can be observed include: time pressure when performing tasks, issuing contradictory or meaningless orders, burdening the employee with high responsibility, while limiting his ability to make decisions and underestimating the actions of subordinates. A bad atmosphere in the workplace is also important, as is the lack of kindness and support in interpersonal relations. These factors foster a sense of threat and uncertainty among employees, thus increasing the risk of mobbing (Mobbing, Materiały Centralnego Instytutu Ochrony Pracy – Państwowy Instytut Badawczy, <http://www.ciop.pl>, access 15.04.2012).

It should be emphasized that the causes of psychological terror can also lie in the personality traits of both the persecutor and the victim. It is worth adding that research on this aspect indicates that there is no single type of bully and victim (Maran, Bernardelli, Varetto, 2018).

Numerous studies show that long-term workplace harassment has serious effects (cf. Leymann, 1996; Einarsen, 2000). People subjected to mobbing experience primarily anxiety (Hansen et al., 2006, Plopa et al., 2017), a drop in self-esteem (Harvey, Keashly, 2003; Ireland, 2002; O'Moore, Kirkham, 2001), shame (Lewis, 2004), a sense of fatigue and depression. The persecuted person may also develop Post-Traumatic Stress Syndrome (after: Matthiesen, Einarsen, 2004; Nielsen, Hetland, Matthiesen, Einarsen, 2012).

It is worth emphasizing that mobbing has serious consequences not only for the individual, but also for the enterprise and society. Such consequences include an increase in sickness absenteeism, staff turnover, a reduction in the quality of work performed, a reduction in satisfaction and the level of commitment to work. The company in which the mobbing took place must take into account the loss of a positive image, as well as financial losses resulting from the costs of conducting the procedure and the possible payment of compensation and redress. The burdens related to the occurrence of mobbing in the work environment also affect the entire society, which bears the costs of treating mobbing victims (Nerka, 2013).

4. Findings

Behavior such as harassment, bullying, and humiliation are not unique in Polish enterprises. The asymmetric relationship between superiors and employees creates an opportunity for this type of behavior. The data collected in the field of labor law and social insurance as part of public statistics shows that the number of cases in courts under the provisions of the Labor Code remains at a similar level with a slight upward trend (Table 1). It should be emphasized,

however, that mobbing in Poland is a phenomenon that is difficult to estimate, as not every employee experiencing mobbing decides to go to court. This is due to the difficulty of proving, the burden of which is on the flood, fear of negative consequences, including losing a job. Many victims of bullying also prefer to focus on changing jobs and forget the unpleasant experience.

Table 1.

Records of cases in courts of first instance for compensation and redress in connection with mobbing in 2017-2021

		2017	2018	2019	2020	2021
District courts						
Art. 94 ³ § 3 LC	women	298	311	305	286	292
	men	160	173	174	157	156
Art. 94 ³ § 4 LC	women	57	48	40	48	52
	men	41	34	44	32	34
Total		556	566	563	532	534
Regional courts						
Art. 94 ³ § 3. LC	women	69	66	66	82	89
	men	35	30	41	50	55
Art. 94 ³ § 4 LC	women	18	12	10	9	15
	men	17	8	9	14	13
Total		139	116	126	155	172

Source: own study based on <https://dane.gov.pl/pl/dataset/1210,dyskryminacja-mobbing-molestowanie-seksualne-w-pracy-w-latach-2011-2017/resource/39511/table>, 06.08.2022).

In order to present a picture of mobbing, research was carried out to identify mobbing behavior in Polish enterprises. The research was of a pilot nature, the article contains only selected results. The survey was conducted in 2021 among employees of West Pomeranian companies. The research method used to achieve the assumed goal was a diagnostic survey, while the research tool used within this method was a standardized interview questionnaire.

The adopted research procedure included the following steps:

1. Preparation of a research tool.
2. Collecting interviews from respondents.
3. Initial selection of answers according to criteria consistent with the definition of mobbing.
4. Classification of respondents' answers according to Heinz Leymann's concept.

In total, 187 people were included in the study. Women predominated in the surveyed group, accounting for 71.6% of the respondents. Over 66% of the respondents came from the city, the least numerous group were respondents from rural areas - 6.4%. The average age of the respondents was 36 years, the average length of service was 12.3 years. The vast majority of respondents (68.45%) were employed in medium-sized enterprises, 26.74% worked in small enterprises, and 4.81% - in large enterprises. Employees were employed based on an employment contract (95.19%). The respondents were asked to make a subjective assessment of their well-being at work. The vast majority of respondents felt good at work (66.3%). Almost one third of the respondents feel bad in their workplace (28.9%), the rest had difficulty responding to the answers. Respondents were asked about their experiences related

to mobbing. Relatively few respondents (18.7%) experienced mobbing behavior in the last two years, while when asked if they had witnessed such behavior, the percentage increased to 34.8%. The respondents indicated that they most often experienced inappropriate behavior on the part of their superiors (73,8%).

Respondents who reported having experienced or witnessed harassment at work were asked to provide examples of specific behaviors. Most often they indicated actions that infringed their image. This included slandering, disseminating false information about them, commenting on their appearance and the way they dressed. It was relatively often pointed out that the subject of comments was their attitude to vaccination, especially in the first year of the pandemic. People who declared an unwillingness to be vaccinated were isolated by co-workers, and they also experienced unfavorable comments that made them feel guilty. The respondents also pointed to comments regarding their negative features affecting the quality of performance of duties - lack of diligence and responsibility, but also conflict in relationships. Sexual behavior and attacks on health were mentioned much less frequently. Detailed results are presented in the table 2.

Table 2.

List of mobbing behaviors

Actions that hinder the communication process	% of indications
- criticizing work (criticism of working with other employees without a justified reason, comments on the quality of the work performed, mocking the way the work is performed)	40,0
- criticizing private life (reference to receiving the Family 500+ benefit, comments on unemployment of your life partner)	52,3
- restriction or obstruction of the victim's speech (continuous interruptions, shouting, hanging up the receiver during telephone conversations, failure to grant the right to speak during employee meetings)	27,7
- harassment over the phone (text messages and phone calls after working hours, on days off)	73,8
Actions negatively influencing social relations	
- physical and social isolation of the victim (not providing information about integration outings and trips, designating a separate place to work, designating a separate place to eat meals due to the lack of vaccination against Covid-19, no teamwork)	12,3
- disregarding the employee (not answering e-mails, avoiding contact, reluctance to talk)	16,9
Actions violating the image of the victim	
- slandering, spreading rumors (disseminating information about the private life and financial situation of the victim, commenting on the appearance, manner of dressing, commenting on the victim's financial situation, political and religious views, attitude towards vaccination against Covid-19, mocking disability, sexual orientation, comments on employee group on FB)	83,1
- sexual innuendo (making sexual offers, making promotion conditional on consenting to sexual situations, sexual jokes, singing sexual songs in the presence of a victim)	6,2
- suggesting mental disorders (referring to a psychiatrist, comments such as "you should be treated, you are emotionally and mentally unstable, referral to psychological and psychiatric examinations)	3,1
- suggesting that the employee has negative qualities (maliciousness, conflict, laziness, lack of diligence and responsibility)	87,7

Cont. table 2.

Actions hitting the professional position of the victim	
- not assigning tasks to be performed (no new tasks in which the victim could prove himself, hindering professional promotion, taking away the project being implemented)	58,5
- violations in the field of finances (failure to pay remuneration on time, no remuneration for overtime, despite no objections to work, failure to award an incentive/reward, financial penalties, awarding high financial benefits to other employees in exchange for loyalty to the employer, forcing them to stay under overtime at work under the threat of losing it)	75,4
- assigning tasks that are too easy/difficult to perform (assigning tasks in which the employee cannot prove himself, thus making it difficult to receive a professional promotion, assigning tasks that are too difficult to perform, punishment for their non-performance, assigning nonsensical tasks, assigning tasks below qualifications, above qualifications, over-checks)	70,8
- undermining the decisions made by the victim (criticizing the decisions made, penalties for the decisions made)	78,5
- rescheduling the leave without consulting the employee	21,5
- threatening with negative consequences when using a sick leave	47,7
Actions affecting the health of the victim	
- entrusting work that is harmful to health (commissioning work in conditions not adapted to this, e.g. with mold, failure to ensure safe working conditions)	15,4
- sexual activities (touching intimate places, supposedly accidentally touching the victim)	1,5
- the threat of using physical force	6,2

Source: own research.

Survey participants were also asked about the effects they experienced due to harassment at work. More than 68% complained of mood disorders, 28.6% had suicidal thoughts, and nearly 80% experienced anxiety caused by excessive work-related stress and insecurity and feelings of threat. The majority of respondents (91.4%) indicated that the experience of bullying caused them to lower their self-esteem and professional usefulness. This is particularly dangerous, as it can result in less motivation to work and negatively affect feelings of agency and career progression. Respondents also experienced exclusion from the work collective (62.9%) and, as a consequence, emotions of shame (28.6%). Respondents were also asked about their need to seek the help of a psychiatrist or psychologist. More than half (51.4%) of the respondents admitted that they had asked for this form of support. Respondents during the survey emphasized that the experience of mobbing at work primarily affected their psychological well-being and their sense of security within and outside the organization.

5. Summary

On the basis of the obtained results, it might seem that mobbing in Polish enterprises is a marginal phenomenon. However, it should be taken into account that this is a phenomenon that is relatively rarely studied. There are many methodological and technical difficulties in assessing this phenomenon. These difficulties relate to the diversity of bullying, the complexity, but also the difficulty of obtaining test subjects. It is worth remembering that despite the relatively low unemployment rate, it is currently difficult to find a stable job, and mobbing is usually associated with a conflict situation in the workplace, resulting from the asymmetry of

dependencies between the employer and the subordinate (Chomczyński, 2008). This can result in a lack of openness about unethical behavior in the workplace. Nevertheless, research shows that the scale of this phenomenon is increasing. In Poland, despite the rapidly growing interest in mobbing, no comprehensive research has been carried out so far to show the nature and scale of the phenomenon in Polish enterprises. However, it can be assumed that the phenomenon of mobbing occurs in Poland on a similar scale as in other EU countries and affects from 4% to 15% of the entire population of employees (Warszewska-Makuch, 2005). In Poland, every sixth employee (17%) declares that they have been harassed by their supervisor in the last five years, including - every twentieth (5%) says that it happened often (Komunikat z badań CBOS, Szykany w miejscu pracy, 2014).

Taking into account the negative effects of mobbing, it would be worthwhile to conduct research relating primarily to the scale of this phenomenon, taking into account various professional groups. It is also worth getting to know the predictors and consequences of mobbing, not only for the individual but also for the organization and society.

References

1. Bańka, W. (2007). *Operacyjne kierowanie pracownikami w organizacjach*. Toruń: Adam Marszałek.
2. Bechowska-Gebhardt, A., Stalewski, T. (2004). *Mobbing: patologia zarządzania personelem*. Warszawa: Difin.
3. Chomczyński, P. (2008). *Mobbing w pracy z perspektywy interakcyjnej*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
4. Einarsen, S. (2000). Harassment and bullying at work: A review of the Scandinavian approach. *Aggression and violent behavior*, 5(4), p. 379-401, [https://doi.org/10.1016/S1359-1789\(98\)00043-3](https://doi.org/10.1016/S1359-1789(98)00043-3).
5. Einarsen, S. (2012). Longitudinal relationships between workplace bullying and psychological distress. *Scand. J. Work. Environ. Health*, 38(1), pp. 38-46, doi:10.5271/sjweh.3178.
6. Einarsen, S., Hoel, H., Zapf, D., Cooper, C.L. (2011). The concept of bullying and harassment at work. In: S. Einarsen, H. Hoel, D. Zapf, C.L. Cooper (Eds.), *Bullying and Harassment in the Workplace* (pp. 3-53). Theory, Research and Practice.
7. <https://dane.gov.pl/pl/dataset/1210,dyskryminacja-mobbing-molestowanie-seksualne-w-pracy-w-latach-2011-2017/resource/39511/table>, 6.08.2022.
8. Komunikat z badań CBOS (2014). *Szykany w miejscu pracy*. Warszawa: CBOS, https://www.cbos.pl/SPISKOM.POL/2014/K_109_14.PDF, 15.08.2022.
9. Kozak, S. (2009). *Patologie w środowisku pracy: zapobieganie i leczenie*. Warszawa: Difin.

10. Labor Code art. 94.
11. Leymann, H. (1990). Mobbing and psychological terror at workplaces: *Violence and victims*, 5(2), pp. 119-126, [https://www.mobbingportal.com/LeymannV&V1990\(3\).pdf](https://www.mobbingportal.com/LeymannV&V1990(3).pdf).
12. Leymann, H. (1996). The content and development of mobbing at work. *European journal of work and organizational psychology*, 5(2), pp. 165-184, https://www.researchgate.net/publication/315480030_Bullying_no_trabalho_Percecao_e_impacto_na_saude_mental_e_vida_pessoal_dos_enfermeiros/fulltext/58d3a1cc458515e6d901d536/Bullying-no-trabalho-Percecao-e-impacto-na-saude-mental-e-vida-pessoal-dos-enfermeiros.pdf.
13. Maran, D.A., Bernardelli, S., Varetto, A. (2018). Mobbing (bullying at work) in Italy: characteristics of successful court cases. *J. Inj. Violence Res.*, 10(1), pp. 17-24, doi: 10.5249/jivr.v10i1.
14. Matthiesen, S.B., Einarsen, S. (2004) Psychiatric distress and symptoms of PTSD among victims of bullying at work. *British Journal of Guidance & Counselling*, 32, 3, 335-356, DOI: 10.1080/03069880410001723558.
15. Matthiesen, S.B., Einarsen, S. (2010). Bullying in the workplace: Definition, prevalence, antecedents and consequences. *International Journal of Organization Theory & Behavior*, 13(2), pp. 202-248, doi: 10.1108/IJOTB-13-02-2010-B004.
16. *Mobbing*, Materiały Centralnego Instytutu Ochrony Pracy – Państwowego Instytutu Badawczego, <http://www.ciop.pl>, 15.08.2022.
17. Nerka, A. (2013). Mobbing jako przykład nieetycznych zachowań w miejscu pracy. *Annales. Etyka w Życiu Gospodarczym*, 16(25), pp. 281-294, http://www.annalesonline.uni.lodz.pl/archiwum/2013/2013_nerka_281_294.pdf.
18. Nielsen, M.B., Hetland, J., Matthiesen, S.B., Einarsen, S. (2012). Longitudinal relationships between workplace bullying and psychological distress. *Scand. J. Work Environ. Health*, 38(1), pp. 38-46, doi:10.5271/sjweh.3178.
19. Plopa, M., Plopa, W., Skuzińska, A. (2017). Bullying at work, personality and subjective well-being: *Journal of Occupational Health Psychology*, 22(1), pp. 19-27, <https://doi.org/10.1037/a0040320>.
20. Warszewska-Makuch, M. (2005). Mobbing w pracy - przyczyny i konsekwencje. *Bezpieczeństwo Pracy: nauka i praktyka*, 3, pp. 5-7, <http://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-40fa5350-746d-44d5-ba1f-60e79dd0a4e8>.
21. Ziółkowska, K. (2015). Zjawisko mobbingu w zakładzie pracy. *Studia Warmińskie*, 52, pp. 227-240, https://bazhum.muzhp.pl/media//files/Studia_Warmińskie/Studia_Warmińskie-r2015-t52/Studia_Warmińskie-r2015-t52-s227-240/Studia_Warmińskie-r2015-t52-s227-240.pdf.

EXPECTED EMPLOYEES' COMPETENCIES IN THE PROCESS OF LAUNCHING NEW PRODUCTS IN JZR LTD.

Adam GUMIŃSKI^{1*}, Katarzyna DOHN²

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

² Silesian University of Technology; katarzyna.dohn@polsl.pl, ORCID: 0000-0002-4178-1347

* Correspondence author

Purpose: The article presents the research results concerning employees' competencies in JZR Ltd. (Jastrzębskie Zakłady Remontowe Ltd.). Human resources management directly affects the operational results of the activity of a manufacturing company. The managers need to recruit employees possessing a high level of competencies. The key expected result is better economic effects. The JZR Development Programme is a good example of the complexity of processes that should be taken into account in good decisions in the area of human resources management in an activity of a manufacturing company. The main purpose of the research was to identify and analyse key employees' competencies needed to launch new products on the market. The specificity of machine-building enterprises determines the scope and scale of the necessary activities for efficient and effective human resources management.

Design/methodology/approach: The objectives of the research were achieved by the analysis of a recruitment process executed in the JZR Development Programme and a questionnaire survey within the project "Development of the skills ecosystem in four countries of the Visegrad Group".

Findings: It was found that key elements determining the productivity level of the JZR Development Programme are the high technical and soft competencies of new employees. A risk analysis is also of high magnificence in so complex and capital-consuming projects.

Research limitations/implications: The research limitations are due to the complexity of the system, the difficulties arising from the specificity of the mine environment, the lack of the possibility of ongoing diagnostics of the entire infrastructure (e.g. pipeline specification, the ability to measure sediment in water galleries, smooth change of the speed of drive mechanisms, etc.).

Practical implications: The analysed investment programme requires workers specializing in the construction and designing of scraper conveyors, belt conveyors and powered supports. Soft skills such as teamwork skills or knowledge of project management methods and tools are highly needed as well. The activity of JZR Ltd. needs specialized software in the field of machine construction in terms of technology and design.

Social implications: The expected requirements are strictly connected with IT skills which should be developed within the education process, especially at technical universities. Manufacturing companies like JZR Ltd. need to participate actively in creating the profile of a graduate at universities. Another possible activity could be achieved by cooperation with a potential candidate for work in a manufacturing company.

Originality/value: The value of the research is the identified requirements in the range of analyzed technical and soft competencies which could be treated as a benchmark for similar complex manufacturing development projects. According to what was analyzed in the area of literature review we were able to find, there are no specific studies referring and reporting on employees' competencies required in projects in mining industry.

Keywords: human resources management, employees' competencies, work performance, machine-building enterprise, new products.

Category of the paper: research paper, case study.

1. Introduction

Manufacturing companies need to undertake new investment projects to develop. These projects should be well-planned and adequately financed. One of the key aspects is to plan and recruit employees whose competencies were adjusted to the needs of the developed projects and the operational activity. The recruitment process is difficult and cost-consuming.

The developmental project launched under the name of the JZR (Jastrzębskie Zakłady Remontowe) Development Programme is an insourcing process within the JSW Capital Group, i.e. direct supplies of products to coalmines whose production is carried out within the capital group. The JZR Development Programme is aimed at achieving strategic objectives on both JZR and JSW sides, among which the production of 5 products which can be considered crucial i.e. scraper conveyor elements, main pipelines, belt conveyor rollers, suspended track rails and sections of powered roof support (Gumiński et al., 2020).

The main purpose of undertaken research, given in this article, was the analysis of employees' competencies expected in the JZR Development Programme, which is a development investment executed by a production and service company i.e. JZR Ltd. The main scientific problem focuses on the identification and analysis of key employees' competencies in the analysed programme. As a result of the study, the authors suggest actions be undertaken to recruit the best-adjusted employees within the JZR Development Programme.

The results concerning employees' competencies within the JZR Development Programme of university graduates expected by JZR Ltd. are part of the project "Development of the skills ecosystem in four countries of the Visegrad Group". The research study within the project proves that the main impact concerns requirements in the field of technical competencies (reported by over 50% of respondents) and in the field of economic competencies (reported by over 20-30% of respondents). Marketing or management competencies are required to a lesser extent (indicated by 10-20% of respondents).

Competences in the ITC area are becoming particularly important and their importance can be expected to increase in the coming years. As a result, it is a great challenge for the appropriate reorientation of the scope and forms of education at universities; this applies to both university and polytechnic education.

2. The characteristics of the JZR Development Programme

The enterprises of the machine building industry have specific features, which generate an increased risk level in the activities of these enterprises, among which should be distinguished (Dohn, Gumiński, Zoleński, 2011):

- ✓ production processes have a tooling and assembly character of high complexity, requiring advanced technology and technical facilities,
- ✓ a significant share of unit production requires a stable technological and construction base for the execution of contracts, mainly highly qualified engineering and technical staff as well as IT infrastructure,
- ✓ effectiveness of functioning of machine-building enterprises depends on appropriate knowledge about suppliers and co-operators,
- ✓ due to high uncertainty and variability in the use of production capacities, there is a need to maintain surpluses in the technical infrastructure (machines, equipment) while balancing the staffing needs of the contract portfolio being realized,
- ✓ implementing favourable contracts requires a careful analysis of many parameters depending on macroeconomic and microeconomic conditions.

JZR Ltd. is a company which since 1993 has provided facilities for the renovation and modernization of machinery and equipment used in the production plants of JSW Capital Group, mainly coal mines. The concept of the JZR Development Programme was prepared in response to the needs of JSW, which strives to ensure stable supplies of machinery and equipment necessary for the ongoing operations of the company's coal mines. The main goal of the JZR Development Programme is to expand production and renovation activities in the scope of delivering ready products to JSW production plants. The key assumptions of the JZR Development Programme were defined as follows (Gumiński et al., 2020):

- ✓ the target production: 5 products, i.e. armoured conveyor elements, main pipelines, belt conveyor rollers, suspended track rails and sections of powered roof support (presented in table 1),
- ✓ location: Suszec Community,
- ✓ additional employment: about 200 skilled workers, mainly welders and CNC operators,
- ✓ using specialized machines and devices, mainly CNC machines and welding robots, to optimize the demand for new employees,

- ✓ estimated capital expenditures: 95 mln PLN (modernization/construction of facilities, including production halls and their equipment),
- ✓ sources of finance: capital from JSW Capital Group with the contribution of the land and production halls in the area of Suszec, own funds of JZR Ltd. and co-financing deriving from operational programmes.

Table 1.

The list of planned products in the JZR Development Programme

No.	The planned product	The visualisation of a product	The start of production
1	2	3	4
1.	Armoured conveyor elements		August 2020
2.	Main pipelines		August 2020
3.	Belt conveyor rollers		August 2020
4.	Suspended track rails		August 2020
5.	Sections of powered roof support		January 2021

Source: own preparation (based on project documentation of JZR Development Programme).

The JZR Development Programme's Project Team consists of the representatives of JZR Ltd. JSW Capital Group and JSW Innovations Ltd.

In Fig. 1. the structure of the manufacturing halls and the equipment within the JZR Development Programme are given.

Achieving the assumed objectives of the JZR Development Programme is going, in the medium-term perspective, to enable strengthening the competitiveness level and increasing the market value of both JZR Ltd. and JSW Capital Group.

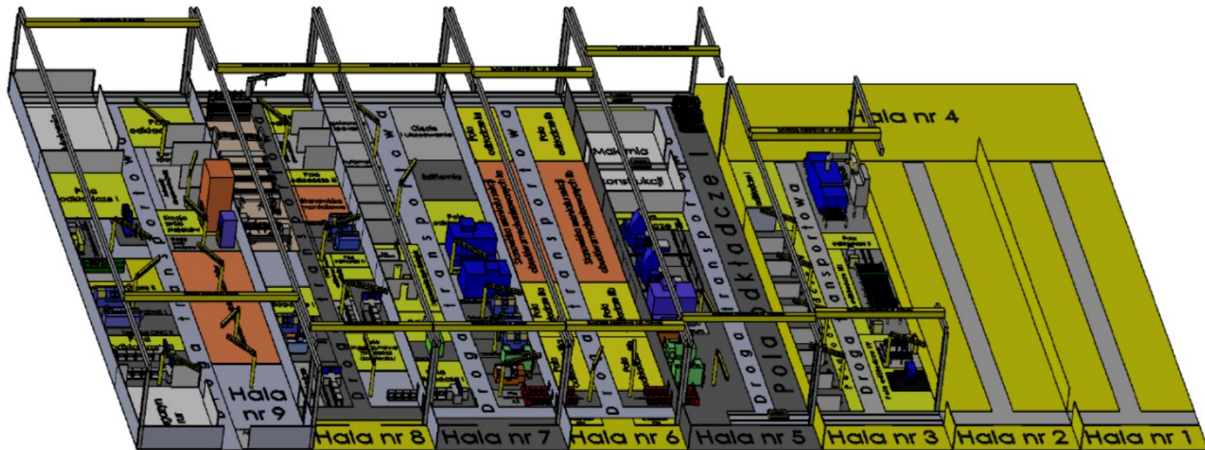


Figure 1. The concept of the halls' development.

Source: own preparation (based on project documentation of JZR Development Programme).

3. The planning process of human resources needs in a manufacturing company

From the point of view of the economically efficient activity of a company, the optimal use of the resources involved in its operations is of key importance. Maintaining a high level of resource productivity requires identification, evaluation and actions limiting the negative effects of operational risk factors. This often means the necessity to engage additional resources due to specific internal and external conditions for the stable functioning of the entire manufacturing system.

Various aspects of resource productivity in manufacturing companies are of interest to researchers who analyse this issue, pointing to its determinants and changes in its level as a result of technical and technological or organizational progress. Numerous studies (Hottenstein, Dean, 1992) are also undertaken on quantitative measures of productivity, which usually represent the relationship between economic effects and inputs (the company's resources involved).

Various indicators reflect the relationship between effects and inputs, e.g. the synthetic economic indicator - return on equity (ROE) representing the net profit earned on the company's equity) or the production indicator machine productivity (as the number of products produced per company). per machine).

The most frequently used measures of resource productivity in a manufacturing company include the following (Mazurek, 2014; Relkar, Nandurkar, 2012; Simões, Gomes, Yasin, 2011):

- *OLE - Overall Labour Effectiveness.*
- *OEE - Overall Equipment Effectiveness.*
- *KPI - Key Performance Indicator.*
- labour productivity indicators.

Overall Labor Effectiveness (OLE) is a key indicator that measures the workforce's utilization, efficiency and quality and its impact on the productivity of a technical system. It is an indicator similar to Overall Equipment Effectiveness (OEE), taking into account the following elements characterizing work resources:

- availability of work - share an employee's effective working time on a working day,
- work efficiency - the share of tasks performed about the standard level,
- quality of work - the share of tasks performed without any errors or interruptions in the total number of tasks performed.

OLE allows you to make the right operational decisions thanks to the analysis of the cumulative effect of the three above-mentioned labour resource efficiency elements.

Overall Equipment Effectiveness (OEE) is the most important element of the quantitative evaluation of the TPM (Total Productive Maintenance) strategy. This indicator can be determined based on the relationship (Loska, 2013):

$$OEE = D \cdot E \cdot J \quad (1)$$

where:

D – availability of the machine (fixed asset) taking into account the available working time,

E – the efficiency of the machine (fixed asset) operation taking into account the operational time work,

J – the quality of operation of the machine (fixed asset) taking into account the number of processed items elements minus the number of defects.

Among the numerous group of indicators relating to the efficiency factors, one can indicate the key efficiency factor KPI - *Key Performance Indicator* (Jonek-Kowalska, Tchórzewski, 2016), which includes 71 indicators for assessing the effectiveness of machinery and equipment operation: 24 economic, 21 technical and 26 organizational. The approved indicators are universal in nature and enable comparisons over time, cross-industry comparisons and benchmarking. The rules for the selection and construction of these indicators were developed based on the Maintenance Terminology standard (EN 13306) (Gumiński, 2017; Klank, 2008).

Synthetically, labour productivity indicators in a manufacturing enterprise can be calculated from the general relationship:

$$W = \frac{P}{NP} \quad (2)$$

where:

P – production level per unit of time, [products/year],

NP – workload expressed as the average level of employment per unit time, [employees/year] or as the number of man-days per unit time year [man-days/year].

The analysis of the labour productivity index can be limited to the production facility or organizational unit, as well as to a selected group of employees. What is to be noticed, the level of labour productivity is strictly connected with the workers' competencies. Technological advancement needs better-adjusted employees to new solutions implemented in an economy. The problem is that when you compare labour productivity you consider the employment level. More competitive, developmental companies, or an economy as the whole system, are the ones depending on the optimal process of all resources, including human resources. The key aspect is the adjustment of competencies to the needs of the contemporary economy.

Planning employment level and its structure in a company is an extremely important area in human resource management because this process determines the potential of the organization in both the short and long term. Planning decisions in the area of employment require taking into account many variable factors and conditions inside the company and in its environment. Effective employment planning is one of the key processes that determine the company's future development potential.

According to the definition of A. Poczowski, "employment planning is a permanent process, including the identification of personnel needs in quantitative and qualitative terms, analysing the existing state and structure of the personnel, creating plans to minimize the gap between supply and demand in the internal labour market, and monitoring the implementation of employment plans into force" (Poczowski, 2008).

The same author also emphasizes the sense of planning in a narrower sense, which "corresponds to the concept of employment planning in the strict sense and means forecasting the necessary number of employees with appropriate qualifications at a given time and place, changes in the state and structure of employment, and the reciprocal assignment of employees to individual organizational units and work stations"(Poczowski, 2008).

The subject of quantitative needs planning is therefore to determine a specific amount of work (working time) necessary to perform the adopted activities at a specific point in the future. In turn, labour supply planning means the process of determining internal labour resources that take into account changes that will occur in the future.

Internal determinants that determine the planning process are ensuring consistency between the strategy, structure, and culture of the company as well as effective human capital management (Poczowski, 2008). In turn, the factors in the external environment are determined by stakeholders and conditions of a technical, economic, legal, demographic, ecological, and socio-cultural nature.

Technical conditions result from the permanent development of civilization, which can be observed in all spheres of human life. Technical innovations lead to an increase in work efficiency, and contribute to the elimination of burdensome, dangerous and inadequate work conditions, to meet the humanization of work. The use of changes in technique and technology can bring benefits to an enterprise provided that employees are prepared for these changes well in advance. It is necessary to adapt employees to the effects of technical changes through

changes in professional qualifications and employee behaviour in the work process, as well as through modernization or liquidation of specific jobs. In enterprises, a new type of employee is shaped, whose dominant feature is a high level of knowledge and the ability to adapt to the changes taking place.

Economic conditions are related to the economic system existing in a given country, and above all, the economic situation and the situation in the labour market. These factors determine the system in which a given enterprise operates. An important aspect is the company's competitive position, financial situation and social potential. Depending on the financial situation, the enterprise may allocate greater or lesser financial resources to expenses related to human resources management. Less financial opportunities limit access to high-class specialists.

Legal conditions regulate the mutual relations between the employer and employee. The Labour Code is of particular importance (the Act of June 26, 1974, as amended). Legal changes require special attention due to the necessity to introduce changes in the employment system in the enterprise and their time-consuming nature.

Demographic conditions are related to such factors as the professional activity of the population, its number and structure, as well as internal and external migrations. Demographic conditions determine the supply of the labour market. The enterprise can obtain information on the available labour resources, their age structure and education structure.

Socio-cultural conditions determine the attitudes and behaviour of people in the work process, and in particular determine the importance of work in the local community. Depending on the value system of potential employees, the enterprise should adjust the incentive system. Each company needs employees with a diverse profile of competencies and skills. By hiring employees within a specific category, i.e. with specific professional requirements, there is a greater possibility of retraining employees to adapt them to the existing needs of the company.

4. Key employees' competencies within JZR Development Programme

The deep analysis of risk factors is of high importance in risk management (Gumiński et al., 2020). The lack of sufficient knowledge about the existing internal and external threats multiplies the negative impact on the efficiency of enterprises. This is particularly important for enterprises in the machine-building industry in a current dynamically changing economic situation.

Considering the complexity of the analysed investment project, the project team of the JZR Development Program in the initial phase of the project's implementation paid much attention to the aspects of risk management. He determined the main risk categories, identified risk factors, and then proposed actions to reduce the negative effects of existing risks. The analyses undertaken allowed us to determine the following main risk categories (Gumiński et al., 2020):

- ✓ design and construction works,
- ✓ technical and technological hazards,
- ✓ human resources,
- ✓ economic hazards.

Table 2 includes both significant standard and specific risk factors related to the implementation of the JZR Development Programme in the area of human resources.

Table 2.

The list of risk factors and actions reducing their negative impact on the JZR Development Programme in the area of human resources

No.	Risk area	Risk factor	Actions reducing risk
1	2	3	4
1.	Human resources	limited access to external specialists	cooperation with research and development centres and universities
		difficulties in acquiring new qualified employees with strictly defined competencies	multi-stage recruitment of employees, changes in a motivation system
		insufficient level of technical and economic competencies of JZR employees	training and professional development of employees
		increased needs for employees handling contracts for the supply of products to JSW coalmines	recruitment of new employees with specific technical and economic competencies, changes in a motivation system
		changes in legal conditions for JZR activity, especially the legal regulations concerning HRM	monitoring of changes and analysing legal effects on JZR activities
		retirement of skilled old workers	acceptance of the risk
		the increasing scale of departure of qualified employees	financial higher remuneration
		recruitment procedures and processes	upgrading the whole process of recruitment

Source: own preparation.

Actions reducing risks given in the Table 2 are of key importance for ensuring the success of the JZR Development Programme.

Table 3.
Staffing needs in the project (for 4 products)

Id.	Products	Total employment (persons / shifts)	Miller (CNC)	Operators (CNC)	Welder MIG/MAG	Welding machine operator	Technological line operator	Welder, locksmith (tacking)	Technical supervisor	Total number of employees
1	Elements of longwall routes of scraper conveyors	7 / 1	1		1	1	1+1	1	1	7
2	Elements of main pressure and discharge pipelines	6 / 1		1+1		1	1+1		1	6
3	Rails of suspended monorails	5 / 2	1		1		1	1	1	10
4	Rollers for belt conveyors	7 / 2		2		1	3		1	14

Source: own preparation (on materials of the JZR Development Programme).

Risks in the JZR Development program in the area of human resource management:

- ✓ limited access to external specialists,
- ✓ difficulties in employing new qualified employees with strictly defined competencies,
- ✓ insufficient level of technical and economic competencies of JZR employees,
- ✓ the increasing scale of departure of qualified employees,
- ✓ growing needs for employees performing contracts for the supply of products to JSW's coal mines.

Within the analysis of competencies requirements of employees the following ones were:

- experience in the construction of scraper conveyors, their types and individual elements,
- experience in the construction of belt conveyors, their types and individual elements,
- design and technological competencies for the modernization of powered supports,
- knowledge of techniques, technologies, and solutions in the field of welding and machining,
- skills in using specialized software in the field of machine construction in terms of technology and design,
- teamwork skills,
- knowledge of project management methods and tools.

Expectations on the part of JZR Ltd. about the competencies of employees are determined by the activity profile of this production and service company. The need to increase the engineering and technical staff as well as production workers poses a great challenge for the recruitment process due to the existing shortage of specialists in the labour market.

A sure solution for JZR Ltd. would be the active participation of the enterprise in creating the profile of a graduate at a university. This would enable establishing cooperation with a potential candidate for work in this enterprise.

5. Conclusions

The undertaken studies for analysing employees' competencies needed for the activities within the JZR Development Programme result in the following conclusions:

1. The JZR Development Programme is a key investment project within JSW Capital Group. The project makes JZR Ltd. an internal supplier of the most needed components and equipment in manufacturing processes executed within JSW Group, mainly in JSW's coal mines. The key effect of the insourcing process is the reduction of the economic risk for JSW's activity.
2. JZR Development Programme needs over 250 new employees to recruit with high technical and soft competencies. The analysed investment programme requires workers specializing in the construction and designing of scraper conveyors, belt conveyors and powered supports. Soft skills such as teamwork skills or knowledge of project management methods and tools are highly needed as well.
3. The activity of JZR Ltd. needs specialized software in the field of machine construction in terms of technology and design. These requirements are strictly connected with IT skills which should be developed within the education process. JZR Ltd. needs to participate actively in creating the profile of a graduate at a university. This could be achieved by cooperation with a potential candidate for work in this company.

References

1. Dohn, K., Gumiński, A., Matusek, M., Zoleński, W. (2013). *Model wspomagania zarządzania w zakresie zarządzania wiedzą w polskich przedsiębiorstwach budowy maszyn*. Warszawa: Difin.
2. Dohn, K., Gumiński, A., Zoleński, W. (2011). Assumptions for the creation of a system supporting knowledge management in an enterprise of the mechanical engineering industry. *Information systems in management, XIII. Business intelligence and knowledge*. WULS Press, pp. 19-27.
3. Dohn, K., Gumiński, A., Zoleński, W. (2012). Uwarunkowania decyzji o realizacji kontraktu w przedsiębiorstwie budowy maszyn. *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Ekonomiczne Problemy usług, vol. 87*, pp. 642-651.
4. Gumiński, A., Dyczko, A., Rychter, R., Bosowski, A. (2020). Risk management in JZR Development Programme. *Zeszyty Naukowe Politechniki Śląskiej. Seria: Organizacja i Zarządzanie, z. 145*. Gliwice, pp. 133-142.

5. Gumiński, A. (2017). *Model analizy wydajności pracy w kopalni węgla kamiennego i w grupie kopalń*. Gliwice: Wydawnictwo Politechniki Śląskiej.
6. Gumiński, A. (2010). *Model planowania poziomu zatrudnienia w kopalni węgla kamiennego i w grupie kopalń*. Wydawnictwo Politechniki Śląskiej.
7. Hottenstein, M.P., Dean, J.W. (1992). Managing Risk in Advanced Manufacturing Technology. *California Management Review*, vol. 34(4).
8. Jonek-Kowalska, I. (2019). Identification, assessment and mitigation of operational risk in a mining enterprise. In: M. Turek (ed.), *Zarządzanie w przedsiębiorstwie górniczym. Wybrane zagadnienia*. Gliwice: Wydawnictwo Politechniki Śląskiej, pp. 193-282.
9. Jonek-Kowalska, I., Tchórzewski, S. (2016). Wskaźniki efektywności wykorzystania maszyn i urządzeń w górnictwie węgla kamiennego - krytyczne podejście do unifikacji i normalizacji. *Inż. Miner*, nr 2, pp. 99-105.
10. Klank, M. (2011). The determinants in the development of coal mining sector productivity (Uwarunkowania w kształtowaniu wydajności pracy branży węglowej). *Arch. Min. Sci.*, Vol. 56, No. 3, pp. 507-516.
11. Loska, A. (2013). Eksploatacyjna ocena obiektów technicznych z zastosowaniem metod taksonomicznych. *Maintenance and Reliability*, nr 15, pp. 125-126.
12. Maintenance – Maintenance Key Performance Indicators. Standard CEN/TC 319 Date: 2005-02 TC 319 WIWG6.50 CEN/TC 319 UNI.
13. Mazurek, W. (2014). Wskaźnik OEE – Teoria i praktyka. *Neuron*, pp. 1-15.
14. Poczowski, A. (2008). *Zarządzanie zasobami ludzkimi. Strategie – procesy – metody*. Warszawa: PWE, p. 101.
15. Relkar, A.S., Nandurkar, K.N. (2012). Optimizing & Analysing Overall equipment efficiency. (OEE) through the Design of Experiments. *Procedia Engineering*, No. 38, pp. 2973-2980.
16. Simões, J.M., Gomes, C.F., Yasin, M.M. (2011). A literature review of maintenance performance measurement: A conceptual framework and directions for future research. *Journal of Quality in Maintenance Engineering*, No. 2, pp. 116-137.
17. Wodarski, K. (2009). *Zarządzanie ryzykiem w procesie planowania strategicznego w górnictwie węgla kamiennego*. Gliwice: Wydawnictwo Politechniki Śląskiej.

RISK MANAGEMENT SYSTEM IN A MANUFACTURING COMPANY – CASE STUDY

Marcin JADCZYK¹, Mariusz JAROSZ², Andrzej KARBOWNIK^{3*}

¹ SOR-DREW S.A., Świętochłowice; m.jadczyk@sordrew.pl

² SOR-DREW S.A., Świętochłowice; m.jarosz@sordrew.pl

³ Silesian University of Technology; andrzej.karbownik@polsl.pl, ORCID: 0000-0001-7372-1691

* Correspondence author

Purpose: The purpose of this paper is to present a case study in the development and implementation of a risk management system in a medium-sized manufacturing company. The first part discusses the basic concepts related to the enterprise risk management process. A five-stage model of this process is briefly characterised which was used to build the system in question. This is followed by a presentation of the procedures developed for use in the practical implementation of the enterprise risk management system at each of the three distinguished levels of risk management. An example of one of the procedures developed and used is presented, together with a checklist for the analysis and assessment of risk factors for the identified risks. The risk management system developed for the company in question was implemented for practical use in the company over several months. At the end of the successful implementation of the system, the minor shortcomings identified have been rectified and it is being used by all, distinguished owners of the identified risks in the enterprise.

Design/methodology/approach: This paper presents a new and original approach to the practical application of risk management in a medium-sized manufacturing company. Risk owners were distinguished for all processes carried out in the company and risk types were identified for them. Checklists were established to analyse and assess the risks for each distinguished risk type.

Originality/value: The results of the conceptual and implementation work on the analysis and risk assessment of the implementation of processes in the enterprise obtained and presented in the paper can be addressed to those involved in company management, both in a practical and theoretical sense.

Keywords: enterprise management, risk management, enterprise risk management.

1. Introduction

The risk of failure is associated with any human activity, and in particular with business activity. In this case, it concerns all the basic areas of business activity, that is, it concerns the enterprise, namely: production, trade and the financing of its activities. We can therefore say that the risk of business failure relates to three aspects:

- a. Risks in production activities.
- b. Risks in commercial activities.
- c. Risks in financial activities.

Business failure risk, or more briefly business risk, is generally understood as the possibility of an uncertain event occurring that may adversely affect the achievement of the objective of a particular activity, cause a loss as a result of that activity, or fail to achieve the objective of a decision made with respect to that activity. Risk in business can therefore be treated as:

- a. Likelihood of not achieving the intended purpose of the activity.
- b. Potential for loss as a result of the activity.
- c. Likelihood of the effect of the decision taken being different from that intended, relating to that activity.

The uncertain events referred to in the above definition of business risk are threats or sources of risk. They are also called risk factors and this is the term we will use later in this discussion. The possibility of an uncertain event occurring is determined by the probability of its occurrence.

Adverse impact in the above definition means the severity of the consequences of the risk factor.

In the face of business risk, a certain strategy is usually adopted in a company, known as the strategy towards business risk. This can include the following:

- a. Risk analysis, assessment and prevention, i.e. business risk management, cannot just be a dedicated task for the risk manager.
- b. Business risk management is a process and should therefore be integrated into the business management process.
- c. Risk management should be an integral part of the company's planning, management and reporting process.
- d. Actions against risks in the company should be written into the responsibilities of the company's management and middle managers.
- e. In order for the company's management to effectively manage its risks, an early warning system of risks, i.e. risk factors in relation to established risks, is necessary.
- f. Business risk management is a complex process and should address all aspects and areas of the business. Therefore, a business risk management system (RMS) should be developed and implemented for effective management of this process.

2. Business risk management

Business risk management can be defined as the process carried out by both its management and middle managers to identify potential risks, and to reduce their impact or eliminate them in order to maintain the level of a given risk at an agreed level.

The following stages can be distinguished in the risk management process (Jonek-Kowalska, 2019; Kaczmarek, 2006; Karbownik, 2017):

- a. Risk identification - involves identifying the risks for the established levels of risk management and identifying the risk factors for each risk.
- b. Risk analysis - involves analysing the risk factors in view of the likelihood of their occurrence and describing the consequences of their occurrence.
- c. Risk assessment consists of - determining, on the basis of the risk analysis, the level of risk for each type of risk in relation to the risk level scale adopted in the company and determining the acceptable level of risk for each type of risk. The risk level scale should be developed in advance, taking into account the likelihood of the risk occurring and the severity of its consequences.
- d. Risk response planning - involves establishing a strategy for dealing with each type of risk in order to reduce it to an acceptable level, taking into account the following options for doing so:
 - risk avoidance - through inaction,
 - risk acceptance - the level of risk here is not high and it is possible to accept it while monitoring the risk factors,
 - risk transfer - the level of risk here is high and unacceptable and action is needed to reduce it, for example through appropriate provisions in the commercial contract and through insurance,
 - risk mitigation - the level of risk here is also high and unacceptable; efforts should be made to eliminate or reduce the impact of specific risk factors.

Risk monitoring and control

In order to be most effective in reducing the negative impact of risk factors on individual risks:

- develop a risk management system and build it into the business management process,
- identify all risks in the different processes carried out in the company,
- create and implement an early warning system for the possible occurrence of risk factors, i.e. monitoring risk factors and determining how to reduce their adverse impact, or eliminate them.

3. Elements of the 'S' company's risk management system

Company 'S' is a medium-sized company operating in the wood and metal industries. It does not produce its own market products, but obtains orders in both industries on the market, i.e. directly from the customers of its products. In order to improve the company's management and production efficiency, the company's management board decided to carry out a project to prepare and implement risk management principles in the company. Due to the complexity of the problem and the coverage of all production and ancillary processes by these principles, these principles were included in the company's risk management system (RMS).

The following three levels of company risk management have been adopted:

- 1 Level of company management. Risk owner: the company's management.
- 2 Level of processes carried out in the company. Risk owners: managers of production departments and functional divisions.
- 3 Project level. Risk owners: project managers.

The following procedures have been developed to implement each of the steps in the risk management process listed above:

a. Risk identification

- 1 At the company management level, risks should be identified that may adversely affect the achievement of the company's business objectives and the failure to achieve the expected results of management decisions. For each type of risk identified, risk factors should be identified and collated into checklists.
- 2 At the process level, for each of the processes carried out in the production departments (6 processes) and in the selected functional divisions (3 processes), risks should be identified that may adversely affect the achievement of the objectives of the implementation of the given process. For each risk type identified, risk factors should be identified and collated into checklists.
- 3 At project level, the following four risks potentially exist for each project (Karbownik, 2016; 2017):
 - failure to achieve the project objective,
 - discontinuing and abandoning the project,
 - failure to meet the deadline for completion of the project,
 - exceeding the project budget.

For each of the above risks, the project manager should determine the risk factors and ways to respond to the risks during the project implementation phase or use a checklist prepared for the system.

b. Risk analysis

For each type of risk, at the first and second risk level of the three above, the risk owner should analyse the relevant checklist to determine:

- whether a risk factor is occurring or is likely to occur (event),
 - what is the likelihood of its occurrence (probability),
 - what the consequences of its occurrence will be (severity of impact).
- c. Risk assessment
1. Within a given risk type, a risk measure should be read out for each risk factor based on the matrix for the risk level measure (Table 1).

Table 1.*Matrix for measuring the level of risk*

No.	Probability Effect	Low (1)	Medium (2)	Relevant (3)	High (4)
1.	Minimum (1)	1	2	3	4
2.	Moderate (2)	2	4	6	8
3.	Serious (3)	3	6	9	12
4.	Very serious (4)	4	8	12	16

To determine a measure of the level of risk based on the above matrix, the formula (Kaczmarek, 2006; Karbownik, 2004) was used:

Risk measure = probability assessment X impact assessment of the event.

2. For each type of risk, on the basis in Table 2, the level of risk should be determined.

Table 2.*The scale of risk in the "S" company*

No.	Measure of risk	Level of risk	Risk response
1.	1,2	1. Low risk	Acceptance
2.	3,4	2. Medium risk	Risk mitigation
3.	6,8	3. Significant risk	Transfer of risk
4.	9,12,16	4. High risk	Risk avoidance

d. Risk response

1. For all risks that may occur in the processes of the "S" company, it is proposed to adopt low risk as an acceptable level of risk ("1. Low risk", measure 1 or 2).
2. In certain, particularly justified cases, it is proposed to allow medium risk ("2. Medium risk", measure 3 or 4) as an acceptable level of risk, taking into account the provisions for the risk management strategy.
3. For risk measures 6 or 8 ('3. Significant risk') and 9 or 12 or 16 ('4. High risk'), follow the risk response notations in Table 2.

e. Risk monitoring and control

Risk monitoring and control should provide the information necessary to make decisions in advance of the occurrence of adverse events, i.e. risk factors.

The purpose of enterprise risk monitoring is to determine whether:

- a. Risk management system has been implemented and is functioning properly.
- b. Risk response strategy has been implemented and is being used.
- c. Results of the risk response strategy meet expectations.

The purpose of enterprise risk control is to provide:

- a. Observation and surveillance of identified risk factors.
- b. Identification of newly emerging risk factors.
- c. Implementation at the company management level of an early warning system for the possible existence of risk factors.

4. Implementation of the 'S' company's risk management system

For the implementation of the company's risk management system (RMS), the following preparatory activities had to be carried out:

1. Identify risks at each of the three established levels of risk management in the company.
2. Identify potential risk factors for each type of risk and compile them into checklists.
3. Develop procedures for the implementation of the RMS for: Company Management, heads of departments and divisions in functional divisions and project managers.

A sample procedure for a selected production department is shown below, together with a checklist (Table 3).

The Metal Department's risk owner, i.e. its director, carries out a risk analysis and assessment for all orders that meet the following conditions:

Table 3.
Checklist for the RMS at Metal Division level

No.	Risk factors	Occurrence of the risk factor	Probability of the risk factor	Effect of the risk factor	Risk measurement	Measuring the risk after risk response
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
1	Insufficient human resources in the quality control division					
2	No measurement of the first item					
3	Lack of new employees with the required skills on the labour market					
4	Lack of specialised measuring tools for products					

Cont. table 3.

5	Lack of sufficient equipment to work ergonomically and safely					
6	Staff errors					

Average risk level for the risk factors indicated:

Types of risk: a. Producing a defective product; b. Customer complaints about product quality

1. Acceptance of the level of risk: YES, NO

2. Risk response

The following actions were proposed to reduce the level of risk to an acceptable level:

1. Order has been obtained from a new customer, i.e. a new customer file has been created or this is the first order from the customer in question.
2. Order for a new product has been confirmed in the form of a new goods file.
3. Order has a value of more than PLN 50,000.
4. Co-op participation is required for order fulfilment in the Metal Division.
5. Non-standard materials are required to complete the order.

The following actions are taken by the risk owner to carry out the risk analysis and assessment:

- 1 For each type of risk (three risks are distinguished), analyse the risk factors (Table 1) on the corresponding checklist.
- 2 To do this, mark an "x" in column 2 as the potential occurrence of the risk factor in question during the execution of the order. You should also estimate and enter in columns 3 and 4 the probability and effect of the risk factor occurring.
- 3 On the basis of the risk factor analysis, determine the level of risk (Table 2) for each factor by entering its level (number from 1 to 4).
- 4 Once the risk level has been determined for the risk factors indicated in the checklist, the arithmetic mean of the risk factors should be determined and the result entered as "Average risk level for all risk factors".
- 5 On this basis, make an acceptance of the risk level (YES) or (NO) under the checklist.
- 6 Where there is an average risk level higher than ("1. Low risk") for a given risk type and there is a lack of acceptance of the risk level, analyse those risk factors that have influenced this risk level and propose specific actions to apply the risk responses given in Table 2 to reduce the risk level.
- 7 The proposed actions should be entered as "Risk response" on the checklist. Assuming that the proposed actions will have a positive effect on reducing the level of risk, enter 1 or 2 in column 6 of the checklist.
- 8 Potential risk factors and proposed actions should be communicated in the form of a memo to the company's Board of Directors once a month.

Note: The risk factors identified and included in the checklist may change. Their list may also change and a new checklist should then be drawn up.

5. Summary and conclusions

The risk management system developed at the 'S' company outlined above is currently being implemented for practical implementation by the risk owners. Three months after the start of implementation, it will be possible to assess its practical implementation and its effectiveness from the point of view of the company's management. There will then be time to remedy any shortcomings or deficiencies, i.e. to improve the system in order to achieve the objectives set out above in the following months of implementation. The following conclusions can be drawn from the current pilot implementation of the risk management system:

- a. In a medium-sized manufacturing company, it is expedient and possible to apply certain principles for managing the risk of business failure.
- b. The "S" company risk management system developed and presented above: covers all production processes carried out in the company and selected auxiliary processes.
- c. For the practical implementation of the system, it is necessary to determine, for each process included in the system, the types of risk associated with the scope of activities carried out within the process.
- d. For each type of risk, potential risk factors should be identified and compiled into checklists, which should facilitate risk analysis and assessment.
- e. For each risk factor that causes the level of a given risk to be higher than the company's acceptable level, propose specific actions that will cause the adverse impact of the risk factor to be mitigated or even eliminated, which in turn will reduce the risk in question to an acceptable level.

References

1. Jonek-Kowalska, I. (2019). Identyfikacja, ocena i ograniczanie ryzyka operacyjnego w przedsiębiorstwie górniczym. In: M. Turek (ed.), *Zarządzanie w przedsiębiorstwie górniczym. Wybrane zagadnienia*. Gliwice: Wyd. Politechniki Śląskiej.
2. Kaczmarek, T.T. (2006). *Ryzyko i zarządzanie ryzykiem*. Warszawa: Difin.
3. Karbownik, A. (2004). Zarządzanie ryzykiem w dużym projekcie. *Przegląd Organizacji*, nr 9.
4. Karbownik, A. (2016). *Zarządzanie zmianami przez projekty w Politechnice Śląskiej w latach 2008-2016*. Gliwice: Wyd. Politechniki Śląskiej.
5. Karbownik, A. (2017). *Zarządzanie projektami w przedsiębiorstwie*. Gliwice: Wyd. Politechniki Śląskiej.

TESTING ALGORITHMS FOR QUICK RESCHEDULING FLOW SHOP PROBLEMS WITH FLEXSIM BASED SIMULATION AND R ENGINE

Piotr JANKE

Silesian University of Technology, Faculty of Organization and Management; piotr.janke@polsl.pl,
ORCID: 0000-0001-8065-9013

Purpose: The aim of this paper is to present a combination of advanced algorithms for finding optimal solutions together with their tests for a permutation flow-shop problem with the possibilities offered by a simulation environment. Four time-constrained algorithms are tested and compared for a specific problem.

Design/methodology/approach: Four time-constrained algorithms are tested and compared for a specific problem. The results of the work realisation of the algorithms are transferred to a simulation environment. The entire solution proposed in the work is composed as a parallel environment to the real implementation of the production process.

Findings: The genetic algorithm generated the best solution in the same specified short time. By implementing the adopted approach, the correct cooperation of the FlexSim simulation environment with the R language engine was obtained.

Research limitations/implications: The genetic algorithm generated the best solution in the same specified short time. By implementing the approach, a correct interaction between the FlexSim simulation environment and the R language engine was achieved.

Practical implications: The solution proposed in this paper can be used as an environment to test solutions proposed in production. Simulation methods in the areas of logistics and production have for years attracted the interest of the scientific community and the wider industry. Combining the achievements of science in solving computationally complex problems with increasingly sophisticated algorithms, including artificial intelligence algorithms, with simulation methods that allow a detailed overview of the consequences of changes made seems promising.

Originality/value: The original concept of cooperation between the R environment and the FlexSim simulation software for a specific problem was presented.

Keywords: flow-shop problem, genetic algorithm, simulation.

Category of the paper: Research paper.

1. Introduction

The scheduling of production orders is one of the most important tasks of companies producing finished goods. One of the basic combinatorial tasks in the scheduling of production orders is the so-called flow-shop problem. In this problem, the sequence of operations on the machines is fixed. All orders pass through all machines without repeating operations. The aim of such scheduling is to work out the sequence of orders execution on the machines in such a way that the execution time of all orders (makespan) is as short as possible. In this way, we are dealing with an optimisation task that can be presented as a permutation problem. The literature on the subject also describes a situation where the flow-shop problem is treated non-permutationally. (Rossit, Tohmé, Frutos, 2018). Depending on the number of jobs (n) and the number of machines (m), the degree of difficulty varies, resulting from the size of the number of permutations to be searched. In the literature, tasks of this type are designated as tasks of NP-hard. In the case of different sequences of tasks on the machines for individual jobs, we are dealing with the so-called jobshop problem. The literature also describes an open-shop problem where no sequence has to be followed. Over the years, quite a few scientific publications have been written on this topic. These problems are solved more or less successfully by well-known metaheuristics such as simulated annealing, tabu search or genetic algorithms (Rolf, Reggelin, Nahhas, Lang, Müller, 2020). Various approaches are used. In works (Ramesh, Kamalakannan, Karthik, Pavin, 2020) simulated annealing was used to optimise the total schedule execution time in a flow-shop problem. The use of genetic algorithms for production scheduling flow-shop problems can also be found in the works of Polish researchers such as: Ławrynowicz (2011), Pawlak (1999), Knosala, Wal (2001). Changes in the limiting conditions or modifications within the operation of the genetic algorithm are very common in scientific papers. In the papers (Andrade, Silva, Pessoa, 2019) a modification of the genetic algorithm to avoid local optima more efficiently is proposed. Further modifications to improve selected algorithms are presented in papers such as: (Jankauskas, Papageorgiou, Farid (2019), Huynh & Chien (2018), Touat, Bouzidi-Hassini, Benbouzid-Sitayeb, & Benhamou (2017), Guido & Conforti (2017). These are just a selection from of the many publications on this subject. The literature on the subject is also rich in publications comparing the performance of selected algorithms for a specific class of problems. In parallel, methods of optimising production processes using event-based simulation tools are becoming equally popular. A comparison of both approaches in solving a flow-shop problem is presented in papers (Kaczmar, Bányai, 2022). This paper proposes a combination of both techniques.

The primary objective of the paper is to compare the performance of selected algorithms for the optimisation of a finite size task in finite (specified) time for the same objective function. In addition, the paper proposes a concept for the interaction of the R engine with an event-driven simulation environment for the analysis of the obtained solutions.

2. Methodology

The problem of scheduling tasks (production orders) presented as a scheduling optimisation task for minimising the execution time of all orders (MakeSpan $C_{max} \rightarrow \min$) can be solved using different methodologies. As mentioned in the introduction, metaheuristics are popular and frequently used. This paper focuses on the permutation flow-shop problem. These algorithms often balance between exploiting a selected space within a defined neighbourhood and exploring to 'refresh' these areas. The test environment in the study is the R language version 4.2.1 on a virtual machine running in a HyperV environment with 32 virtual cores and 20 GB of RAM allocated. The hypervisor is a dual-processor Xeon E5-2620 with RAID 1 on SSDs. The selected algorithms are from packages made available in the CRAN repository. As most of the algorithms used in the study do not run natively on permutations, it was decided to use their own implementations.

None of the algorithms tested had parallelization computation mechanisms running.

As the simulation environment does not perform any complex calculations it can be run on any hardware configuration that meets the minimum requirements of the simulation software.

The proposed approach is as follows:

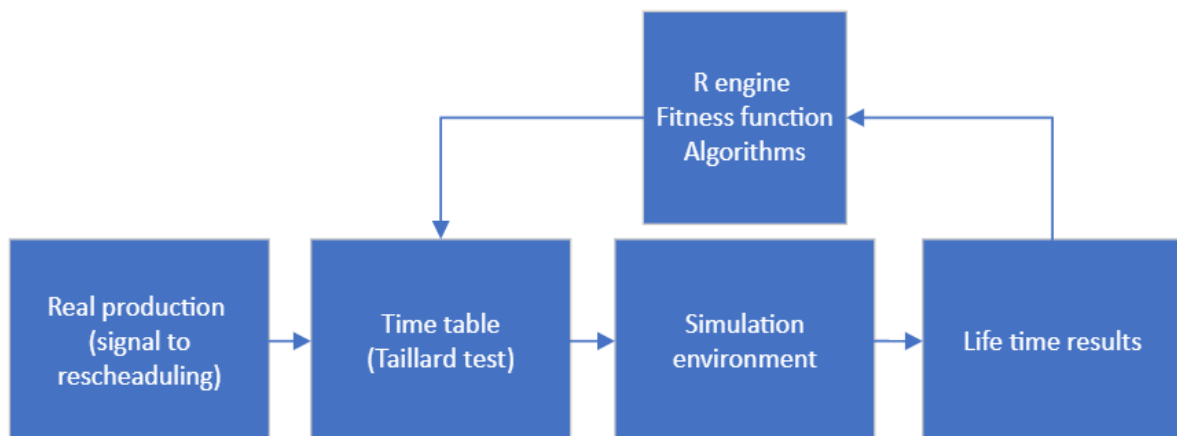


Figure 1. The proposed approach to implementing the environment.

Source: Own study.

The need for changes is implemented through a signal from real production updating the time tables. Changes in the production schedule change the results of the simulation execution. These results, via a trigger, activate calculations on the R side of the language to eventually return a new optimised time table at finite output.

2.1. Algorithms

The comparative study first used the well-known methodology of creating new permutations of a set allowing all of them to be found without the possibility of repetition.

For this purpose, the chosen 'perm' function of the Combinat package was selected (Carey, 2015) modifying it so that in each successive iteration it is possible to generate another permutation to check the objective function. Originally, the function returned all permutations of the set.

The next algorithm created random permutations using the 'sample' function analogously to the previous one by checking the value of the objective function.

The third algorithm was simulated annealing – own implementation.

The last algorithm tested was the genetic algorithm, which is an original implementation for the R language from the GA package (Scrucca, 2013). This implementation was the only one in the study that could work natively on permutations.

2.2. Data set

In the comparative study of algorithms, it was decided to choose a problem for the number of jobs $n = 20$ and the number of machines $m = 10$ and set number 8 from Taillard's test field data set also called benchmarks for scheduling problems (Taillard, 1993).

Table 1.

Taillard test - set number 8 for 20 jobs

	X	JOBS	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1	1	JOB1	9	91	96	73	37	28	32	27	4	83
2	2	JOB2	19	54	78	88	94	58	18	63	67	4
20	20	JOB20	76	4	24	74	19	46	27	82	26	63

Source: Own study.

The changeover times in this set are neglected. The space of all solutions, i.e. the number of all permutations for the jobs in this problem, is of size 20 factorial. The flow-shop problem for the Taillard test under study can be represented by a simulation model of the FlexSim software (Fig. 2).

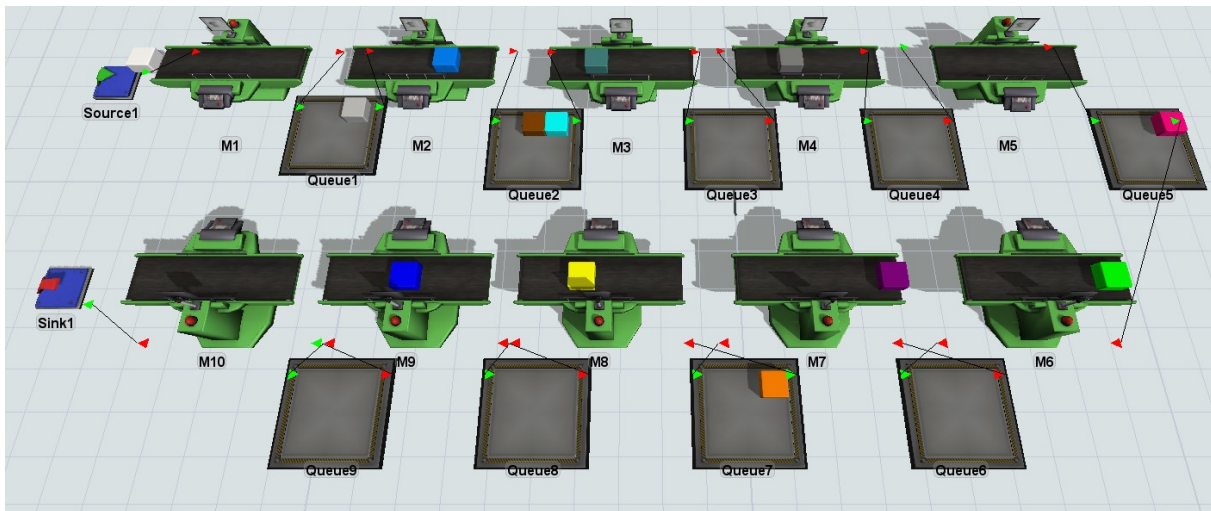


Figure 2. FlexSim simulation model for a 20x10 flow-shop problem.

Source: Own study.

The buffer fields are represented as queues between the machines. The processing times of the workpieces on the individual machines "Processing Time" depend directly on the job number. This relationship is shown as a reference to the corresponding cell in the global table of the Taillard test imported into it:

`Table("Taillard20_10x8")[JobNumber][MachineNumber]`

The material processing times on all machines for the default order sequence of 1 to 20 are respectively:

Table 2.

Completion times on all machines of each job for the default sequence

Results	
JobNumber	SimulationTime
1.00	480.00
2.00	666.00
3.00	789.00
4.00	863.00
5.00	909.00
6.00	957.00
7.00	1064.00
8.00	1101.00
9.00	1236.00
10.00	1247.00
11.00	1305.00
12.00	1336.00
13.00	1401.00
14.00	1483.00
15.00	1571.00
16.00	1663.00
17.00	1716.00
18.00	1886.00
19.00	1945.00
20.00	2044.00

Source: Own study.

For the default order (permutation) in this task, the total completion time for all jobs on all machines equals the completion of the last job and is 2044 units.

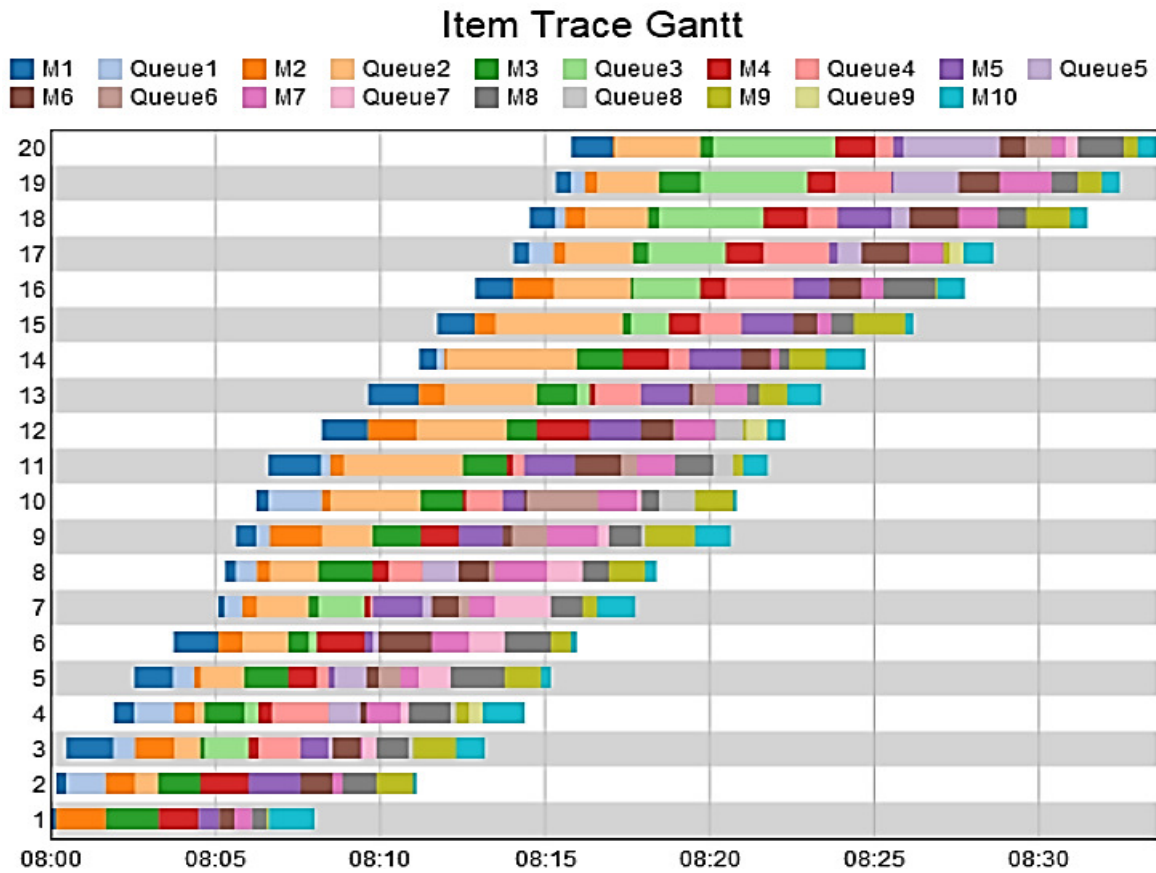


Figure 3. Job-machine and queue Gantt chart for the default sequence.

Source: Own study.

As previously mentioned, the queues in the simulation model correspond to the buffer fields that allow the machine to be released after the job is done.

2.3. Fitness function

The total and maximum execution time of the whole schedule (makespan) is calculated using the following parameters (Pang, Xue, Tseng, Lim, Liu, 2020):

- $t(\sigma_j, k)$ = processing time for job j on machine k ($j = 1, 2, 3, \dots, n$), ($k = 1, 2, 3, \dots, m$).
- n = total number of jobs to be processed.
- m = total number of machines in the process.
- $\sigma = \{\sigma_1, \sigma_2, \dots, \sigma_n\}$ = permutation job set.

Makespan can be formulated as follows:

- $C(\sigma_1, 1) = t(\sigma_1, 1)$,
- $C(\sigma_j, 1) = C(\sigma_{j-1}, 1) + t(\sigma_j, 1)$ where $j = 2, 3, \dots, n$,
- $C(\sigma_1, k) = C(\sigma_1, k-1) + t(\sigma_1, k)$ where $k = 2, 3, \dots, m$,
- $C_{\max} = C(\sigma_j, k) = \max(C(\sigma_{j-1}, k), C(\sigma_j, k-1)) + t(\sigma_j, k)$.

3. Results

Due to the large solution space in the proposed approach, calculations can be performed on the R engine side and then imported as a time table natively into FlexSim software.

The first will present the values of the matching function for an algorithm that searches all permutations (first from the right) for a fixed order. The second algorithm is random search. The third Simulated annealing and the fourth a genetic algorithm. The results are presented on fig. 4 for an assumed 100 seconds of operation in the same environment and with the same parameter seed fixed.

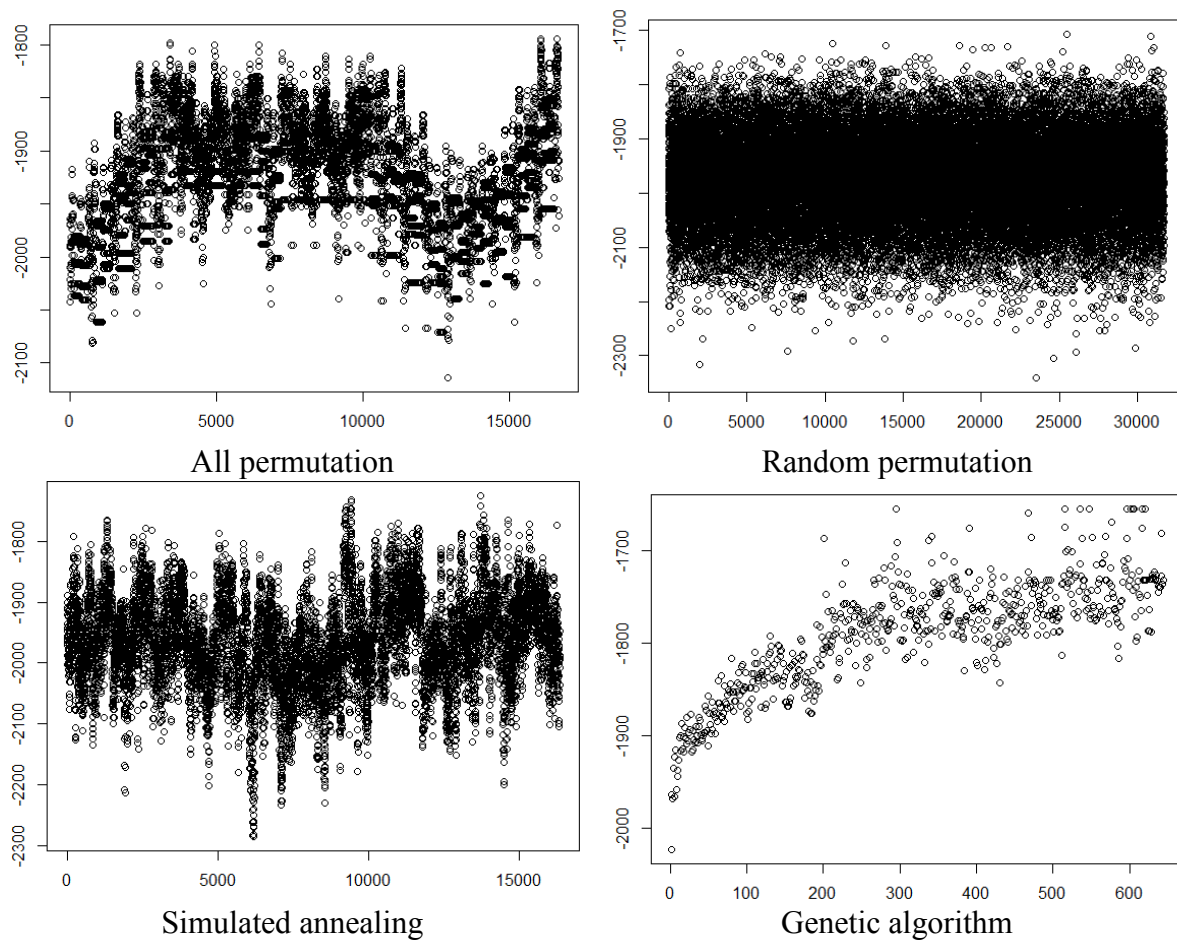


Figure 4. All fitness function values for all iterations of the running algorithms.

Source: Own study.

On the horizontal axis is the number of iterations of the running algorithm during the fixed 100 seconds of operation. On the vertical axis, the values of the objective function. The graphs were generated using the "plot" function of the R language.

As can be seen, the space available per 100 seconds for all running algorithms varies. Due to the complexity and thus the number of necessary calculations performed in iterations, the algorithms also differ in the number of iterations performed in the same time. The leader in this respect is the random search algorithm whose calculations in a single iteration only require

drawing permutations and calculating the matching function. An algorithm that calculates permutations according to a fixed order and allows all available permutations to be generated without repetition takes on average twice as long as random search in a single iteration. In the case of the simulated annealing algorithm, the amount of computation per iteration is greater. In each iteration, the algorithm searches a defined neighbourhood, compares the results and determines the temperature to decide on exploration or exploitation on this basis. The genetic algorithm is the most computationally advanced in this comparison.

The next graphic (Fig. 5) shows a comparison of the results of the algorithms keeping the best solutions (Cmax \rightarrow min) in relation to all preceding ones. In this way, the convergence of the algorithms in iterations can be compared and evaluated.

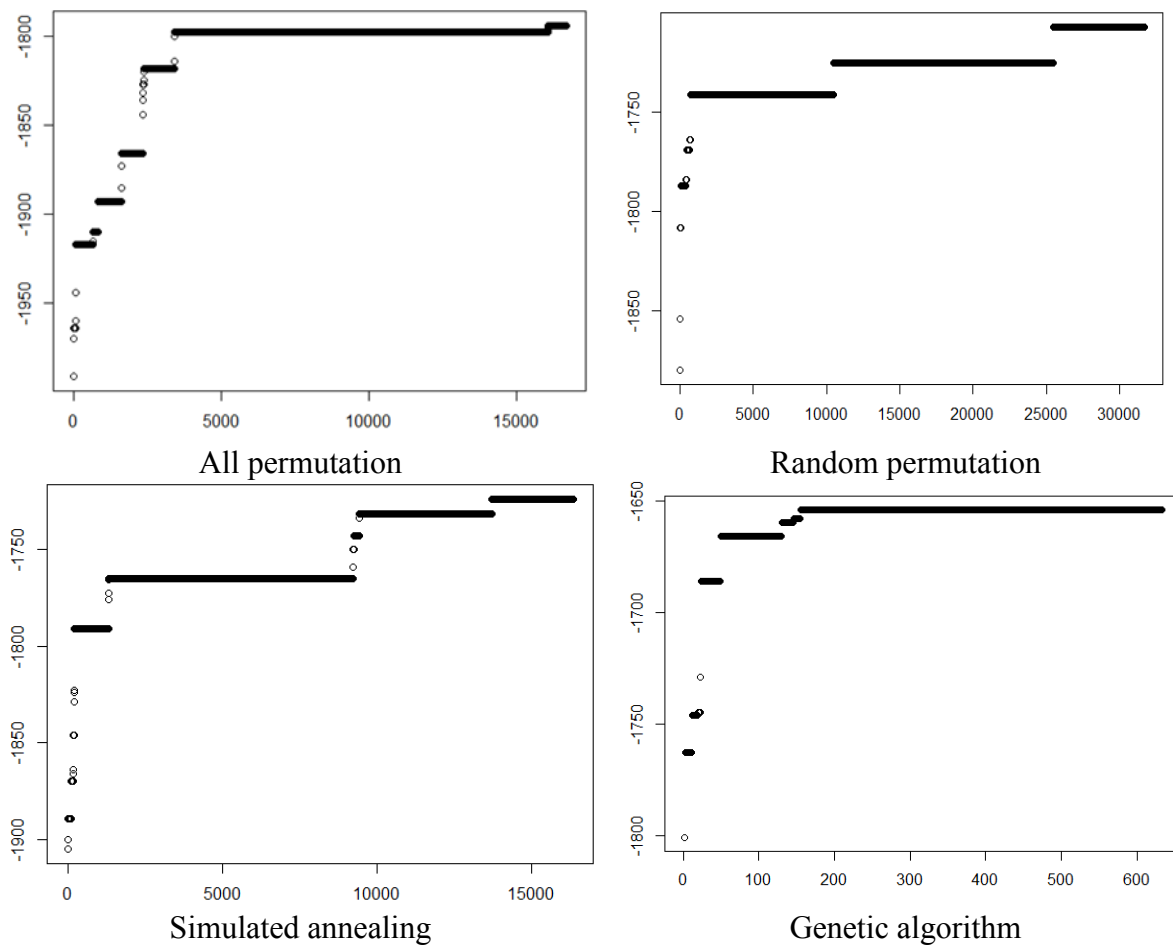


Figure 5. Best fitness function values for all iterations of the running algorithm.

Source: Own study.

The genetic algorithm, among those being compared, is the fastest converging to the best solution. This happens both in time and, of course, in the number of iterations.

The next table shows the results of the obtained parameters over the set time:

Table 1.
All final results with 100 second running algorithms

Algorithm	Iterations	Fitness Value
All permutation	16800	1794
Random permutation	31663	1707
Simulated annealing	16359	1724
Genetic algorithm	633	1654

Source: Own study.

Each of the solutions found is better than the default solution. The genetic algorithm was able to find the best solution among the available solutions for the algorithms tested in 100 seconds. Best chromosome selected for the values of the matching function: job8, job19, job7, job18, job9, job1, job5, job15, job20, job13, job6, job11, job14, job4, job12, job3, job10, job17, job2, job16.

The performance parameters of the genetic algorithm are as follows:

GA settings:

- Type = permutation.
- Population size = 100.
- Number of generations = 5000.
- Elitism = 50.
- Crossover probability = 0.8.
- Mutation probability = 0.1.

The results of a simulation of one of the best solutions found by the genetic algorithm are shown below.

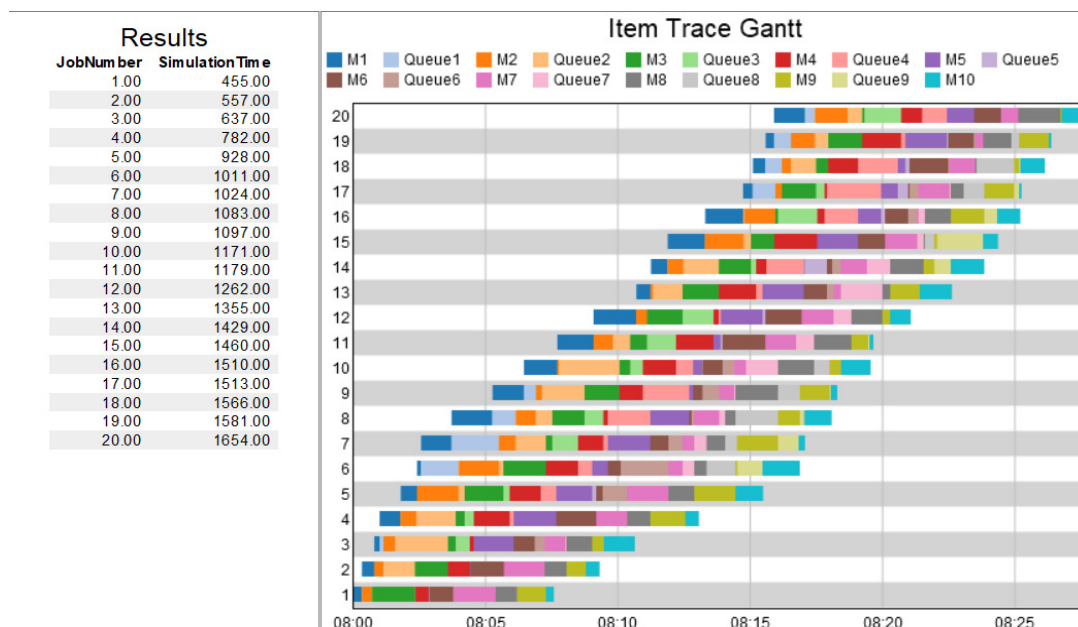


Figure 6. Completion times on all machines of each job and Gantt chart in job-machine and queue layout (time unit seconds).

Source: Own study.

The sequence selected by the genetic algorithm was imported as a time table. The results of the simulation coincide with the values of the matching function obtained from the genetic algorithm. Completion times on all machines of each order are shown in a Gantt chart in the job-machine layout and the queues associated with the job waiting before the machine. The next graphic (Fig. 7) compares the Gantt charts with the orders on the machines in the second layout in both environments. The top part comes from the FlexSim simulation software and the bottom part is the result of an algorithm on the R language side.

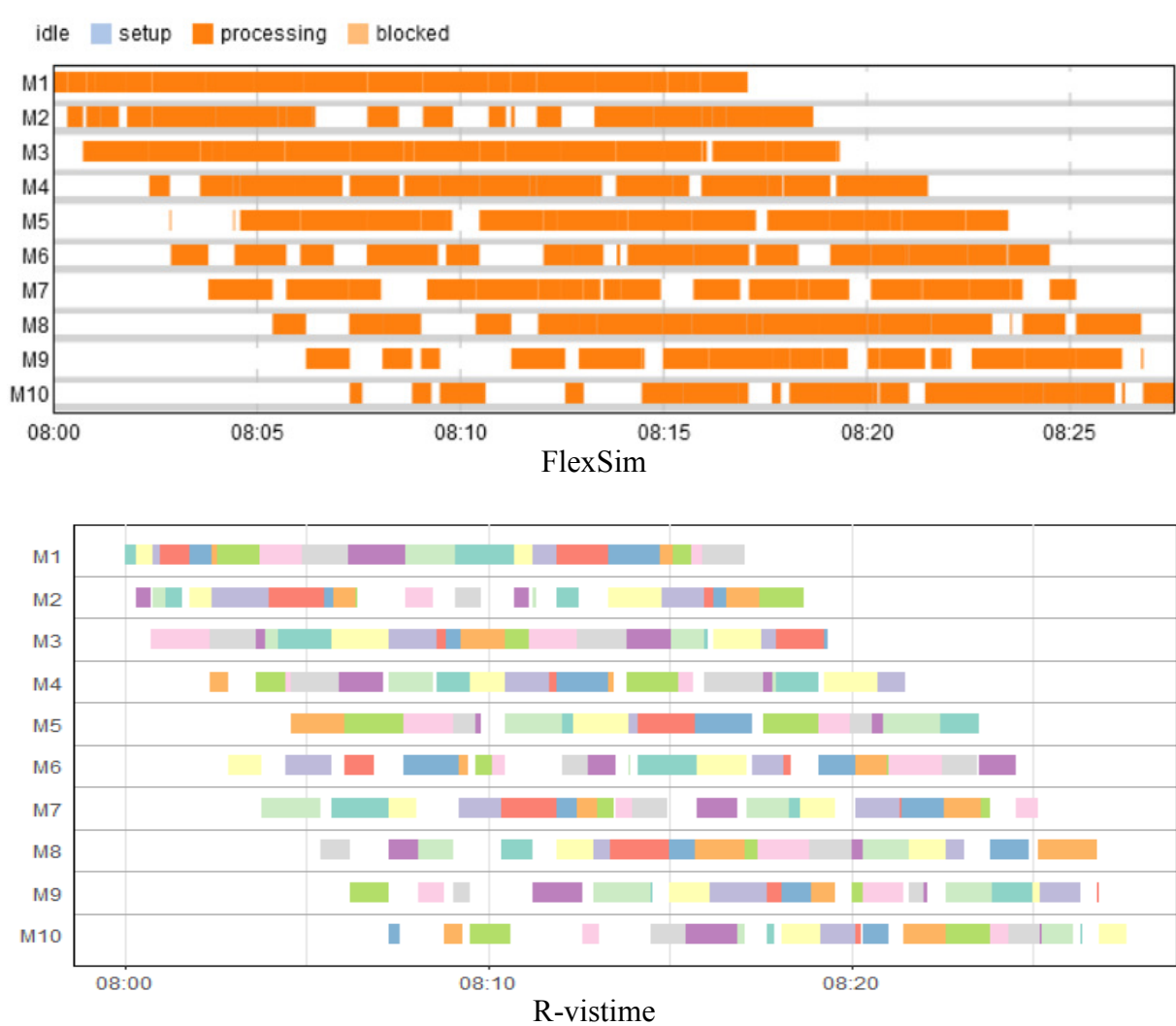


Figure 7. Comparison of Gantt charts made in FlexSim and R software (time unit seconds).

Source: Own study.

In the case of the FlexSim simulation, the "Gantt State" template was used to plot the chart and, in the case of the R language, the "vistime" package. Both the execution times on the machines and the gaps between jobs are arranged in the Gantt chart in the same way, representing the same schedule.

4. Discussion

In reality, the scheduling problem of an actual production is very rarely presented as a single type of task. Nevertheless, in an actual production scheduling it is possible to find a place where some order influences the final completion time of all jobs. This may be, as in this paper, the sequence of jobs with different execution times on the machines, the sequence of tooling for retooling a particular machine or permutations can be made with job-shop problems with the machines themselves. The paper shows that it is possible to represent a flow-shop problem in the form of an event-driven simulation with data from external sources. The paper uses a Taillard test of a certain size, which can be replaced by any data table. The results of the implementation of the algorithm on the R engine side, i.e. the values of the fit function (objective function) obtained from the best achieved permutation of jobs, are identical to the values obtained from the simulation. The simulation experiment does not evaluate the solution but only represents the execution process of the jobs on the basis of a time table. The paper does not compare the performance of algorithms written in R language with those that would be performed in simulation software. Instead, a combination of one and the other is presented. This solution undoubtedly has the advantages of making the calculations independent of the simulation itself, which can allow implementation in an environment unconstrained by the requirements of simulation software. The results from one source can be fed back in parallel to the real production as well as to the digital twin of that production in the simulation environment. The advantage of using simulation is undoubtedly that, in this case, it is possible to trace, step by step, the events and consequences of the changes introduced into production.

4. Conclusions

The four algorithms were tested for a limited time of 100 seconds in the R engine with identical hardware configuration and the same seed parameter. The following algorithms were tested sequentially: random permutations, all according to a fixed order, a simulated annealing algorithm and a genetic algorithm. The test field was the chosen Taillard test for the flow problem with permutations. The results of the algorithms and the proposed concept served as input for a simulation experiment in FlexSim software. A simulation model for the flow problem conforming to the 20x10 test was developed and the obtained results of the algorithms' fit function were verified with the result of the simulation.

References

1. Andrade, C.E., Silva, T., Pessoa, L.S. (2019). Minimizing flowtime in a flowshop scheduling problem with a biased random-key genetic algorithm. *Expert Systems with Applications*, 128, 67-80. <https://doi.org/https://doi.org/10.1016/j.eswa.2019.03.007>.
2. Carey, M.V. (2015). Package 'combinat'.
3. Guido, R., Conforti, D. (2017). A hybrid genetic approach for solving an integrated multi-objective operating room planning and scheduling problem. *Computers & Operations Research*, 87, 270-282. <https://doi.org/https://doi.org/10.1016/j.cor.2016.11.009>.
4. Huynh, N.-T., Chien, C.-F. (2018). A hybrid multi-subpopulation genetic algorithm for textile batch dyeing scheduling and an empirical study. *Computers & Industrial Engineering*, 125, 615-627. <https://doi.org/https://doi.org/10.1016/j.cie.2018.01.005>.
5. Jankauskas, K., Papageorgiou, L.G., Farid, S.S. (2019). Fast genetic algorithm approaches to solving discrete-time mixed integer linear programming problems of capacity planning and scheduling of biopharmaceutical manufacture. *Computers & Chemical Engineering*, 121, 212-223. <https://doi.org/https://doi.org/10.1016/j.compchemeng.2018.09.019>.
6. Kaczmar, I., Bányai, T. (2022). Optimisation of flow shop scheduling problem: simulation system vs. evolutive solver. *Advanced Logistic Systems - Theory and Practice*, 16(1), 31-40. <https://doi.org/10.32971/als.2022.003>.
7. Knosala, R., Wal, T. (2001). Production scheduling problem using genetic algorithm. *Journal of Materials Processing Technology*, 109(1-2), 90-95. [https://doi.org/10.1016/S0924-0136\(00\)00780-9](https://doi.org/10.1016/S0924-0136(00)00780-9).
8. Ławrynowicz, A. (2011). Genetic Algorithms for Solving Scheduling Problems in Manufacturing Systems. *Foundations of Management*, 3(2), 7-26. <https://doi.org/10.2478/v10238-012-0039-2>.
9. Pang, X., Xue, H., Tseng, M., Lim, M.K., Liu, K. (2020). *Applied Sciences Improved Fireworks Algorithm for Permutation*.
10. Pawlak, M. (1999). *Algorytmy ewolucyjne jako narzędzie harmonogramowania produkcji*. Warszawa: PWN.
11. Ramesh, C., Kamalakannan, R., Karthik, R., Pavin, C. (2020). A lot streaming based flow shop scheduling problem using simulated annealing algorithm. *Materials Today: Proceedings*. <https://doi.org/https://doi.org/10.1016/j.matpr.2020.05.108>.
12. Rolf, B., Reggelin, T., Nahhas, A., Lang, S., Müller, M. (2020). Assigning dispatching rules using a genetic algorithm to solve a hybrid flow shop scheduling problem. *Procedia Manufacturing*, 42, 442-449. Elsevier B.V. <https://doi.org/10.1016/j.promfg.2020.02.051>.
13. Rossit, D.A., Tohmé, F., Frutos, M. (2018). The Non-Permutation Flow-Shop scheduling problem: A literature review. *Omega*, 77, 143-153. <https://doi.org/10.1016/J.OMEGA.2017.05.010>.

14. Scrucca, L. (2013). GA: A Package for Genetic Algorithms in R. *Journal of Statistical Software*, 53(4 SE-Articles), 1-37. <https://doi.org/10.18637/jss.v053.i04>.
15. Taillard, E. (1993). Benchmarks for basic scheduling problems. *European Journal of Operational Research*, 64(2), 278-285. [https://doi.org/10.1016/0377-2217\(93\)90182-M](https://doi.org/10.1016/0377-2217(93)90182-M).
16. Touat, M., Bouzidi-Hassini, S., Benbouzid-Sitayeb, F., Benhamou, B. (2017). A hybridization of genetic algorithms and fuzzy logic for the single-machine scheduling with flexible maintenance problem under human resource constraints. *Applied Soft Computing*, 59, 556-573. <https://doi.org/https://doi.org/10.1016/j.asoc.2017.05.058>.

SOCIAL ECONOMY ENTITIES AS ORGANIZATIONAL ELEMENTS OF ECONOMIC CIVIL SOCIETY IN POLAND

Włodzimierz KACZOCHA^{1*}, Jan SIKORA²

¹ School of Communication and Management, Poznań; wlodzimierz.kaczochoa@gmail.com

² University of Zielona Góra; j.sikora@wez.uz.zgora.pl, ORCID: 0000-0002-1667-5622

* Correspondence author

Purpose: The article is intended to present the theoretical concept of the organisation of economic civil society shaped by social economy entities.

Design/methodology/approach: Critical analysis methods used in literature studies; analysis of secondary documents such as legal acts, and official institutional documents.

Findings: First, the article presents the theoretical concept of civic society, the conditions and reasons for its emergence, and describes its four forms. One of these forms consists of the emerging organisation of economic civil society. Such a society is based on the activity of social enterprises as social economy entities. We also stressed the need for cooperation between public administration units and social enterprises.

Originality/value: The novelty of this article consists in outlining the concept of economic civil society. We also point-ed out that examples of the activities of social economy entities that organise economic civil society delineate the object of interest of the social economy. It takes into account social, economic, and environmental interests. We emphasised that this is the direction towards which economics, as a scientific discipline, should head. It should be heterogeneous and holistic.

Keywords: civil society, economic civil society, social economy entities.

Category of the paper: Literature review.

1. Introduction

In 2013, we outlined the concept of civil society development, including its new form, the economic society (Kaczochoa, Sikora, 2013). Now, we present an improved theoretical project that we relate to all forms of civil society. However, we will only discuss economic civil society here.

For our theoretical and empirical considerations, we adopted the typology proposed by J. Raciborski, who formulated an understanding (but not a definition) of two “model types”: “Type A is a political civil society formed by citizens [...] to force the state to favourably allocate to them some goods that the state has at its disposal or that can only be produced at the state level or, conversely, to defend some of their freedoms or goods against the state. Type B is an autonomous civil society understood as a sphere of private, inherently selfish, conflicting and very broadly defined interests, including economic ones. Individuals voluntarily associate, co-operate in this sphere to effectively meet their needs in cooperation with others”. According to this author in a type B civil society, individuals “only exercise their civil (personal) rights”. Whereas in type A society, “besides civil rights” citizens also enjoy “in particular political rights, to influence the state and to enforce their claims [...]”. By discussing they co-create the law and “influence whether and how the law is applied” (Raciborski, 2010, pp. 8-9).

In a theoretical sense, the presented typology allows for describing the different forms of civil society whereas in an empirical sense, for defining the scopes of practical actions. Before we proceed to further considerations, we need to stress that the newly emerging form, i.e. economic civil society, needs to be classified under model B, with some similarities to type A in terms of political requests to influence national and regional policies, and with reference to the allocation of specific goods by the state.

Based on J. Raciborski's typology, we present our understanding of civil society and economic civil society. Civil society consists of free citizens who, sovereignly, without external coercion and out of their own will, organise its various forms, discuss and then adopt political, economic, cultural or other objectives. The adopted objectives can refer to all spheres of social life, both in the national and specific local space, as well as in relation to global political, social and cultural processes. The civil society operates under democratic law, but they are independent of the state and its institutions. Citizens' participation in its various forms makes it possible to achieve individual goals aligned with the group and societal goals that the members of a given civil society form have endorsed. Individuals implement their social subjectivity and freedoms assigned to them in a democracy: political freedom, economic freedom and cultural freedom (Kaczocho, 2015).

2. Objective and subjective conditions for the emergence of civil society

Five causal conditions are necessary for civil society to emerge. The first objective (political) condition is the existence of a political form of government, i.e. democracy with the law guaranteeing every citizen the (formal) possession and the (material) realisation of the three civil liberties. The second pre-condition, which can be described as socio-material, is the emergence of recognisable economic, political or cultural situations and processes that pose

specific impediments in people's lives (specific irrational state policies, unethical actions of economic entities in the free market, such as exclusion of the poor from social and economic life, lack of opportunities to participate in high culture, etc.). Citizens who recognise such socio-material situations, phenomena and processes, and who at the same time fulfil the three subjective conditions described below, use their sovereign will to decide on establishing a corresponding form of civil society.

What is an important aspect of this condition is that civic associations intend to eliminate the negative phenomena and processes, design their institutions and activities that rationalise policies in the economy, and culture, in selected social relations, create social entrepreneurship, i.e. social economy entities. These initiatives are most often directed against negative local phenomena dealt with by various associations as part of a “bottom-up” form of civil society (other authors often write about ‘bottom-up’ civil society).

In its subjective sense, the third condition is the individual awareness of the possession and possibility of exercising the three above-mentioned freedoms. Citizens who are not aware of their freedoms do not participate in politics at all, nor do they organize any forms of civil society, unless forced by material deprivation they decide on some form of collective action and then, as if secondarily, slowly develop an awareness of their freedoms. If it is an economic reason (poverty, desire to find a job, etc.), then by forming an economic association, these entities get the conviction that they have the freedom to act economically. In a way it is a stage of spontaneous interaction, which then develops into a stage of rational and long-term cooperation, as social economy entities.

The fourth subjective condition for the emergence of civil society is that citizens need to have some knowledge of the actions and effects of civil society, be it contemporary or past. This subjective awareness of the positive outcomes is, as the members of the societies believe, important for the creators and members of any form of such a society who wish to achieve some updated social goals. It is all the more important that it is precisely in a subjective way motivation to create various forms of civil society is strengthened (Grabowska, Szawiel, 2001).

Finally, the fifth, subjective condition for the emergence and further existence of civil society is that citizens have at least a minimum of organisational experience. The ‘old’ A. Tocqueville’s view needs to be quoted that the participation of citizens in all the social association activities is the ‘great free school’ of learning the principles of social interaction (de Tocqueville, 2019).

Within the presented framework of the theoretical civil society concept (explaining the pre-conditions for its emergence, two models describing the scopes and goals of action, and an elaborate understanding of such a society), its four forms need to be distinguished. They include political civil society; civil society in the sphere of culture; ‘bottom-up’ society, which is a local society aiming to achieve some goals within the village, municipality, city, and finally, economic civil society (Kaczocha, 2015).

Depending on the pursued objectives, these four forms can be placed within certain activity spheres: sometimes within model A, and at other times, when the objectives are changed or modified, within model B. Without any doubt, political civil society belongs to model A and this is because associations or political parties seek the allocation of certain state-owned goods or act in defence of a certain range of freedoms that either the state or corporations restrict (for example, the latter restrict the economic freedom of small market players). In this form, members of associations or parties seek to co-legislate either through their elected parliamentary representatives or within local government.

However, if certain material goods or cultural values are scarce and restricted, a civic association in model B may conclude that the standard of living of many people is deteriorating. Under such circumstances, the association's objectives are of general social significance (and thus fall under model A). This phenomenon is confirmed by the activities of the Obywatele Kultury [*Citizens of Culture*] association founded in Warsaw at the end of 2010. During the 2011 Congress of Culture, a Pact for Culture was adopted, which postulated, among other things, an amendment to the tax law regarding the deduction of 1% of CIT for the support of culture and the public-social-private partnership law in financing cultural institutions. As stipulated by the Pact, people's participation in high culture and training of cultural competencies are subjective, important factors in supporting civilisation development, including the development of the economy. Such a transition in the activities of a civic association from model B to model A should be perceived as a trend towards the universalisation of civil society objectives. A similar transition can be observed in the activities of economic civil society, as we will outline in the following section of this paper.

To conclude this section we will discuss a view according to which the activities of all forms of civil society strengthen the group character of social capital within each association in terms of mutual trust among members as joint activities boost cooperation skills, form an ethical conviction about the importance of common goals uniting people in the local environment (Pietrzyk-Reeves, 2004).

3. Understanding the concept of economic civil society – a reference to social economy actors

The social economy as a sphere of socio-economic life is related to the individual and group entrepreneurship sector and non-governmental organisations. It is a tool for social and professional reintegration, pursuing professional objectives and supporting local and regional development in the broader sense in local government entities. Support for local and regional development is now particularly important in the face of growing demand for social services mostly linked to demographic change in Poland.

In the literature on the social economy and its actors, we only found two authors mentioning that the social economy fosters the realisation of the 'idea of citizenship' assuming the subjective participation of citizens in economic activity (Hausner, 2008). J. Orczyk states that the social economy is "linked to specific social policy doctrines or models [...]" that recognises "its significance in forming civil society" (Orczyk, 2012, p. 184). In the previously outlined theoretical conception of civil society, we presented a novel view according to which its fourth form includes economic civil society, which falls under the model B because it enjoys civil autonomy understood as independence from the state and other forms of civic action, it relates to people's private economic interests, and its founding members make a sovereign decision to establish such an association and to set up certain economic institutions, referred to as social economy actors, which include social enterprises.

The following entities are eligible for the status of a social enterprise: social cooperatives, non-governmental organisations (except those established by political parties and rural housewives' circles), work cooperatives, disabled and blind cooperatives, agricultural production cooperatives and entities which run social integration centres and clubs, occupational therapy workshops, and vocational activity establishments. Social enterprises aim to reintegrate people at risk of social exclusion and to provide social services to the local community. This translates into two operational levels.

The first includes activities addressed both to people at risk of social exclusion (such as the long-term unemployed, addicts and homeless), activities in social integration centres and clubs and those taking the form of occupational therapy workshops for people with disabilities.

The second level comprises various forms of reintegration in which support recipients are at the same time employees. For example, with regard to people with disabilities, such measures take the form of occupational workshops and sheltered workshops. People whose difficult life situation results from being unemployed or for other reasons can receive support through employment in social cooperatives.

For a social enterprise to operate it needs to employ at least three persons under an employment contract or a cooperative employment contract (at least half FTE). If a social enterprise operating has social and professional reintegration of persons at risk of exclusion as its major goal, at least 30% of the total number of employees must be at risk of social exclusion and performing work based on an employment contract or a cooperative employment contract.

Let us emphasise that a social enterprise cannot distribute profit or surplus to its members, employees or shareholders. The generated profit needs to be used for the social and professional reintegration of the employees at risk of social exclusion, the realisation of social objectives or the strengthening of the enterprise's potential. It's also worth stressing that the material profit value is endorsed by social economy actors in a "weaker" sense. This means that profit is not the supreme norm and the objective of the enterprise's activities, because these activities are targeted at social objectives such as education and employment for the jobless on one hand and, on the other hand, the services or goods produced are intended to satisfy the needs of the local

communities and they are not economically viable for the remaining free market actors. In other words, social economy entities are not geared toward profit maximisation and its distribution among its founding members and employees and providing bonuses to the board members. The fact that profit generation is not given priority means that this very profit is desirable for the material development of the enterprise, for covering the costs of vocational training for employees, and for providing social assistance to them when they find themselves in a difficult situation.

Employees can be involved in the decision-making processes, which means that a social enterprise is managed democratically or using a consultative and advisory model with the participation of employees and other stakeholders. Members of these economic entities discuss its objectives in line with approved axiology, and its accepted values. In particular, they recognise work as a value not only in the material sense of the sustenance basis but this value is also treated in its ethical sense as the basis for shaping a sense of personal dignity as individuals acquire a sense of professional worth exactly through their work.

As social economy entities social enterprises may apply for various forms of support, such as one-off subsidies for the creation of workplaces for persons referred by local labour offices, refunds for social insurance premiums for employees at risk of exclusion, exemption from CIT on profits used for social and professional reintegration activities, application of solutions facilitating their participation in public procurement procedures (Act..., 2022).

In addition, social economy entities can apply for funding for their activities under ministerial or official programmes supporting the social economy. In their turn, local and regional government units can support social enterprises by commissioning social services under negotiation and public-social partnership modes.

According to the Ministry of Family and Social Policy, approximately 100,000 social economy entities are operating in Poland. NGOs are by far the largest group (97%), with the remainder made up of cooperatives (around 1.5%) and reintegration units (around 1.5%). In 2019, social economy entities employed approximately 210,000 people accounting for 1.8% of the employed in the Polish economy (Rekrutacja..., 2022).

The entities responsible for the coordination of social economy measures include the minister responsible for social security, at the national level, and the voivodeship self-government at the local level. The National Committee for the Development of the Social Economy provides advisory services to the Minister. Voivodeship governments, in their turn, are supported by Regional Committees for the Development of the Social Economy (Act..., 2022).

Using the example of the Obywatele Kultury association, we have previously mentioned the emerging tendency to universalise objectives and thus transitioning from model B to model A. Suggestions or concrete political requests to the state and local authorities are then formulated. At the end of the 20th century, small social enterprises, social cooperatives, had been established in Wielkopolska and created jobs for many unemployed as a result of

an initiative of a dozen of individuals and a few socially active organisations, including, in the first place, the Barka Foundation. It can be perceived as the starting point in the organisation of economic civil society in the Wielkopolskie Voivodeship. Objectives started to get universalised in 2010 when the Barka Foundation organised a Social Entrepreneurship Fair in Poznań (attended by more than a thousand people), during which it showcased practical achievements in developing the social economy (also known as 'solidarity economy'). (Sadowski, 2012). The authors of this economy concept and its implementers refer to the constitutional principle (Constitution of the Republic of Poland, chap. 20) of 'social market economy'. Then, the Wielkopolska Memorandum of Understanding on the establishment of the Wielkopolska Social Economy Centre has been made. The authors of the Memorandum of Understanding and the Centre founders refer to the Wielkopolska traditions of cooperative-based and self-governing economic activity, developed in the mid-19th century by the protopositivists and their 20th-century followers. Among other things, the Centres role includes educational and information activities to enhance further development of social economy entities in Wielkopolska. Please note that the activities of social economy entities and organisers are constantly supported by local and regional authorities, as well as the provincial governor, and this is how the principle of state subsidiarity gets implemented through the regional economic policy. Concerning the drafted Social Economy Development Programme, we need to mention that the second phase of 'strictly' rationalised activity, where the social economy is co-shaped at the regional/voivodship level, has been initiated. We might thus accept the view that such a form of civil society, starting with the second stage of activities, becomes a subject of economic regional policy. Following the initiative of the founders and activists of economic civil society, voivodship governments create Regional Social Policy Centres entrusted with the task of drawing up a multiannual development programme for the economic civil society and its actors. That is, they create Regional Social Economy Development Programmes. The structure of such a programme should primarily include topics such as Introduction; Mission of the Regional Social Economy Development Programme (co-creators, implementers, stakeholders); Vision of the development of the social economy in the voivodeship from the perspective of EU, national and regional social policy; Objectives of the Regional Social Economy Development Programme and the rationale behind them; Structure of the Regional Social Economy Development Programme; Programme management; Implementation of programme monitoring; Funding sources. Annex (social economy entities in the region (Frątczak-Müller, Kwiatkowski, 2020).

Increasingly often, the social economy gets in the focus of public administration organisations, especially at all levels of local government. These entities are dealing with such issues as poverty reduction and social exclusion. Employees of local governments, local leaders, and animators of grassroots initiatives are all supporters of social economy and contribute to the emergence and proper functioning of social economy entities and the dynamic development of economic civil society.

4. Summary

Organisers and activists of economically organised civil society vividly debate the foundations and theoretical assumptions that are formulated in the context of practical action (Niesporek, 2019). In this context, it is conceivable that discussions among practitioners, with very modest input from economic theorists, would result in the emergence of a well-developed concept of social economics which will be a strong theory with strong social ethical and economic bases rather than a strictly economic one. There are broad axiological underpinnings accepted by all the actors contributing to this form of civil society to support this view. We thus need to emphasise that the social economy must constitute a holistic and comprehensive consideration of the individual organisational elements of the complex economic civil society system. A holistic take on social economy ensures reconciliation of social, economic, technological and environmental interests. This idea corresponds to the concept of ‘clinical economics’ formulated by Jeffer Sachs (Sachs, 2006). “As Mączyńska emphasises, ‘clinical economics’ is exactly this holistic approach to solving socio-economic problems, combining economic and social aspects. This approach is modelled on holistic medicine” (Mączyńska, 2011, p. 46). This means that economic knowledge cannot be separated from social knowledge, as economics is a social science after all and draws on the achievements of other scientific disciplines such as sociology, psychology, pedagogy, and anthropology. This is what gives birth to the need for a holistic and interdisciplinary, yet heterogeneous, approach to economics (Rethinking..., 2018), including the subject of social economics.

References

1. De Tocqueville, A. (2019). *Democracy in America*. London: Wordsworth Editions Ltd.
2. Fischer, L., Hasell, J., Proctor, J.C., Uwakwe, D., Perkins, Z.W., Watson, C. (2018). *Rethinking Economics. An Introduction to Pluralist Economics*. Abington, Oxon: Routledge.
3. Frątczak-Müller, J., Kwiatkowski, M. (2020). *Lubuski Program Rozwoju Ekonomii Społecznej na lata 2021-2023*. Zielona Góra: Urząd Marszałkowski.
4. Grabowska, M., Szawiel, T. (2005). *Budowanie demokracji. Podziały społeczne, partie polityczne a społeczeństwo obywatelskie w postkomunistycznej Polsce*. Warszawa: PWN.
5. Hausner, J. (2008). *Ekonomia społeczna a rozwój*. Kraków: MSAP, UEK.
6. Kaczocho, W. (2015). *Filozofia społeczna. Wybrane zagadnienia filozoficzno-teoretyczne oraz empiryczne*. Warszawa: Scholar.

7. Kaczocha, W., Sikora, J. (2013). Gospodarcze społeczeństwo obywatelskie jako remedium przeciwko bezrobociu (na przykładzie Wielkopolski). In: S. Partycki (Ed.), *Samorządność w warunkach kryzysu* (pp. 9-15). Lublin: KUL.
8. Mączyńska, E. (2011). Ekonomia w warunkach gospodarki nietrwałości. Polska myśl strategiczna na spotkanie z enigmą XXI wieku. *Biuletyn PTE. Wydanie specjalne, Vol. 52, Iss. 2*, pp. 35-46.
9. Niesporek, A. (2019). Siła i słabość społeczeństwa obywatelskiego w Polsce. In: K. Wódz (Ed.), *Negocjowana demokracja, czyli europejskie governance po polsku* (pp. 191-214). Warszawa: Scholar.
10. Orczyk, J. (2012). Ekonomia społeczna a polityka społeczna. In: M. Frązka, J. Hausner, S. Mazur (Eds.), *Wokół ekonomii społecznej* (pp. 181-192). Kraków: MSAP, UEK.
11. Pietrzyk-Reeves, D. (2004). *Idea społeczeństwa obywatelskiego. Współczesna debata i jej źródła*. Wrocław: Wydawnictwo Uniwersytetu Wrocławskiego.
12. Raciborski, J. (2010). Wprowadzenie. In: J. Raciborski (Ed.), *Praktyki obywatelskie Polaków* (pp. 8-9). Warszawa: PWN.
13. *Rekrutacja. Miejsca pracy dla wykluczonych*. Retrieved from: http://www.pulshr.pl/rekrutacja/miejsca-pracy-dla-wykluczonych-...I?utm_source=newsletter&utm_medium=, 08.09.2022.
14. Sachs, J. (2005). *The End of Poverty: Economic Possibilities for Our Time*. New York: Penguin Books.
15. Sadowski, T. (2012). *Wielkopolskie Centrum Ekonomii Solidarności jako wzór działania partnerskiego*. Retrieved from: <http://siecbarki@barka.org.pl>, 07.09.2022.
16. Ustawa z dnia 5 sierpnia 2022 o ekonomii społecznej. Dz.U. 2022, poz. 1812. Retrieved from: <http://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20220001812>, 07.09.2022.

PRODUCTION WASTE OF THE TEXTILE AND CLOTHING INDUSTRY IN SUSTAINDEVELOPMENT CONTEXT

Simona KLÍŠ

Silesian University of Technology, Faculty of Organization & Management; simona.klis@polsl.pl,
ORCID: 0000-0001-5346-5651

Purpose: The main aim of the research presented in this article was identification and categorization of the main production waste generated in the textile and clothing industry and their impact on the environment in the context of sustainable development, together with the presentation of several proposals for solutions to the problem of production waste. Nowadays, through the newly emerging EU directives, the increasing population and consumer lifestyle, thus the huge amounts of generated waste, the problem of waste coming from textile and clothing industry will increase and it will be more important to find new solutions to it.

Design/methodology/approach: In the research presented in this article, an analysis of the literature on the processes of the textile and clothing industry was used; waste generation from these industries and their impact on the environment along with the concept of sustainable development.

Findings: The management of waste from the textile and clothing industry is an important factor influencing the sustainable development of the economy, both in the world and in Poland. Under the newly created EU directives, it will be a very important issue in the future, which will require urgent addressing this topic and finding optimal solutions in the context of sustainable development or the circular economy.

Research limitations/implications: In the future, research will be continued in the field of production waste management in the textile and clothing industry, their disposal or recycling.

Practical implications: This article provides an overview of quantitative research and diversity of waste from the textile and clothing industry in Poland and in the world. This review shows the importance and scale of the problem and allows for further continuation of research to manage the generated waste. The author has also collected concepts for the further management of post-production waste, which she presented in the article, but they require a broader and more detailed analysis.

Originality/value: Based on empirical research, the article shows the scale of the problem that, through the new EU directives on the circular economy and sustainable development, will be a forward-looking and important issue. Additionally, the article presents concepts for waste management from the industrial and consumer perspective.

Keywords: textile industry, textile industry waste, sustainable development.

Category of the paper: Research paper.

1. Introduction

The textile industry is a branch of the light industry that produces semi-finished products and textile products from textile raw materials. This industry includes cast-ironing, spinning, weaving, knitting, as well as non-woven and yarn manufacturing technologies. After the industrial revolution, since the replacement of the hand spindle and loom with spinning machines all over the world, there has been a massive increase in the number of textile factories created, and thus the amount of waste generated. Apart from traditional techniques of fabric production, new ones were introduced (especially in the last quarter of a century): texturing, open-end spinning. New products were also created, such as textured silks, yarns, and laminates, as well as new techniques of finishing fabrics, which gave them special properties, such as non-flammability or moth resistance (PWN, 2022).

Unfortunately, along with the development of the textile industry, the amount of generated waste, which is an indispensable element of this process, has increased. These wastes occur both in liquid form (colored effluents and effluents after finishing and processing fabrics), gaseous (substances emitted into the air) and solid (fibre waste – dust and fluff, yarn and product residues, selvedge, cuttings, defective products, fibres). This waste is often not used, managed, utilized, or recycled in any way, especially liquid and solid waste, which contradicts the idea of sustainable development. Fast fashion, which consists in the constant supply of new, fashionable clothes at low prices, also contributes to the significant development of the industry due to the seasonal demand for new products. People should remember that most of the factories are in developing countries, mainly in Asia, where the water and sewage management together with sewage treatment plants and solid waste disposal methods are not yet developed enough. Therefore, wastewater contaminated with dyes, bleaches or heavy metals most often goes directly to rivers, and solid waste is deposited or incinerated in landfills, which is a heavy burden on the environment.

This procedure is against the idea of sustainable development. Companies producing clothing and footwear should consider the ecological approach (goin' green) to the environment and the life of future generations. The so-called sustainable fashion should refer to processes where new products are designed and manufactured in a rational manner, bearing in mind environmental protection. With this approach, many aspects should be addressed: ecological, social, cultural, and financial in the production of textiles and clothing to minimize their negative impact on the environment (Kramarczyk, 2015; Szewczyk, 2017).

2. Conceptual background

2.1. Textile industry

According to the Product Stewardship Institute, the textile and apparel industry is one among the greatest sources of threats to the natural environment, right after the processing of crude oil and gas (Interreg 1, 2020). Moreover, the production processes are mainly based on natural, non-renewable, and ending resources. In 2015, the Ellen MacArthur Foundation released a report which shows that the consumption of non-renewable resources was 98 million tones, considering only the clothing sector. In addition, forecasting by 2050 the consumption of non-renewable resources will triple with the increase in CO₂ emissions to 26% (Ellen MacArthur Foundation, 2015). According to a report by Le K. in *Textile Recycling Technologies, Coloring and Finishing Methods*, the level of CO₂ emissions increased by about 2.5 billion tons per year (by over 60%). At the same time, there was a 50% increase in the amount of freshwater consumption (Le, 2018). According to Report of the European Parliament in 2015, the clothing and textile industry used 79 billion m³ of water, this report informs about the scale of the problem – 2700l of water is needed to produce one T-shirt, which is as much as drinking water is consumed by an average person in 2.5 years (European Parliament, 2020). In 2018, the textile and clothing sector generated a turnover of € 178 billion in European Union countries, which allows to state that it is a very important sector for the EU economy. In addition, the EU is the second (after China) largest exporter of clothing and textiles in the world, with the largest producers located in France, Italy, Spain and Germany, who are responsible for the production of approx. 75% of EU production. In 2019, compared to the previous year, clothing exports increased by 13.8% to Switzerland, by 6.8% to the USA and by 2.9% to China. Therefore, the activity of the textile and clothing industry is taken up in many global debates, as 5% of the total amount of waste worldwide comes from this industry (Fisher, Pascucci, 2017).

It must be remembered that in the textile and clothing industry, not only finished products are a waste problem all over the world, but also the so-called production waste. During the production of fabrics, huge amounts of cuttings, pieces of textiles (selvedge), fiber waste (dust and fluff), yarn waste, fibers and defective products are produced, which are rejected at the production stage (Wałętrzak 2016; Szewczyk, 2017).

2.2. Outline of technological processes in the production of fabrics

Technological processes in the textile industry include several unit operations, as a result of which utility textiles in the form of woven, knitted fabrics and felt are produced. A yarn is obtained from the fibre, from which a fabric in the form of pig iron is produced on a weaving loom. Then the pig iron is subjected to bleaching, dyeing, and finishing processes to give it special properties, such as resistance to creasing, water, etc. The technological processes of

processing wool, cotton, cellulose, and silk consist of several operations and processes of obtaining, processing, dyeing and processing the raw material (Meinck et al., 1975). Technological processes in textile plants include several intermediate stages listed below (Szosland, 1981; Mihułka, 2003).

Stage 1 includes knitting, i.e., the application of lubricants (fats, mineral oils) and mechanical processing of the yarn into a textile product.

Stage 2 is a prewash to remove dirt (animal grease, dirt, dry sheep sweat) and includes:

- washing with water, with the use of detergents and alkaline agents at a temperature of 55-70°C,
- solvent washing - with the use of organic solvents and detergents,
- drying.

Stage 3 is a chemical treatment that removes natural impurities and previously applied preparations from the fibers and consists in:

- sunbathing – leveling the surface of the fabric over the flame,
- peeling off – removing sizing from the fabric with Na₂CO₃ solution,
- mercerization – increasing material strength, giving gloss, improving the sorption properties of the fabric with NaOH solution,
- bleaching – removal of the natural color of the fiber (e.g. cotton, linen) with H₂O₂, NaClO, NaClO₂, CH₃COOOH,
- thermal stabilization – ensuring the shape stability of fabrics in further stages of processing.

Stage 4 involves dyeing – giving the fabric colour with the use of reactive, direct, vat and sulphur dyes, whereby dyeing is carried out using various methods:

- bathing methods (periodic, exhaust) – consisting in immersing the fabric in a dyeing bath containing dyes and auxiliary agents for a certain time, which causes the diffusion of dye particles to the surface of the fibres, and then migration of these particles into the interior of the fibre,
- continuous and semi-continuous methods – the fabric is pre-filled with dye by using, for example, sprays or foam, and then using thermal methods (steam, hot air) or chemical methods, the dye is permanently bonded with the fibre,
- fabric washing – removal of unfixed dye particles and residues of chemicals previously added to the dyeing bath.

After the dyeing process is completed, the used dye bath with the remaining dye and auxiliary agents is discharged into the sewage. Likewise, during washing, dye wastewater is also produced and discharged into the sewage system. An important and basic technical and technological parameter of dyeing apparatuses is the concept of the bath multiplication factor (k , dm³/kg), i.e., the appropriate ratio of the mass of the dyed product to the minimum mass of the bath, to obtain the proper dyeing effects. This parameter also influences the amount and

physicochemical properties of the generated wastewater – the greater the bath ratio, the more dye is used, which at the same time causes more dye to be transferred to the wastewater. In addition, for higher values of the multiplication factor of the bath, the specific consumption of water and heat energy is higher.

Stage 5 includes finishing the products by giving them the desired properties utilities and consists of the following unit operations:

- anti-wrinkling finishing – cross-linking agents, catalysts, additives (softening, hydrophilizing agents, etc.),
- waterproof finishing,
- softening finishing,
- anti-inflammatory finishing,
- molar resistant finishing.

Stage 6: thermal treatment, as the final stage of production, consists in fixing the previously applied chemicals by high temperature (150-190°C). A general outline of the technological processes of fabric processing, considering the places of dye application and the formation of colored wastewater, solid waste and the emission of toxic substances into the air is presented in Figure 1.

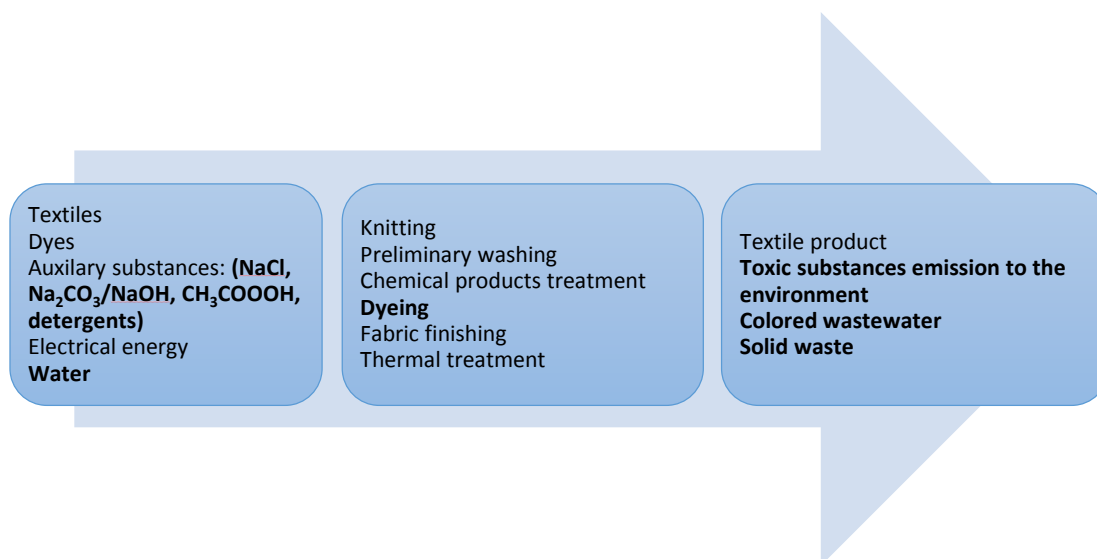


Figure 1. Selected raw materials, technological processes and products created in textile processes, considering the places where dyes are used and the formation of colored wastewater.

Source: own elaboration.

2.3. The environmental impact of production waste

Currently, the textile industry is considered the most water-intensive and energy-intensive. The volume of wastewater generated in factories dealing with the processing and finishing of fabrics (including dyeing and modification to give specific properties) may reach values from 100 dm³/kg of raw material for artificial fibers, up to over 300 dm³/kg for woolen products. In addition, 90% of the amount of water used produces sewage, and the remaining 10% is

evaporated or disposed of with fiber (Anielak, 2002). World production of textile products reaches 40 million Mg/year, which results in the generation of 4-8 million m³ of sewage containing dyes (Wang et al., 2004). The European Parliament estimates that the textile industry is responsible for around 20% of global clean water pollution due to dyeing and finishing processes.

Colored wastewater that enters the aquatic ecosystems causes the color of the water, which reduces the photosynthesis process, and as a result, oxygen deficit conditions may arise in the ecosystem. They also have a direct or indirect negative effect on all levels of the ecosystem's trophic chains. The breakdown of azo dyes by aquatic microorganisms can generate DNA adducts, which changes their genetic code (Bell et al., 2010). Synthetic dyes that get into the environment in the form of industrial wastewater pose a serious threat not only to organisms found in aquatic ecosystems but are also not indifferent to higher organisms such as mammals, including human health. They can also be carcinogenic and mutagenic (Attia et al., 2006; Aravindhana et al., 2007). As shown in the literature (Amin et al., 2010), rats administered orally with aqueous solutions of the two azo dyes Tartrazine (dose 15 or 500 mg/kg body weight) and Kamizine (dose 8 or 100 mg/kg body weight) showed insufficiency multi-organ system – especially the liver and kidneys. The research showed that both pigments change the biochemical markers of the liver and kidneys and induce oxidative stress through the formation of free radicals. Moreover, Sudan 1 azo dye is considered carcinogenic to the liver and bladder of mammals, including humans, and Sudan 2 dye is considered genotoxic to rat liver cells (Xu et al., 2010). Therefore, tests for determining toxicity play a very important role in environmental protection.

Due to the ionic nature of the pigments, the adsorption process takes place in soils, and in aqueous solutions the process of complete or partial dissociation takes place. The solubility of non-ionic azo dyes is lower than that of ionic dyes, which is related to their low mobility in soil and sediments, so that dyes will accumulate in the surface layers of the soil (Baughman et al., 1991; Tabaraki et al., 2007).

Another group of waste is solid waste in the form of cuttings, shavings, fibers or defective products, e.g. in 2018 according to Oakdene Hollins Report, the total amount of production waste generated in the EU countries was 9.35 million tonnes (Oakdene, 2014). During the production of textile products, large amounts of process waste are generated, which are sometimes purchased and sold to other companies or transformed into other products, e.g., Resyntex or Sinoma, but it is still done on a small scale. Moreover, often raw textiles purchased by intermediaries are not provided with reliable information from suppliers about the quantity, type and quality of agents applied to the fibers of the material (preparations, pesticides, knitting oils). Knowledge of such residual compounds on fabrics is very important as further environmental impacts can be controlled as it is known that these fabrics will be further processed. In the entire clothing industry in the EU, only 13% of the material used for production is recycled. In contrast, less than 1% of the material used in the production of

clothing is recycled into new clothing. Most of the recycling of materials consists in using them in other industries, e.g., insulation materials or fabrics for wiping or mattress fillings, but in this form, they are difficult to recover and therefore most likely it will be their last use (Interreg 2, 2018). In less developed industrially and economically, e.g., China or India, which are the main importers of clothing and textiles, such treatments are not practiced and, unfortunately, most of the textile waste ends up in landfills (Szewczyk, 2017). An example of this is the Atacama Desert in Chile, where 60 000 tons of old clothes are deposited there every year, the decomposition time of which can be up to 200 years (Bankier.pl, 2021).

What's more, during pre-washing of the finished product and when washing synthetic clothes, every year as much as half a million microfibers end up in the seas and oceans. Washing of synthetics accounts for 35% of the primary microplastics released into the environment, e.g., when washing polyester, 700 000 microfibers may be released and can get into the food chain and accumulate in the trophic chain, even in man as the final consumer (Boucher, 2017; European Parliament, 2020).

The last type of waste is gaseous waste - mainly carbon dioxide. According to the European Parliament's data, the clothing industry is responsible for 10% of global CO₂ emissions - much more than emissions from international flights and shipping, inclusive. According to the World Environment Agency's in 2017 purchases of textiles in the EU resulted in the emission of 654 kg CO₂ per person (European Parliament, 2020).

A summary of the places where production waste is generated along with the percentage of its management is shown in Figure 2.

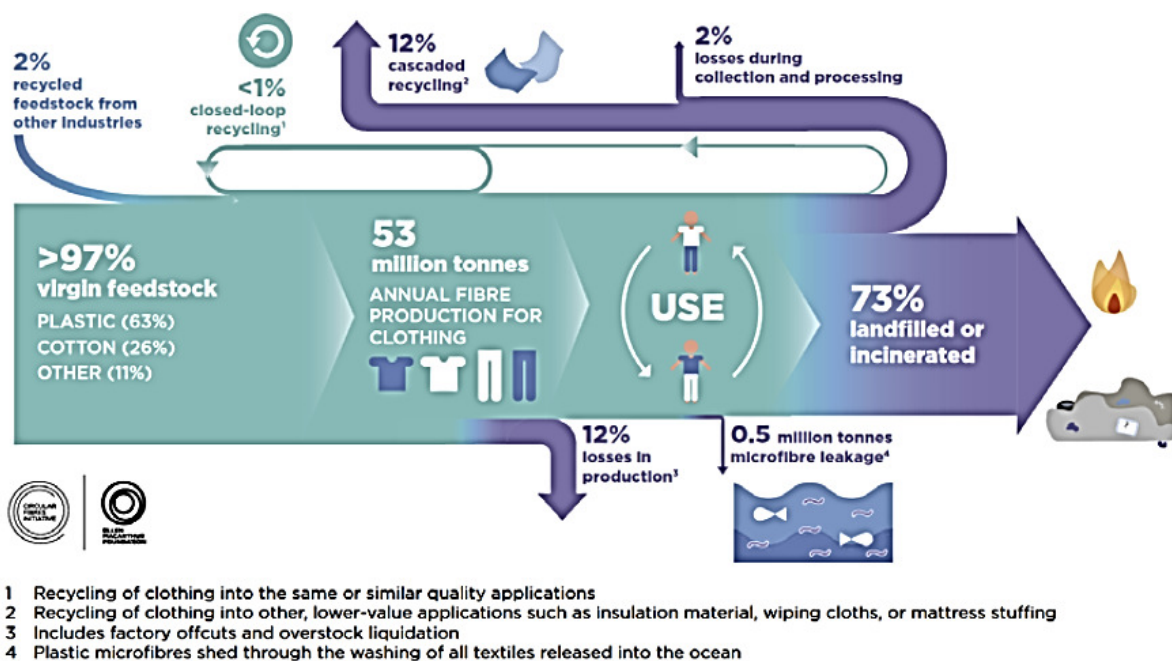


Figure 2. Global material flows for clothing in 2015.

Source: Wicker, 2016.

3. The concept of sustainable development

“Sustainable development is one in which the needs of the present generation can be met without compromising the chances of future generations to meet them” (World Commission Report, 1987). One of the main challenges facing the textile and clothing industry is more efficient management of natural resources (non-renewable) and increasing the innovation of waste recycling. The changes cover 3 spheres of life:

- economic (prosperity) – reducing the costs of raw materials and energy consumption and waste disposal, creating new business networks, which gives new market opportunities,
- environmental (planet) – optimization of the consumption of natural resources, reduction of environmental impact and reduction of gas emissions, avoiding landfilling, recovering energy from waste,
- social (people) – raising the standard of living, more green jobs (increase in employment).

To strive for a more sustainable development, the activities of the textile and clothing industry should focus on (Oakdane 2014, Zitting, 2017, Safer, 2018):

- a. changing the logistics of collection and transport of materials for recycling – new business models, new waste collection schemes,
- b. acquiring new stakeholders – creating new companies that will deal with the processing of e.g., synthetic fibers into natural ones,
- c. exchange of information on the development of recycling technologies – perhaps replacing mechanical treatment with chemical treatment will allow to obtain more valuable materials and use them later,
- d. automating the sorting and identification of fibers – exact knowledge and the identification of the chemical and structural composition of the textile waste stream is necessary for the efficient processing of the fibers and maintaining them in a better quality,
- e. systematization of information on waste and traceability – knowledge of the materials and chemicals used in textiles and clothing during production would allow for safer subsequent management of the given fiber,
- f. financing – costs are a significant barrier for various companies to expand their research and update recycling technologies. Therefore, mutual assistance and cooperation of government, companies and universities can help in the development of technology,
- g. measuring and distributing chemicals – accurate measuring and dosing of chemicals and dyes will allow for the optimal use of these compounds without using them in excess,

- h. selection and use of chemicals and dyes – considering the need to use a given auxiliary agent or dye, replacing chemicals with products with higher biodegradability, lower toxicity, lower emissions to air and a milder odor,
- i. using appropriate equipment – in the case of surfactants or anti-foaming agents, the use of devices with lower air entrainment will reduce the foaming of the agents.

Consumers can also themselves influence the quantity and quality of clothes and textile products produced by:

- a. education and promotion of a minimalist approach of consumers to the clothes they buy - consumers will buy less clothes, their purchases will be more thoughtful, and the clothes they choose will be more universal and functional. This is the so-called slow fashion. All these treatments should reduce the amount of clothes produced, and thus the amount of waste generated,
- b. re-use of worn-out clothes – this is extending the life of a given product by repairing, mending, sewing, or modifying it (shortening, narrowing). There are also companies offering the possibility of selling and buying their belongings (e.g., Vinted) and secondhand shops. You can also give used clothes to the poor (Wtórpol containers, PCK).
- c. recycling – processing of used clothes, scraps of materials, cuttings, and other waste into new fibers of comparable value.

The eco-design trend is part of the concept of sustainable development. It is an approach to design that considers its environmental impact throughout the entire life cycle of a product. It concerns design that minimizes the harmful effects of the production and use of products on the environment. The concept of eco-fashion is directly related to the concept of eco-design. Eco-fashion products are characterized by (Muthu, Gardetti 2016; Gwilt, Rissanem, 2011):

- the use of organic raw materials grown without pesticides,
- the use of textiles without the use of chemicals and bleaches,
- reusing recycled materials or fibers,
- durability and quality so that consumers can keep them for longer,
- considering the principles of fair trade.

4. Summary and conclusion

At every stage of production, dyeing and repeated use of colored products, contaminants are created that get into sewage, surface waters and soil. The tanning, food, paper, and cosmetics industries are responsible for generating large amounts of colored pollutants, but the largest amounts of colored wastewater are produced by the textile industry (4-8 million m³/year). Coloring substances belong to the compounds that are difficult to biodegrade and are not

susceptible to light and temperature and other chemicals. It has been shown that even partial biodegradation of dyes can result in the formation of many harmful and toxic products. Problems during dyeing such as excess dyes used, their residues in dyeing baths, or the loss of dyes in the subsequent stages of fabric processing, affect the release of dyes to the wastewater, and in combination with the insufficient effectiveness of conventional treatment methods, may cause the degradation of the aquatic environment.

In addition to dyes, waste from the textile and clothing industry is a big problem, i.e., scraps, selvedge, fibers, fluff, and dust. In less developed countries, they are not properly managed, but deposited in landfills, which poses a threat to environmental protection. What's more, in contact with water (e.g., washing of synthetic materials), they release huge amounts of microfibers that get into the seas and oceans, causing accumulation in living organisms, not only in marine but also in humans.

The high carbon dioxide emissions are also a big problem with a huge carbon footprint, even greater than the CO₂ emissions of the aviation and maritime industries.

The textile and clothing industry is the second most water-absorbing and energy-intensive from all industries, besides the oil processing industry. It also produces a very large amount of production waste as well as colored wastewater along with chemicals from the fabric finishing processes, which are very difficult to clean and use later. Therefore, the textile and clothing industry should be more consistent with the concepts of sustainable development. Textile wastewater treatment processes as well as methods of collecting and recycling production waste in developed countries are at the crawling stage, while in less developed countries they are usually absent, and colored wastewater and wastes are deposited directly in the environment (discharge into rivers or landfills). Therefore, further directions of the textile and clothing industry should be related to the concept of sustainable development. Financial and administrative relief from the state would encourage industry to develop technical developments in the treatment of production and textile waste, as well as waste management and recycling. The next step could be the creation of well-functioning production waste collection systems and cooperation with other collection companies. Additionally, international expert networks and platforms can be developed that will enable the matching of textile waste. The next step may be to move towards a circular economy and eco design. All these activities would be aimed at slowing down the growth rate of the consumption of natural resources and the consumption of secondary raw materials.

This article presents some of the many solutions for the management of production waste, which can be the basis for introducing changes aimed at including the textile and clothing industry in the concept of sustainable development. The presented solutions apply not only to the industry itself, but also to consumers, which proves that every person in their home, with a few small choices, can affect the environment. Recycling of production waste is strongly related to innovation and the development of enterprises, so by following the path of sustainable development, you can contribute to the development of new technologies and have a positive impact on the economy and the surrounding natural environment.

References

1. Amin, K.A., Hameid, H.A., Abd Elstar, A.H. (2010). Effect of food azo dyes tertrazine and carmoisine on biochemical parameters related to renal, hepatic function and oxidative stress biomarkers in young male rats. *Food and Chemical Toxicology*, Vol. 48, Iss. 10, pp. 2994-2999, doi: 10.1016/j.fct.2010.07.039.
2. Anielak, A.M. (2002). *Chemiczne i fizykochemiczne oczyszczanie ścieków*. Warszawa: PWN.
3. Aravindhnan, R., Rao, J.R., Nair, B.U. (2007). Removal of basic yellow dye from aqueous solution by sorption on green alga *Caulerpa scalpelliformis*. *Journal of Hazardous Materials*, Vol. 142, Iss. 1-2, pp. 68-76, doi: 10.1016/j.jhazmat.2006.07.058.
4. Attia, A.A., Rashwan, W.E., Khedr, S.A. (2006). Capacity of activated carbon in the removal of acid dyes subsequent to its thermal treatment. *Dyes and Pigments*, Vol. 69, Iss. 3, pp. 128-136, doi: 10.1016/j.dyepig.2004.07.009.
5. Bankier.pl. Retrieved from: <https://www.bankier.pl/wiadomosc/Wysypisko-smieci-dla-swiata-Co-roku-trafia-tu-60-tys-ton-starych-ubran-8275336.html>, 25.08.2022.
6. Baughman, G., Weber, E.J. (1991). Estimation of water solubility and octanol/water partition coefficient of hydrophobic dyes: Part I: Relationship between solubility and partition coefficient. *Dyes and Pigments*, Vol. 16, Iss. 4, pp. 261-271, doi: 10.1016/0143-7208(91)85016-2.
7. Bell, J., Plumb, J.J., Buckley, C.A., Stuckey, D.C. (2010). Treatment and decolourization of dyes in anaerobic baffled reactor. *Journal of Environmental Engineering*, Vol. 126, pp. 1026-1032, doi: 10.4314/wsa.v29i2.4847.
8. Boucher, J., Friot, D. (2017). *Primary microplastics in the oceans: A global evaluation of sources*. International Union for Conservation of Nature and Natural Resource (IUCN), Gland.
9. Ellen MacArthur Foundation, Retrieved from: <https://ellenmacarthurfoundation.org/towards-a-circular-economy-business-rationale-for-an-accelerated-transition>, 25.08.2022.
10. *Encyklopedia PWN*. Retrieved from: <https://encyklopedia.pwn.pl>, 23.08.2022.
11. *European Parliament*. Retrieved from: <https://www.europarl.europa.eu/news/pl>, 25.08.2022.
12. Fischer, A., Pascucci, S. (2017). Institutional incentives in circular economy transition: The case of material use in the Dutch textile industry. *Journal of Cleaner Production*, Vol. 155, Iss. 2, pp. 17-32, doi: 10.1016/j.jclepro.2016.12.038.
13. Gwilt, A., Rissanem, T. (2011). *Shaping Sustainable Fashion: Changing the Way We Make and Use Clothes*. Routledge. ISBN-13: 978-1849712422.
14. *InterregI*. Retrieved from: <https://iw.lukasiewicz.gov.pl/wp-content/uploads/2021/07/Broszura-ENTER.pdf>, 28.08.2020.

15. *Interreg2*. Retrieved from: <https://www.interreg-central.eu/Content.Node/Strategic-Agenda.pdf>, 25.08.2022.
16. Kramarczyk, J. (2015). Mieć czy być? Minimalizm jako przykład świadomej konsumpcji w świetle badań własnych. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Vol. 414*, pp. 270-286, ISBN 978-83-7695-570-4.
17. Le, K., *Circle Textiles Program*. Retrieved from: <http://www.circle-economy.com/textiles>, 24.08.2022.
18. Meinck, F., Stoff, H., Kohlschütter, H. (1975). *Ścieki przemysłowe*. Warszawa: Arkady.
19. Mihałka, M. (2003) *Charakterystyka technologiczna przemysłu włókienniczego w Unii Europejskiej*. Warszawa: Ministerstwo Środowiska.
20. Muthu, S.S., Gardetti, M.A. (2016). *Green Fashion, Vol. 2*. Springer. ISBN-13:978-9811002441.
21. Oakdene, H. (2014). *Apparel and Footwear Recycling Innovation*. Sustainable Apparel Coalition.
22. Safer, M. (2018). *Safer Chemistry Innovation in the Textile and Apparel Industry*. Barkley: Fashion for Good.
23. Szewczyk, M. (2017). Szanse na rozwój gospodarki okrężnej w przemyśle tekstylnodzieżowym. Repozytorium Uniwersytetu Łódzkiego. *Gospodarka w praktyce i teorii, Vol. 3, Iss. 48*, pp. 57-67, doi: 10.18778/1429-3730.48.05.
24. Szosland, J. (1981). *Podstawy dziewiarstwa*. Warszawa: WNT.
25. Tabaraki, R., Khayamian, T., Ensafi, A.A. (2007). Solubility prediction of 21 azo dyes in supercritical carbon dioxide using wavelet neural network. *Dyes and Pigments, Vol. 73, Iss. 2*, pp. 230-238, doi: 10.1016/j.dyepig.2005.12.003.
26. Wałętrzak, G. (2016). Odpady tekstylne i włókiennicze – wartościowy surowiec czy problematyczna pozostałość. *Logistyka Odzysku, Vol. 4*, pp. 18-20, ISSN 2083-6422.
27. Wang, L.K., Hung, Y.-T., Lo, H.H., Yapijakis, C. (2004). *Handbook of industrial and hazardous wastes treatment. Treatment of textiles wastes*. NY: Marcel Dekker.
28. Wicker, A. (2016). Fast fashion is creating an environmental crisis. *Newsweek*.
29. *World Commission Report*. Retrieved from: <https://www.gov.pl/web/rozwoj-technologie/zrownowazony-rozwoj>, 26.08.2022.
30. Xu, H., Heinze, T.M., Paine, D.D., Cerniglia, C.E., Chen, H. (2010) Sudan azo dyes and Para Red degradation by prevalent bacteria of the human gastrointestinal tract. *Anaerobe, Vol. 16, Iss. 2*, pp. 114-119, doi: 10.1016/j.anaerobe.2009.06.007.
31. Zitting, J. (2017). Optical sorting technology for textile waste: Development of an identification method with NIR spectroscopy, Bachelor's Thesis. Lahti: Lahti University of Applied Sciences.

COORDINATION OF TRANSPORTATION OPERATIONS BY 3PL BASED ON REAL-TIME CLOUD DATA

Mariusz KMIECIK

Silesian University of Technology; mariusz.kmiecik@polsl.pl, ORCID: 0000-0003-2015-1132

Purpose: Main aim of the following paper is to present the conception of logistics coordination from the point of view of transportation actions from the perspective of the international 3PL company.

Design/methodology/approach: In the paper used the case study based on the case of chosen international 3PL, where the distribution network was analyzed.

Findings: 3PL is able to support the transportation planning operation in the considered distribution network by using a developed cloud-based infrastructure that supports demand forecasting tool and transportation planning.

Originality/value: Paper connects the one function of logistics coordination – transportation planning – with the demand forecasting tool and the issues of 3PL. It is also shown the case study with implemented solution based on cloud infrastructure to support the transportation operations.

Keywords: 3PL, logistics service provider, distribution network, transportation, logistics coordination.

Category of the paper: case study.

1. Introduction

Transportation is considered one of the most energy-consuming activities in the whole supply chain (Halldorsson et al., 2020) but on the other hand, it is also one of its main components (Paul et al., 2020). An appraisal of prior studies on the types of logistics services indicated that the most common service attributes were related to warehousing, logistics value-added services, information service, financial service, and transportation (Kuo et al., 2020). Transportation is one of the most common outsourced functions in the supply chains (Multaharju, Hallikas, 2015) and also is one of the most visible operations in logistics (Lin, 2008). Operation connected with breaking the distance barriers and responsible for providing the goods in the proper places and time.

Transportation in the context of order delivery or distribution is the primary function of logistics in a supply chain. The growing demand for this type of service gave birth to the emergence of 3PL (Robas et al., 2020). Over the two last decades, the logistics service providers and logistics state the essential to develop the supply chains and logistics networks (Ashrafian et al., 2019). 3PL could be defined as an external supplier that performs or manages the performance of all or part of a company's logistics functions (Langley, 2020). What is important, the 3PL should also be able to create value in logistics processes. In the following article, the 3PL will be used repeatably with a logistics service provider (LSP) and third-party logistics. The author is aware of some literature differences between LSP and 3PL but decided to not divide these two creations separately. Companies that outsourced the logistics activities to 3PL could expect a more efficient and cost-effective process than the others (Robas et al., 2020).

Even in the nowadays conceptions like omnichannel distribution, the transportation issues like delivery efficiency and costs are the most exploited areas (de Borba et al., 2020; Lin et al., 2022; Mishra et al., 2021). This trend (which is still very popular in different markets, even in the case of groceries (Ehrler et al., 2021)) is also seen in the different types of multichannel distribution like online-to-offline (O2O) (Lafkihi et al., 2019). The other factors which are also still important in contemporary logistics are location problems, vehicle routing, and last-mile delivery (Bayliss et al., 2020; Bergmann et al., 2020). Current turbulent surrounding (implicated for example by COVID-19 pandemic) also has a strong impact on the transportation industry (Hu et al., 2022). The following article connects the issues of 3PL activity in nowadays market in the conception of logistics coordination with a special emphasis on transportation operation. Paper also try to answer to the following research questions:

RQ1: Which kind of process flow is needed for cloud solution for support the transportation operation in distribution network by 3PL?

RQ2: Which kind of data are needed for support the 3PL actions in the case of transportation planning?

and verifies the following hypothesis:

H1: 3PL is able to support the transportation planning operation in the considered distribution network.

Research questions, hypotheses, and methodology are discussed in more detail in the methods section and they were elaborated based on the author's conception connected with logistics coordination (the logistics coordination concept is shown, among others, at Kmiecik (2022)). Which assumes the 3PL as the main node to taking the function of logistics coordination in distribution networks using a mechanisms (market, social and hierarchic) of network coordination and conducting the actions connected with demand management, transportation planning, inventory management, resource planning, demand forecasting in the support of contemporary technology achievements.

2. Logistics service providers (3PL) in nowadays market

2.1. Transportation coordination by 3PL

Nowadays, we are dealing more and more often with the one delivery day standard in transport operations (Grzelak et al., 2019). Logistics operators are struggling with the need to meet the increasingly demanding order deadlines, especially in the area of road distribution. As highlighted by some authors, 3PL, through appropriate transport planning, can reduce flow times and reduce inventory levels (Wang et al., 2020a) by increasing the speed of reaction and eliminating the need to maintain high safety stocks. Companies outsourced not only the traditional logistics services but also managerial activities, so logistics providers have developed both services to fulfill the market requirement (Fabbe-Costes et al., 2009) and still looking forward to gathering the new skills and offering the new services to their contractors. Usage of 3PL could lead to reducing the disruptions in logistics in a more easy way (Nel et al., 2018). Coordinated actions in this area may also lead to the shortening of transport routes and bring savings (Wang et al., 2020b). Currently, an increasingly important criterion is also the ability of the operator to meet the assumptions of sustainable development, CO₂ emissions, and adaptation to modern solutions related to, for example, Smart Cities in the area of urban logistics in the long term. (Kramarz et al., 2020).

The trend of e-commerce did not reduce the meaning of brick-and-mortar point of sales (POS) (Lin et al., 2022), so the traditional transportation issues are still very important even in reality when literature focuses mostly on last-mile deliveries. Transport operations, and in particular the ability to carry them out efficiently and flexibly, play a significant role in the coordination of the distribution network.

In addition, many companies from the 3PL group provide transport services. There are so many of these enterprises that the problem becomes the choice of the right operator to provide transport services - hence, numerous mathematical models appear in the literature, which is used to assess and select the operator. According to the research (figure 1) in about 90% of cases, the 3PL are treated as a member of supply chains, and in 80% of cases, the supply chain members thought that they need to integrate with the other chain nodes. What is interesting only about 50% of supply chain members think that 3PL contributes to chain performance.

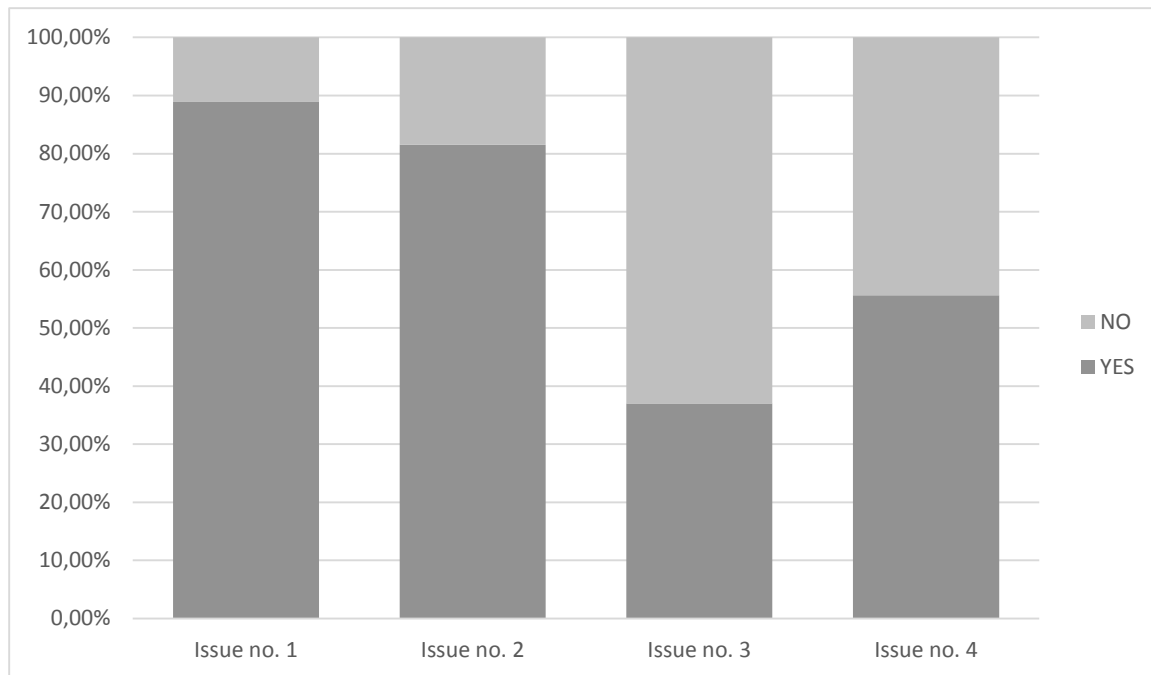


Figure 1. Logistics services providers in supply chain.

Source: (Fabbe-Costes et al., 2009).

It is hard to achieve coordination in the supply chain while considering the transportation costs separately to the whole operational activity and the lack of coordination between transportation companies leads to insufficient logistics efficiency (Hu et al., 2022). The interesting model presented by Yayla et al. (2015), distinguishes three main criteria for assessing the operator's ability to perform transport services efficiently: possibility of developing sustainable cooperation, which mainly manifests itself in generating low transport costs, good financial condition, correct reputation and showing similar values between enterprises; ensuring an appropriate level of service quality, which is mainly manifested in keeping the on time delivery ratio at a high level, speed of response and reliability of deliveries and the ability to continuously improve, mainly related to technological sophistication, solid infrastructure and the ability to optimize operations

Undoubtedly, these criteria must be considered when choosing an operator that will be able to coordinate the company's activities in the distribution network. Of course, not every operator who is able to provide transport services can coordinate the flows, but the ability to plan and organize transport operations is, according to the author, one of the necessary requirements for the implementation of the assumptions resulting from logistic coordination.

2.2. Contemporary challenges of 3PL in transportation operations

Transportation is stated as one of the main components of the operational aspect of supply chain activities (Paul et al., 2020). Even in the nowadays market usage of effective transportation routes provides the possibility of achieving competitive advantages for companies (Abbasi et al., 2020). Driver shortage may negatively affect an LSP's competitiveness. It could influence the price and on-time delivery; as driver pay increases due to the shortage, it significantly impacts the fleet. Transportation capacity shortage is a significant problem in the modern transportation and logistics industry (Wang et al., 2020c). Contemporary transportation needs to handle massive, high-frequency volumes characterized by short lead times and a high level of fluctuation (Lafkihi et al., 2019).

One of the most important challenges is adjusting the transportation structures to last-mile deliveries due to rapid urbanization and the development of mass transit systems (Halldorsson et al., 2020; Shu et al., 2021).

3PL which focuses on standard solutions may lose significant market share shortly, management-related 3PL actions seem to be the time more existing by new external competitors. Digitalization enables the forward or backward combination of 3PL customers and suppliers when they establish their services. Digital technology reduces labor cost by streamlining data imprisonment and dropping error (Ruthramathi, Sivakumar, 2020). Digitalization and technology is also one of the most common issues in the transportation industry (the rest are environment, government, roads, financial, cold chain, and legal) (Mangla et al., 2019).

Different issue, connected also with digitalization is Big Data in transportation. Handling with Big Data is different in the comparison of standard data because of three main factors: data volume, data velocity and data variety (Torre-Bastida et al., 2018). Big data analytics allows the processing of voluminous data from multiple sources to create meaningful insight not only on customer satisfaction but, among others, transportation management (Jagtap et al., 2020). Innovation can reinforce competitive advantage for companies in markets where customer preferences change rapidly, where differentiation is limited, and where competition is intense (Lin, 2008).

One of the most trendy issues in transportation is the usage of Collaborative Transport Management (CTM). CTM could be defined as the collaboration in the transportation area, notably among truckload transportation. The goal of the CTM is the "win-win-win" outcomes to all the parties involved in the collaboration and it is aimed to reduce inefficiency, avoid logistics bottlenecks as well as to provide mutual benefits to all parties (Sitadewi et al., 2018). CTM was initially developed to complement CPFR (Collaborative Planning, Forecasting, and Replenishment).

The fact that logistic operators can coordinate and perform transport operations in distribution networks is influenced, among others, by the fact that these enterprises usually either have TMS (Transport Management System) class systems or have an easy ability to adapt such systems to their structures (Melanici et al., 2013). Also, a popular solution is information and communication technologies (ICT) which support transportation in the field of intelligent cargo, intelligent containers, and intelligent trucks (Liu, Ke, 2022; Nemoto, Tezuka, 2002; Tran-Dang et al., 2022). Transportation cyber-physical systems (TCPS) integrate cyber systems and physical systems using communication networks, and they interact with each other to support various applications (Deng et al., 2020) and they are also shown as a future of transportation and is connected with the rapid development of IoT (Internet of Things) provides the opportunity to solve some common problems in transportation connected with decision-making and information asymmetry (Xu et al., 2019). Contemporary solutions which support the transportation activity should be the answer for fragmented and fluctuant volume, high-speed flow, variety of delivery points, direct to customer requirements and should act in the fierce competition, low margin environment, strict constraints and regulations and the problem of drivers shortage (Lafkihi et al., 2019). Robotics is also commonly seen in transportation (Jagtap et al., 2020) like the solutions connected with sharing economies, crowd shipping, horizontal cooperation, dynamic delivery systems, and online marketplaces (Lafkihi et al., 2019).

The solution which is also really important in nowadays companies' activities is cloud technology. Cloud computing plays an instrumental role in this endeavor by storing, processing and transferring the enormous amounts of data generated by various types of said sensors, in the cloud instead of the connected devices (Agalianos et al., 2020). Cloud solutions usually supports the information and ICT in transportation (Deng et al., 2020; Tran-Dang et al., 2022). Cloud-based real-time data provides information regarding to location of objects, parameters and transportation surroundings (Agalianos et al., 2020). Traditionally, when using a server-based architecture, application developers need to establish a cloud server instance according to their computing requirements (Deng et al., 2020). One of the most important features of cloud computing is sharing the configurable resources among many users (cloud clients) flexibly with minimal management efforts (Xu et al., 2019). Google Cloud Platform (GCP) is stated as one of the most suitable software to cloud computing also in the case of transportation issues (Deng et al., 2020).

3. Methods

The research paper consists of a case study conducted on the chosen international 3PL company with showing the implementation case of a cloud-based solution for support transportation planning proposed by the author (figure 2).

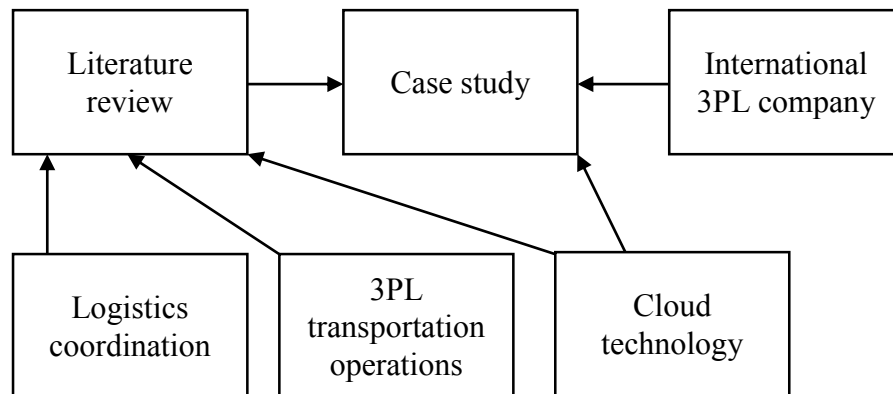


Figure 2. Main research steps.

Source: own elaboration.

Proposed solution based strictly on data analysis. This kind of solutions in the conditions of transportation improvement are described as one of the most important issues (Shu et al., 2021). Proposed solution and case study construction is shown at figure 3.

The case study focuses on 3PL company which is international logistics service provider and acting the logistics outsourcing activities for the manufacturers in distribution networks. The chosen 3PL provides goods directly to middlemen, customers or to POS (Points of Sales) – depends on the distribution network. Also, in one network, 3PL could provide the goods and services to the few kinds of recipients – depends also on network specification and configuration. In the chosen case the 3PL the case of road transportation services to POS is analyzed. Currently, the 3PL actions in the area of transportation are supported by TMS (Transport Management System) which is used for transportation planning and fleet control. Information which are taken into consideration are the information about quantity and capacity of own transportation fleet. So the main considerate issue in this case is the current information about road fleet capacity. TMS data, in the author proposition, are supported by demand forecasting tool to achieve the planned result of tool for transportation coordination. Demand forecasting tool is the concept created by the author (more specific information could be found, among others, at Kmiecik (2022) and Kramarz and Kmiecik, (2022)) which is under the implementation in the few distribution network where chosen 3PL provide the services. Modified version assumed the TMS support will be presented in the further part of following paper.

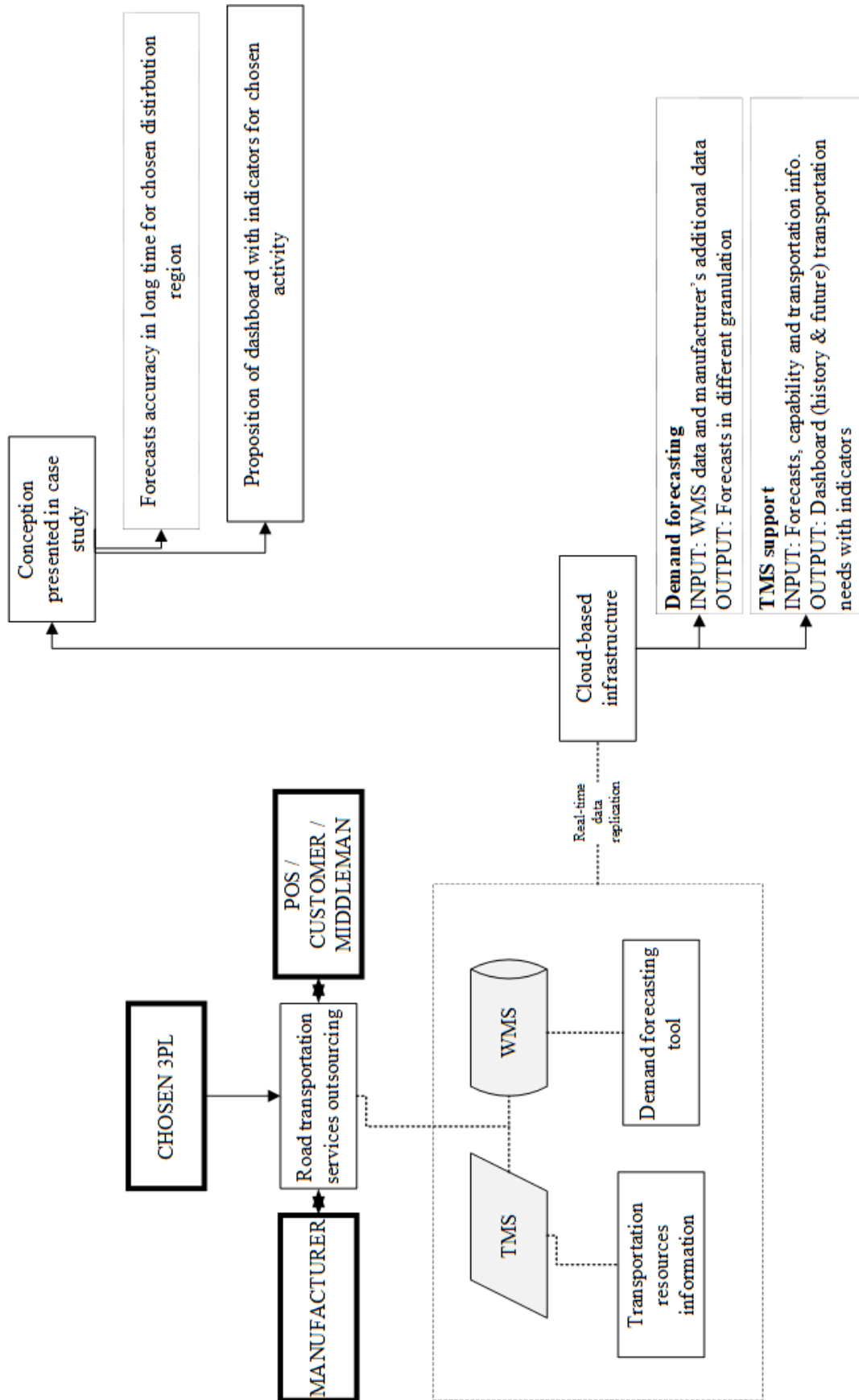


Figure 3. Case study construction.

Source: own elaboration.

Whole tool, proposed by the author, will be settled in the cloud-based infrastructure. The chose of this kind of technology will be dictated by its functionality and easy access to real-time data which support the fast decision-making process. Data set consist of daily data about regions (postal codes) of distribution, quantities of distributed pallets (e-pal) and dates of movements. Data are limited only for one country of distribution (Poland), one point of distribution (one of warehouse of 3PL), one customer (manufacturing company which provide goods to POS) and one type of goods according to transportation requirements (goods which could be handled on e-pal without additional requirements about transportation temperature). General data set consists of data from January 2012 to June 2021 and is presented at figure 4.

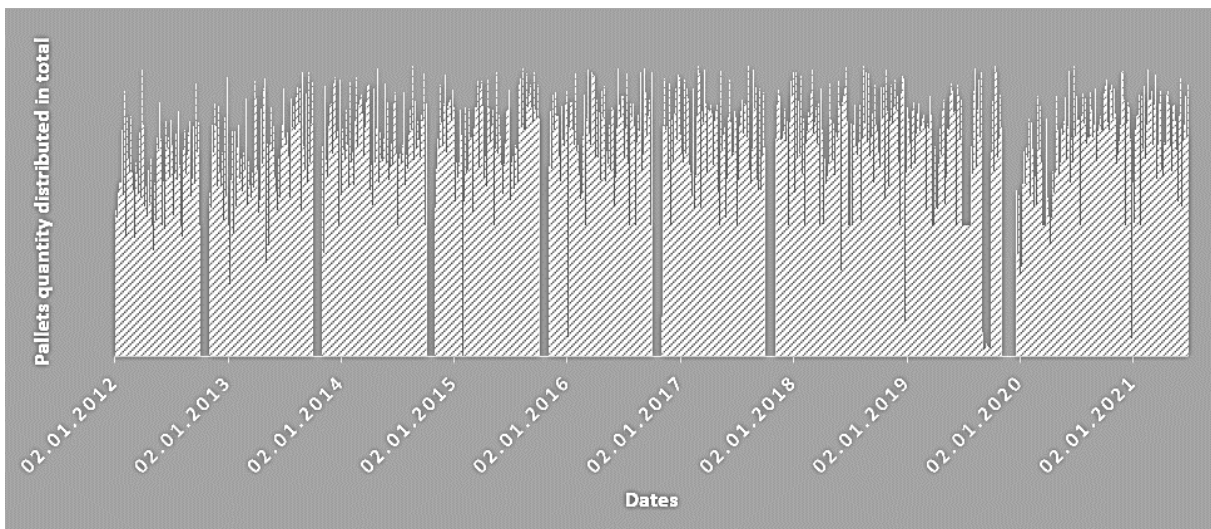


Figure 4. General data set.

Source: own elaboration.

The following data are analyzed according to the logic presented at figure 5.

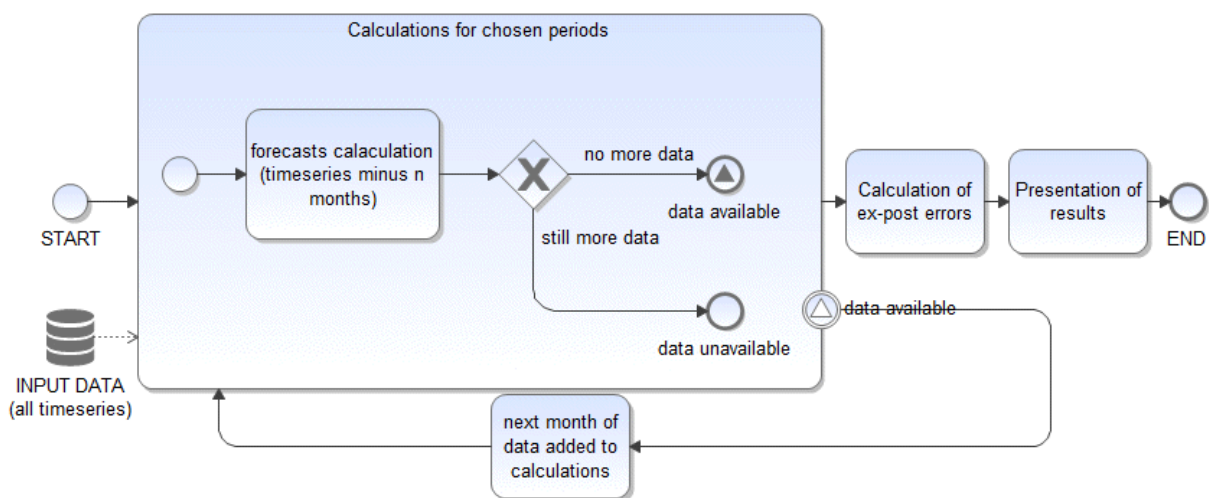


Figure 5. Data analysis general logic.

Source: own elaboration.

Analysis of chosen data set considers the dividing data into 6 sub sets and creating the forecasts for each of this data set. Creating a forecast is supported by the conception of adding the TMS data and creating the dashboard to present the results and support the decision makers in the field of transportation activity in the distribution network.

4. Results

The proposed tool is shown in figure 6 and assumes the usage of cloud-based real-time WMS data support. The user in this case uses the demand forecasting tool which is supported by TMS and WMS data to achieve the planned dashboard as a managerial tool for better coordination the transportation.

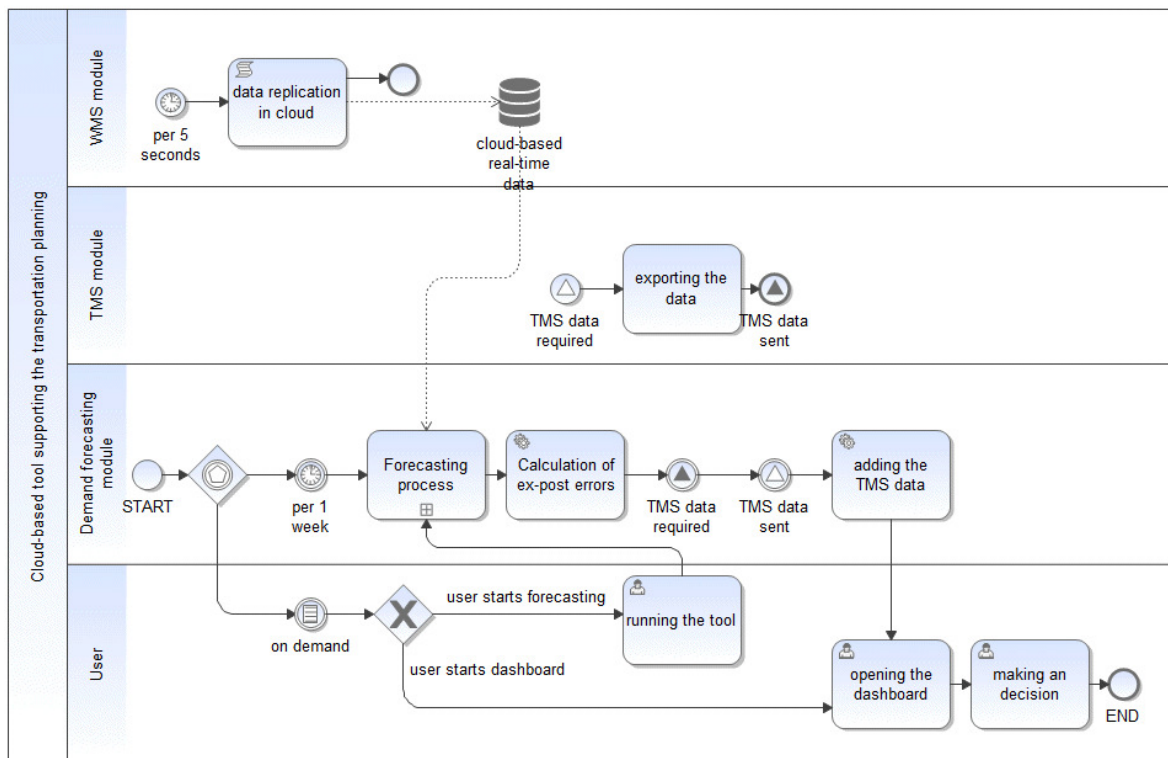


Figure 6. Transportation supporting tool – concept (simplified version).

Source: own elaboration.

Forecasts are updated once per week automatically or on demand by the user. TMS data support the final dashboard by the information about possible extensions in transportation capacity and giving information about the available vehicles. As a measure for accuracy the RMSE (root mean square error) was chosen. RMSE was calculated in the EUR1 (1200x800 [mm]) pallets dimension by using a following equation:

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (\hat{y}_i - y_i)^2},$$

where:

N – number of observations,

\hat{y}_i – historical quantity of distributed pallets (pallets spaces in EUR1) in period I ,

y_i – forecasted quantity of distributed pallets (pallets spaces in EUR1) in period i .

Results for six months were shown in table 1. Additionally, there is also shown the average accuracy for mentioned months. For simplification, each month is stated as four weeks.

Table 1.
Forecasting tool accuracy

Week	Accuracy [%]					
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
1	6,59%	9,13%	10,14%	4,68%	4,92%	8,41%
2	9,34%	10,39%	2,10%	1,04%	10,11%	7,49%
3	5,96%	3,75%	1,93%	6,22%	12,02%	5,77%
4	8,00%	9,04%	6,96%	4,45%	4,79%	11,72%
Average accuracy [%]	7,47%	8,08%	5,26%	4,10%	7,96%	8,35%

Source: own elaboration.

The mean of the presented RMSE is equal to 6,17%, the median – 5,87%, and the standard deviation – 3,56% (it was presented in figure 7). Ranges of standard deviation up and down were calculated by adding or reducing the mean value by standard deviation.

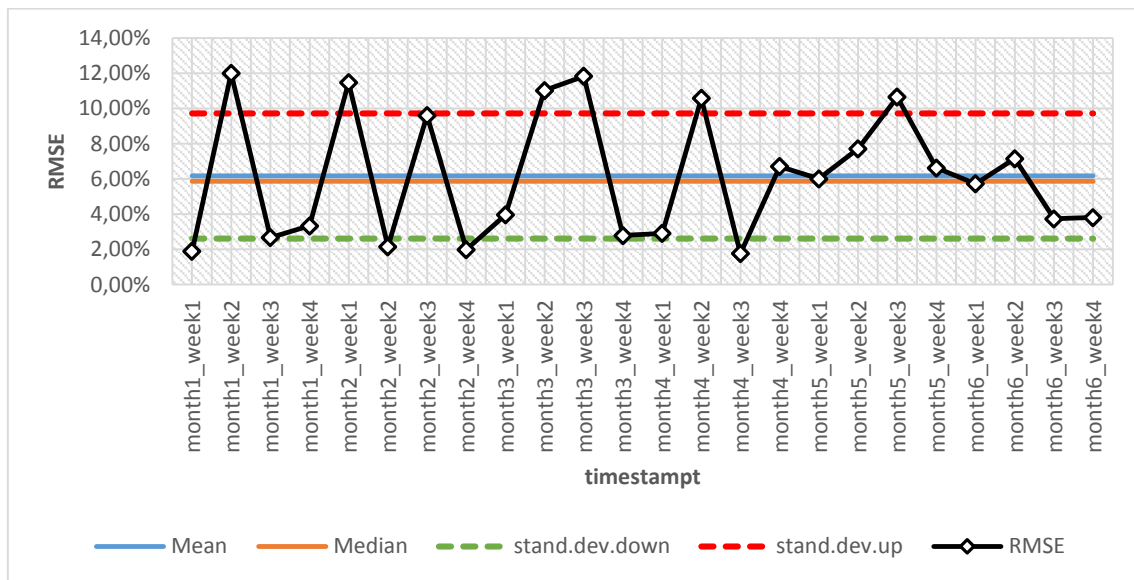


Figure 7. RMSE in the following periods.

Source: own elaboration.

Six of accuracy results were deviated for mean in the non-standard way, but generally it could be stated that accuracy is on relatively repeatable level. Forecasts could be additionally aggregated to the particular geographical region in the final dashboard. As a result, 3PL could be able to provide the early information about the future demand (in the pallets spaces point of

view) in the individual areas of distribution. Part of dashboard which supports the transportation planning process by in-formation about forecasts is showed in the figure 8.

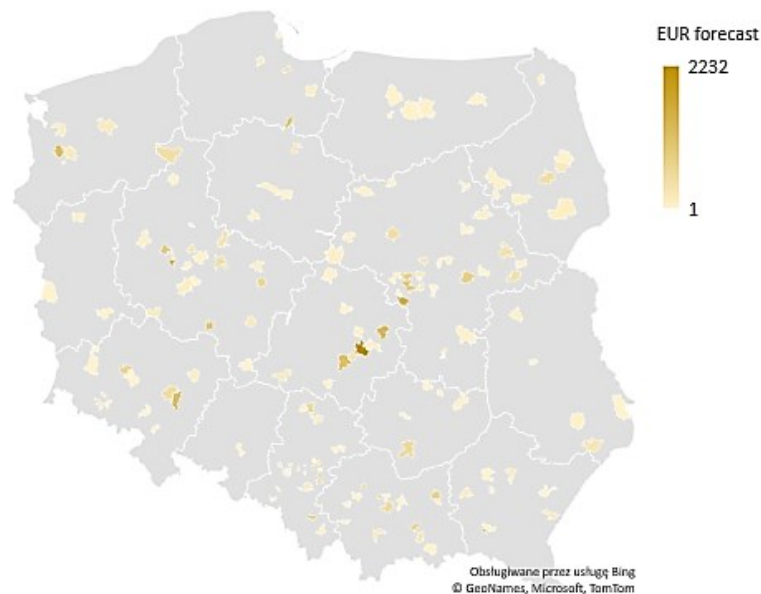


Figure 8. Forecasts information in the division to different geographical region.

Source: own elaboration in MS Excel & Bing.

Figure 7 shows the predicted demand information in EUR pallets quantities in the region of Poland. Thanks to this kind of solution the 3PL is able to modify the information about forecasts to knowledge about transportation demand.

5. Discussion

5.1. Transportation coordination by 3PL supported by demand forecasting

Demand forecasting tools could support coordination actions in the area of transportation in the distribution network. Transport operations, and in particular the ability to carry them out efficiently and flexibly, play a significant role in the coordination of the distribution network. The fact that logistic operators can coordinate and perform transport operations in distribution networks is influenced, among others, by the fact that these enterprises usually either have TMS class systems or have an easy ability to adapt such systems to their structures. Undoubtedly, these criteria must be considered when choosing an operator that will be able to coordinate the company's activities in the distribution network. Of course, not every operator who is able to provide transport services can coordinate the flows, but the ability to plan and organize transport operations is, according to the author, one of the necessary requirements for the implementation of the assumptions resulting from logistic coordination

On the other hand, in the logistics service industry, the most common issue is to keep the initiatives connected with environmental and sustainability issues (Cenrobelli et al., 2017), this, which was proven in much research, is leading to cost reduction and increasing sales (Marchet et al., 2014). In the author's opinion, the proposed solution also could have an influence on these two factors: sustainability and costs reduction. Better coordination in the area of transportation could allow to reduce the empty runs, increase the usage of truck loads and reduce the emergency transports

5.2. Is the 3PL enough for coordination?

Logistics operators (3PL) help the enterprise with meeting the increasingly growing customer requirements by generating added value in logistics processes. One of the most common barriers during development of collaboration with logistics operator are unreal requirements of enterprise which outsourced their processes to 3PL enterprise, because of their important meaning of nowadays markets and distribution networks, can contribute to shaping modern distribution networks, as well as perform more and more complex functions related to the provision of complementary services and often go beyond the logistics itself in order to gain a competitive advantage and provide their clients with appropriate conditions to co-create flexible and dynamic market systems in the form of reliable networks distribution. It is also to consider the role of 3PL, is it enough to talk about 3PL, or maybe we need to discuss of 4PL (fourth-party logistics)? 4PL is aimed more at strategic actions and knowledge (Multaharju, Hallikas, 2015) - logistics coordination could be also treated in this way. But in the author's opinion, the more practical case is to consider 3PL as a node able to take the function of logistics coordination in distribution networks. The reason for that is the larger number of 3PL in the market and the high probability of taking this function also by 4PL as the organization with the higher competency than 3PL, so if 3PL will be able to take this function there will be also some high probability that 4PL will be also able to do it.

5.3. Prospects for developing the conception

The usage of cloud infrastructure gives the possibility of achieving real-time data and accessibility to huge calculation power. The great access to data and prediction system could be also used for digital, computer models. It is also a good idea to support the cloud system with simulation software like Flexsim (Ashrafian et al., 2019) or to use additional Discreet Event Simulation or Digital Twins conception elements (Agalianos et al., 2020). In the case of transportation and logistics coordination could be consider as the models which support the 3PL by providing the models to check the transportation system in the real time and also could provide the interesting background for improving it.

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References

1. Abbasi, M., Rafiee, M., Khosravi, M.R., Jolfaei, A., Menon, V.G., Koushyar, J.M. (2020). An efficient parallel genetic algorithm solution for vehicle routing problem in cloud implementation of the intelligent transportation systems. *Journal of cloud Computing*, 9(1), 1-14.
2. Agalianos, K., Ponis, S.T., Aretoulaki, E., Plakas, G., Efthymiou, O. (2020). Discrete event simulation and digital twins: review and challenges for logistics. *Procedia Manufacturing*, 51, 1636-1641.
3. Ashrafiyan, A., Pettersen, O.G., Kuntze, K.N., Franke, J., Alfnes, E., Henriksen, K.F., Spone, J. (2019, September). *Full-scale discrete event simulation of an automated modular conveyor system for warehouse logistics*. IFIP International Conference on Advances in Production Management Systems. Cham: Springer, pp. 35-42.
4. Bayliss, C., Martins, L.D.C., Juan, A.A. (2020). A two-phase local search with a discrete-event heuristic for the omnichannel vehicle routing problem. *Computers & Industrial Engineering*, 148, 106695.
5. Bergmann, F.M., Wagner, S.M., Winkenbach, M. (2020). Integrating first-mile pickup and last-mile delivery on shared vehicle routes for efficient urban e-commerce distribution. *Transportation Research Part B: Methodological*, 131, 26-62.
6. Centobelli, P., Cerchione, R., Esposito, E. (2017). Environmental sustainability in the service industry of transportation and logistics service providers: Systematic literature review and research directions. *Transportation Research Part D: Transport and Environment*, 53, 454-470.
7. de Borba, J.L.G., de Magalhães, M.R., Filgueiras, R.S., Bouzon, M. (2020). Barriers in omnichannel retailing returns: a conceptual framework. *International Journal of Retail & Distribution Management*.
8. Deng, H.W., Rahman, M., Chowdhury, M., Salek, M.S., Shue, M. (2020). Commercial cloud computing for connected vehicle applications in transportation cyberphysical systems: A case study. *IEEE Intelligent Transportation Systems Magazine*, 13(1), 6-19.
9. Ehrler, V.C., Schöder, D., Seidel, S. (2021). Challenges and perspectives for the use of electric vehicles for last mile logistics of grocery e-commerce – Findings from case studies in Germany. *Research in Transportation Economics*, 87, 100757.

10. Fabbe-Costes, N., Jahre, M., Roussat, C. (2009). Supply chain integration: the role of logistics service providers. *International Journal of productivity and performance management*.
11. Grzelak, M., Borucka, M., Buczyński, Z. (2019). Forecasting the demand for transport services on the example of a selected logistic operator. *Archives of Transport, vol. 52*, pp. 81-93.
12. Halldorsson, A., Wehner, J. (2020). Last-mile logistics fulfilment: A framework for energy efficiency. *Research in Transportation Business & Management, 37*, 100481.
13. Hu, X., Fu, K., Chen, Z., Du, Z. (2022). Decision-Making of Transnational Supply Chain Considering Tariff and Third-Party Logistics Service. *Mathematics, 10(5)*, 770.
14. Jagtap, S., Bader, F., Garcia-Garcia, G., Trollman, H., Fadiji, T., Saloniitis, K. (2020). Food logistics 4.0: Opportunities and challenges. *Logistics, 5(1)*, 2.
15. Kmiecik, M. (2022). Logistics Coordination Based on Inventory Management and Transportation Planning by Third-Party Logistics (3PL). *Sustainability, 14(13)*, 8134.
16. Kramarz, M., Dohn, K., Przybylska, E., Knop, L. (2020). *Scenarios for the development of multimodal transport in the TRITIA Cross-Border Area, vol. 12*, pp. 7021
17. Kramarz, M., Kmiecik, M. (2022). Quality of Forecasts as the Factor Determining the Coordination of Logistics Processes by Logistic Operator. *Sustainability, 14(2)*, 1013.
18. Kuo, S.Y., Yang, C.C., Lai, P.L. (2020). Determining inland logistics service attributes: a case study of Chinese landlocked regions. *Maritime Business Review*.
19. Lafkihi, M., Pan, S., Ballot, E. (2019). Freight transportation service procurement: A literature review and future research opportunities in omnichannel E-commerce. *Transportation Research Part E: Logistics and Transportation Review, 125*, 348-365.
20. Langley, C.J., Novack, R.A., Gibson, B., Coyle, J.J. (2020). Supply chain management: a logistics perspective. Cengage Learning.
21. Lin, C.Y. (2008). Determinants of the adoption of technological innovations by logistics service providers in China. *International Journal of Technology Management & Sustainable Development, 7(1)*, 19-38.
22. Lin, Y.H., Wang, Y., Lee, L.H., Chew, E.P. (2022). Omnichannel facility location and fulfillment optimization. *Transportation Research Part B: Methodological, 163*, 187-209.
23. Liu, C., Ke, L. (2022). Cloud assisted Internet of things intelligent transportation system and the traffic control system in the smart city. *Journal of Control and Decision*, 1-14.
24. Mangla, S.K., Sharma, Y.K., Patil, P.P., Yadav, G., Xu, J. (2019). Logistics and distribution challenges to managing operations for corporate sustainability: study on leading Indian dairy organizations. *Journal of Cleaner Production, 238*, 117620.
25. Marchet, G., Melacini, M., Perotti, S. (2014). Environmental sustainability in logistics and freight transportation: A literature review and research agenda. *Journal of Manufacturing Technology Management*.

26. Melanici, M., Marchet, G., Perotti, S. (2013). An exploratory study of TMS adoption in the 3PL industry. *AWERProcedia Information Technology & Computer Science*, vol. 3, pp. 1390-1399
27. Mishra, R., Singh, R.K., Koles, B. (2021). Consumer decision- making in Omnichannel retailing: Literature review and future research agenda. *International Journal of Consumer Studies*, 45(2), 147-174.
28. Multaharju, S., Hallikas, J. (2015). Logistics service capabilities of logistics service provider. *International Journal of Logistics Systems and Management*, 5, 20(1), 103-121.
29. Nel, J., De Goede, E., Niemann, W. (2018). Supply chain disruptions: Insights from South African third-party logistics service providers and clients. *Journal of Transport and Supply Chain Management*, 12(1), 1-12.
30. Nemoto, T., Tezuka, K. (2002). *Advantage of third party logistics in supply chain management*. OAI.
31. Paul, A., Moktadir, M.A., Paul, S.K. (2020). An innovative decision-making framework for evaluating transportation service providers based on sustainable criteria. *International Journal of Production Research*, 58(24), 7334-7352.
32. Robas, K.P.E., Valimento, J.C.D., German, J.D. (2020). *Performance Measurement of 3PL Service Providers for Online Retailers in the Philippines*.
33. Ruthramathi, R., Sivakumar, V. (2020). *Digital technology on third-party logistics service providers in supply chain: Tamil Nadu*.
34. Shu, P., Sun, Y., Xie, B., Xu, S.X., Xu, G. (2021). Data-driven shuttle service design for sustainable last mile transportation. *Advanced Engineering Informatics*, 49, 101344.
35. Sitadewi, D., Okdinawati, L., Farmaciawaty, D.A., Rahadi, R.A. (2018). The conceptual framework of horizontal collaborative transportation management in Indonesian trucking industry. *International Journal of Modern Trends in Business Research*, 3(4), 42-58.
36. Torre-Bastida, A.I., Del Ser, J., Laña, I., Ilardia, M., Bilbao, M.N., Campos-Cordobés, S. (2018). Big Data for transportation and mobility: recent advances, trends and challenges. *IET Intelligent Transport Systems*, 12(8), 742-755.
37. Tran-Dang, H., Krommenacker, N., Charpentier, P., Kim, D.S. (2022). The Internet of Things for logistics: Perspectives, application review, and challenges. *IETE Technical Review*, 39(1), 93-121.
38. Wang, Ch.-N., Day, J.-D., Nguyen, T.-K.-L. (2018a). Applying EBM and Grey forecasting to assess efficiency of third-party logistics providers. *Journal of Advanced Transportation*, vol. 2108, pp. 44575.
39. Wang, J., Lim, M.K., Zhan, Y., Wang, X. (2020b). An intelligent logistics service system for enhancing dispatching operations in an IoT environment. *Transportation Research Part E*, vol. 135, pp. 101886.
40. Wang, M., Wood, L.C., Wang, B. (2022). *Transportation capacity shortage influence on logistics performance: evidence from the driver shortage*. Heliyon, e09423.

41. Xu, G., Li, M., Luo, L., Chen, C.H., Huang, G.Q. (2019). Cloud-based fleet management for prefabrication transportation. *Enterprise Information Systems*, 13(1), 87-106.
42. Yayla, A., Oztekin, A., Gumus, A.T., Gunasekaran, A. (2015). A hybrid data analytic methodology for 3PL transportation provider evaluation using fuzzy multicriteria decision making. *International Journal of Production Research*, pp. 44579.

INNOVATION MANAGEMENT IN THIRD-PARTY LOGISTICS

Mariusz KMIECIK

Silesian University of Technology, Zabrze; mariusz.kmiecik@polsl.pl, ORCID: 0000-0003-2015-1132

Purpose: The main purpose of the following article is to present the implementation process of interactive platform to exchange the information about innovations in the chosen international third-party company. The main identified problem is the problem connected with insufficient knowledge about innovation possible to use and even innovation already in use in the different logistics platforms when the need of its usage appears.

Design/methodology/approach: Identified problem was connected with the not enough knowledge of current innovation in use or in consideration. The different platforms in the different regions or countries were not aware about technological solutions used in the whole organization and waste time and human power for searching the suitable solutions and solutions suppliers for the regional activity. Needs in this case were identified among the managers. The 60 managers from Poland, Czech Republic and Slovakia were asked about the preferred user requirements of such a tool.

Findings: The proposed platform allowed implementation in the 3PL company structure the knowledge about innovation flow and make such information highly available. Currently, the innovations in the field of 3PL activity were divided into main categories as follows: picking, packing, transportation, internal transportation, sustainable solutions, quality control, reverse logistics and claims, warehousing and Big Data analysis. A presented case study was implemented in the activity of an international 3PL company which gain the awareness of innovations which are used in the different regions or which were considered to use.

Originality/value: In the following research paper were presented the knowledge about innovation sharing platform for logistics operator to facilitate their activity connected with innovations implementation and as a result to provide the logistics services in the more efficient way.

Keywords: 3PL, innovation, logistics service provider, knowledge sharing platform.

Category of the paper: Research paper.

1. Introduction

Innovation exhibits the direction and progress of the regional and world economic development (Gao et al., 2017). Innovation is critical to the success of many firms, including providers of logistics services (Flint et al., 2005) and could be described as implementation of new or improvement of existing goods and processes (Juchniewicz, 2015) or as a process that goes from problem identification to development to adaption and then, finally, to diffusion of the product or process (Heaslip et al., 2018).

Being innovative is not just a challenge for the companies it is a must (Barczak et al., 2019) and the new technologies are creating the strategic opportunities for the organizations to build (Bhandari, 2014). The innovation management literature can be characterized not only in terms of its huge volume but also by an evolving understanding and sophistication in the conceptual and practical models describing how innovation takes place (Heaslip et al., 2018). However in 2005 the innovation in logistics was summarized by Flint et al. in a few words: “logistics research largely ignored the concept of innovation” (Flint et al., 2005). It means that the innovation area was a poor consideration area, but for now the trend changed and we can be witnesses of more and more research papers connected with logistics and innovation. Currently still there is not a lot of research papers in the logistics field of study connected with innovations. Gopfert and Wellbrock examined the top nine logistics journals and make the conclusion that the only from 1,15% to 8,10% research papers in the years 2000-2013 were related to innovations (Gopfert, Wellbrock, 2016). Other researches show that about 32% of research papers connected with innovations are based on case studies (Gao et al., 2017). The acceleration of the technological route in the form of digitization, Internetization, virtualization, and automation has resulted in the recalibration of economies and societies during the last century (Kosińska-Morawska et al., 2022). The current trends in research are usually connected with e-commerce, e-tailing or fresh products distribution (Gu et al., 2018) or the solutions supported the multi-, cross- and omnichannel distribution (Saskia et al., 2016).

In the following paper will be considered the platform to exchange the knowledge about innovations thought the international logistics operator based on case study. Case study was elaborated based on implementation of such a platform in the outsourcing company. Outsourcing, an operations strategy that influences the performance of a supply chain, has become an important component of global operations management (Gunasekaran et al., 2015). Additionally the following hypothesis will be tested: cloud-based solution provide the proper environment for innovation knowledge sharing inside the logistics operator structures.

2. Literature review

While innovativeness helps an organisation to develop new products and services and effectively use technology, the way partnerships and innovativeness are managed in an organisation heavily depends on how deeply knowledge management practices are embedded within the organisation and how easily this knowledge can be transferred (Tajdini, Tajeddini, 2018). Main drivers of logistics innovation are as follow: governmental support, environmental uncertainty, organization of labour, competition, outsourcing pressure, customer demand, capital scarcity, knowledge, technology, relationship network, financial resources, management resources and organizational encouragement (Sumantri, 2020). The main task of logistical support of innovation solutions system should become: optimization of economic flows, rationalization of operations and building and expanding innovation potential (Smerichevskiy et al., 2020). The development of logistics technologies has become possible due to the active introduction of information technologies that allow processing large amounts of data and open up prospects for the use of information and analytical centers of logistics providers (Gabdullina, Tolysbaev, 2020).

Representation of technological innovations is usually associated with Smart Logistics (Kosińska-Morawska et al., 2022) or Logistics 4.0 concept. The Logistics 4.0 concept implementation advantages are: savings in human work, high standardisation of linking logistic functions to information pieces and the use of equipping logistic enterprises with the newest technology. The disadvantages are: high investment costs and the IT supply network possession requirement (Szymańska et al., 2017). Logistics 4.0 should also take into account technological applications connected with resource planning, warehouse management, transportation management, intelligent transportation systems and information security (Cimini et al., 2019). Contemporary we also be aware of the new conception connected with Industry 5.0. The concept of Industry 5.0, first introduced in 2015 with an emphasis on the human dimension of industry, refers to the collaboration between people and intelligent manufacturing systems, and thus goes beyond the production of goods and the offering of services for profit (Kosińska-Morawska et al., 2022). Logistics 5.0 could be in this case also derivative of next industry revolution and could take the biggest interest on human factors in logistics technology and flows. Human factors are defined as the “scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance (Cimini et al., 2019).

Some authors proposed grouping the logistics innovations into two types: Type-1 innovation: technical/technological (stages include data acquisition, information management, warehousing and transportation) and Type-2 Innovation: administrative and nontechnological (activities include; changes in structures, business processes, customer and supplier

relationships management and knowledge management issues) (Sundarakani, 2016). On the other hand the latest new technologies used in logistics could be sorted into three main areas: automatic identification technologies, communication technologies and information technologies (Bhandari, 2014). In business services we can witness the five different types of innovative functions: technological, organizational, strategic, commercial and operational (Gallego et al., 2013) or we can group it at technological, conceptual and strategic areas (Zhang et al., 2008).

Inventions in technology, process or market that simultaneously create economic and societal value. Societal value can be differentiated in protecting the environment, ensuring economic growth and advancing social well-being (Orellano et al., 2021). Saskia et al. shows the few areas of innovation in contemporary food logistics as follows (Saskia et al., 2016):

- Send a food brand without supermarket intermediary.
- Use of chilled lockers.
- Direct selling wholesaler-consumer.
- Fresh-produce Drive associated with a standard Drive.
- More products than many POS.
- Corner shop culture combined with ITC.

Another prospective technologies could be grouped according to Cichosz (2018) which was shown at table 1.

Table 1.
Technological trends in logistics

Time of relevant	Chosen solutions
< 5 years	<ul style="list-style-type: none"> • Robotics & Automation • Internet of Things • Cloud Logistics • Big Data Analytics • Augmented Reality • Low-Cost Sensor Solutions
> 5 years	<ul style="list-style-type: none"> • Self-Driving Vehicles • Artificial Intelligence • 3D Printing • Unmanned Aerial Vehicles • Blockchain • Next-Generation Wireless • Bionic Enhancement • Virtual Reality & Digital Twins

Source: (Cichosz, 2018).

Mass customization is also added to mentioned technologies as one of concepts referred to innovation in logistics (Liu et al., 2015). Barczak et al. specified the following new technologies in logistics: cloud computing, the internet of things, three-dimensional printing (3D printing), artificial intelligence, big data analytics, blockchain, automation, robotics, drones, machine learning, augmented reality, self-propelled vehicles, and digital Platforms. (Barczak et al., 2019).

Today we have widespread internet access in most countries, 76% in Europe, which makes it possible to get in contact with each other easily (Saskia et al., 2016) which makes technologies like Internet of Things (IoT), cloud technologies, cyber physical systems has been recognized as the main drivers of traditional logistics transformation into smart logistics (Cimini et al., 2019). Since 2018, Blockchain is also considered a breakthrough innovation in the T&L sector. The following places were taken by Artificial Intelligence, robotics, independent vehicles and drones (Klein et al., 2022) and there is also visible a huge impact of innovation on reverse logistics (for example e-waste management (Zhang et al., 2010)).

Yan et al. propose a network-based typology of supplier innovation value, which differentiates suppliers not only by levels but also types of innovation value to a buying company (Yan et al., 2017) and in this methodology a important role is playing by ICT (information and communication technologies). ICT technologies are adopted for capillary tracking of displacements with localization technologies, retrieving and providing data and information, developing user-friendly technologies, and smart collecting and elaboration of information through IoT and BigData tools (Ranieri et al., 2018). It is important issued to include both quantitative and qualitative data during consideration about ICT tools (Keller et al., 2015). Information, communication and automation technologies has substantially increased speed of identification, data gathering, processing, analysis and transmission, with high level of accuracy and reliability. Technology is a means to enhance business competitiveness and performance (Bhandari, 2014).

Next important areas of innovation in logistics are digital technologies. Digital innovations and digital technologies stimulate mobility in terms of access to information and its analysis (Barczak et al., 2019). Digitalization is a reflection of an object or analog activity in binary form (Cichosz, 2018) and has been shown to be a powerful way to reduce the cross-border logistics friction (Lee, Shen, 2020). Digital personel management is also state as a future solution for supporting logistics activities (Barykin et al., 2021). With the active use of digital technologies in the nodes of logistics networks starting 5-7 years ago, their implementation was carried out on the principle of replacing the people of operators on information flows (Shmatko et al., 2021) and one of the most trendy solution connected with digitalization is Digital Twin. Digital Twin usually includes: real space, virtual space and the spreading of data/information flow between real and virtual space (Marcucci et al., 2020). Digital Twins could be supported by foresight support systems to predict the future information. Foresight support systems plays an important role in the modern supply chains (Keller et al., 2015). The integration of various technologies is referred to as digitalization, a superordinate concept. Although technologies are a necessary pre-condition for digitalization, they do not have to be digital (Marhauer, Hofman, 2019).

Looking at the whole supply chain, improving the internal logistics performance, exploiting better coordination and management of warehouses and transport, can also bring benefits to other departments of the enterprise. Logistics operator working in the shop floor can support

sales processes, contributing to the improvement of the customer service level of the enterprise, with responsive information exchange about material and production management (Cimini et al., 2019). Supply chain innovation is vital across all product and service categories for the provision of new services (Wong, Ngai, 2019) and generate a positive impact on risk management capabilities (Kwak et al., 2018).

More and more activities in enterprises are dominated by innovative business models (Cichosz, 2018). The, One way to prevent lock-in effects is through an effective regional innovation system (RIS) that incorporates external and unorthodox knowledge into the region's and companies' learning processes (Keller et al., 2015). Learning process is more and more considered in business models. Usually with innovation in logistics there are associated the logistics knowledge creation business models (Grawe et al., 2014), but there is also a model based on voice-of-customer which is state as one of the most important innovation models in logistics (Su et al., 2011). Voice of customer based strictly on value creation. Innovations in the case of value creation focus on servitisation processes, global value chain and open innovation models (Gallego et al., 2013).

3. Research methodology

The main purpose of the following article is to present the implementation process of interactive platform to exchange the information about innovations in the chosen international third-party company. The main identified problem is the problem connected with insufficient knowledge about innovation possible to use and even innovation already in use in the different logistics platforms when the need of its usage appears. Many researchers give attention to the fact that organizational learning could be supported in the efficient way by IT technologies (Ardito et al., 2018). In the proposed solution a similar ideology was used – in research paper is the proposition of IT platform based on cloud technology which provides the current information about innovations used or considered by company. A similar concept was presented by Keller et al. – they presented the platform for application based on foresight supporting tools (Keller et al., 2015) in this case the platform will be aimed to sharing the knowledge about innovations. The process of platform implementation is shown at figure 1.

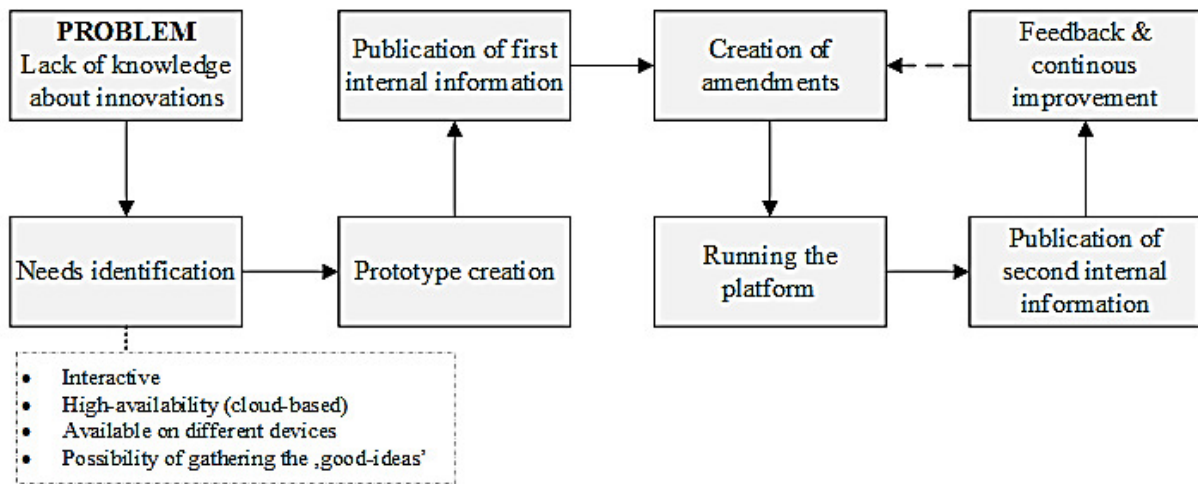


Figure 1. Process of platform implementation.

Source: own elaboration.

Identified problem was connected with the not enough knowledge of current innovation in use or in consideration. The different platforms in the different regions or countries were not aware about technological solutions used in the whole organization and waste time and human power for searching the suitable solutions and solutions suppliers for the regional activity. Needs in this case were identified among the managers. The 60 managers from Poland, Czech Republic and Slovakia were asked about the preferred user requirements of such a tool. Information platforms should meet the basic requirements connected with quality standards, the structure of information, and amount of information (Keller et al., 2015), but according to mentioned analysis among managers, it should also have some additional features. After this step the prototype were elaborated – a prototype was the tool based on a cloud platform which provide a wide range of possibilities connected with its availability and active collaboration with the user in the perspective of continuous improvements. Next step is sharing the prototype platform to the wide range of potential users with asking for improvement propositions. Last phase is connected with implementation and gathering the ideas of improvements in the continuous way.

4. Results

During the process of preparing the prototype of platform for sharing the knowledge about the innovation the 60 managers from Poland, Czech Republik and Slovakia were asked about their users preferences. To gather the preferences the e-survey was used and the most common answers were shown on figure 2. Survey allows to multiple answers and chose the few preferred platform functions by the managers.

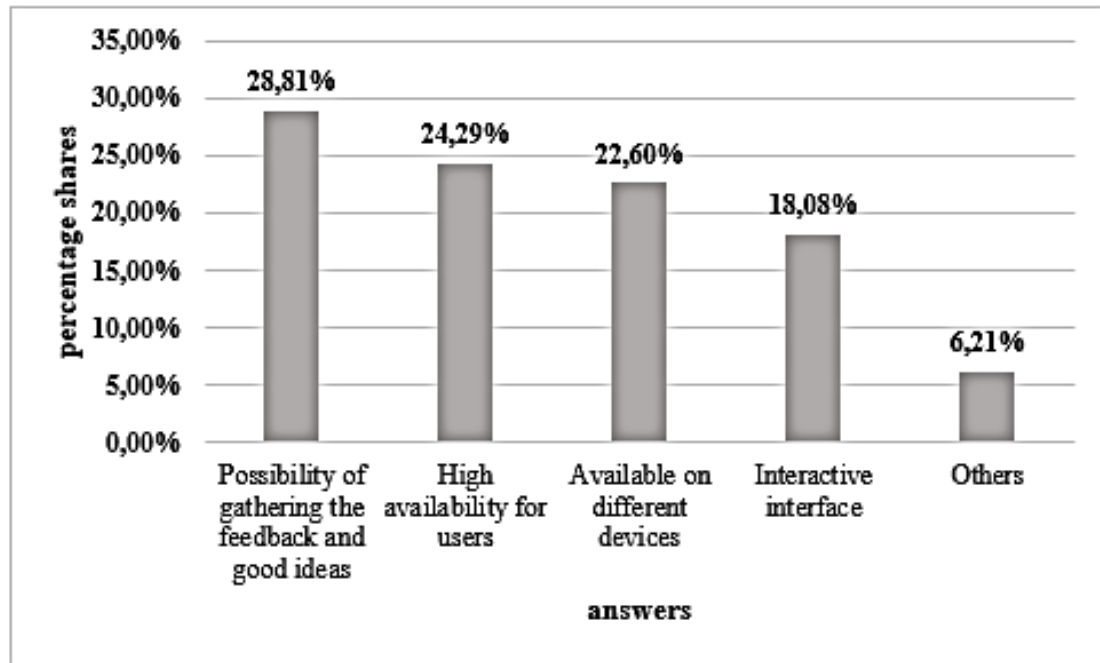


Figure 2. Preferred features of the proposed platform.

Source: own elaboration.

According to the survey results the most wanted features of the platform is the possibility of gathering the feedback and good ideas from the users. So, the platform will be additionally supported by the system of feedback which will be still available on the tool. Next two features: high availability for users and available on different devices (like phones, computers or tablets) create the necessity of adopting the tool into current IT architecture and also it should be cloud-based to provide the high availability and integration of information. Interactive interface was provided by usage of nowadays solutions connected with the intranet websites. The prototype was created to support the workflow of information shown at figure 3.

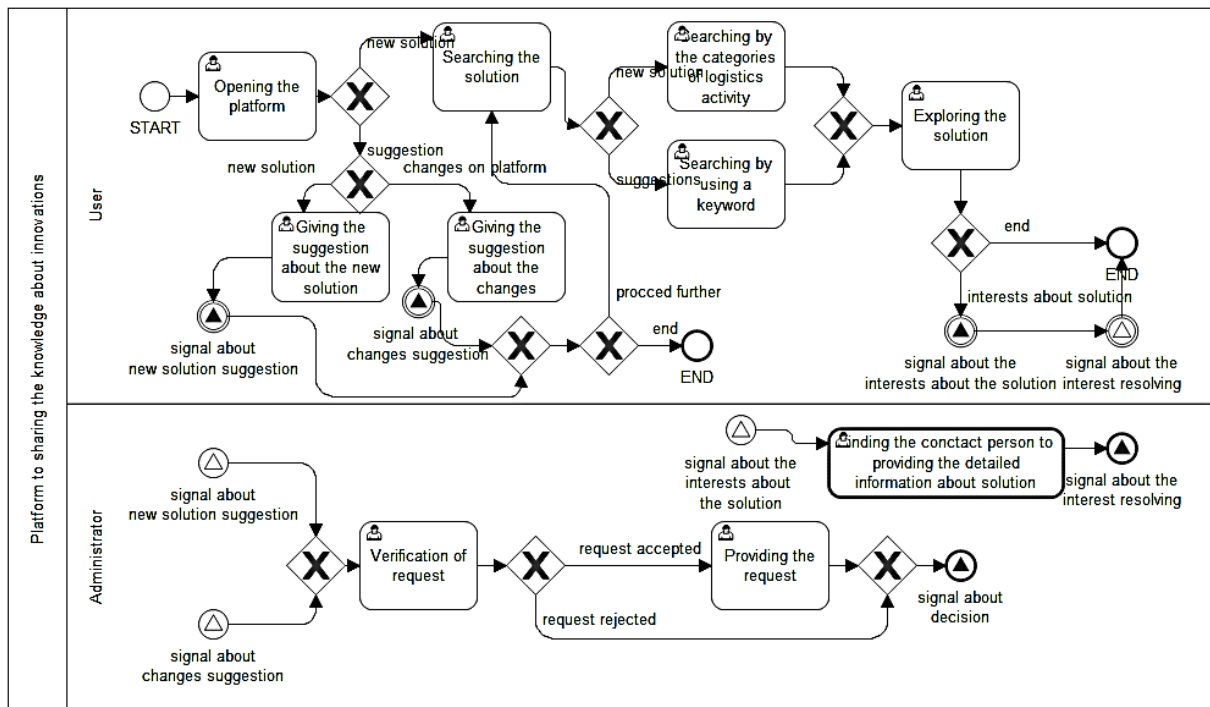


Figure 3. Workflow of platform.

Source: own elaboration.

After preparing the prototype, the beta version of the platform was shared into the main communication channel. In this step, within two weeks, the 34 suggestions of modification were received, where the 28 suggestions were accepted and implemented into the platform. After that the final version of the platform was published. From the time of final version publishing to current situation takes 2 months. At this time the additional 8 changes were made according to users suggestions, the 17 new solutions were added and 13 users were linked with the people responsible for implementation of activities in the company. Before the platform such a statistic was unavailable. Additionally the following hypothesis: cloud-based solution provide the proper environment for innovation knowledge sharing inside the logistics operator structures was tested positive.

5. Discussion and conclusions

Logistics service providers continuously adopt new technologies (Marhauer, Hofman, 2019). As a service innovation, it unites the interests of bank, 3PL (third-party logistics) providers, and SMEs and integrates material, finance, and information (Song et al., 2016). Currently we could see two cases in the market. First when the activity of logistic operator is replaced by new technologies and second when the activity of operator is supported by new technologies (Cimini et al., 2019) and we could also see the one-stop logistic provider (ISLP)

which offers services ranging from raw materials handling, manufacturing, assembling, storage, transportation, sales and marketing, customer call centers, and cash flow management (Trappey et al., 2016). Logistics innovation are also strictly connected with organizational knowledge broadening (Ardito et al., 2018).

The proposed platform allowed implementation in the 3PL company structure the knowledge about innovation flow and make such information highly available. Currently, the innovations in the filed of 3PL activity were divided into main categories as follows: picking, packing, transportation, internal transportation, sustainable solutions, quality control, reverse logistics and claims, warehousing and Big Data analysis. A presented case study was implemented in the activity of an international 3PL company which gain the awareness of innovations which are used in the different regions or which were considered to use. The additional category of innovations kind was depended on the phase of implementation and in this case the innovations were tagged as implemented in the more than one activity or warehouse, implemented in one activity or warehouse, in tested phase, prospective and closed. These elements increased the knowledge flow in the 3PL. In practice the most important benefit of such a platform is the easy and fast way of sharing the knowledge about innovations and providing the possibility of continuous growth in this area. The most important research limitations are as follow: implementation of platform in the activity of one company, relatively short time of platform activity and small feedback in the first stage of platform running.

References

1. Ardito, L., Besson, E., Petruzzelli, A.M., Gregori, G.L. (2018). The influence of production, IT, and logistics process innovations on ambidexterity performance. *Business Process Management Journal*.
2. Barczak, A., Dembińska, I., Marzantowicz, Ł. (2019). Analysis of the risk impact of implementing digital innovations for logistics management. *Processes*, 7(11), 815.
3. Barykin, S.Y., Kapustina, I.V., Valebnikova, O.A., Valebnikova, N.V., Kalinina, O.V., Sergeev, S.M., ... Volkova, L. (2021). Digital technologies for personnel management: Implications for open innovations. *Academy of Strategic Management Journal*, 20, 1-14.
4. Bhandari, R. (2014). Impact of technology on logistics and supply chain management. *IOSR Journal Of Business And Management*, 2(17), 19-24.
5. Cichosz, M. (2018). Digitalization and competitiveness in the logistics service industry. *e-mentor*, 5(77), 73-82.
6. Cimini, C., Lagorio, A., Pirola, F., Pinto, R. (2019). Exploring human factors in Logistics 4.0: Empirical evidence from a case study. *IFAC-PapersOnLine*, 52(13), 2183-2188.

7. Flint, D.J., Larsson, E., Gammelgaard, B., Mentzer, J.T. (2005). Logistics innovation: a customer value- oriented social process. *Journal of business logistics*, 26(1), 113-147.
8. Gabdullina, L.B., Tolysbaev, B.S. (2020). Foreign experience in implementing and applying innovations in transport logistics. *Экономическая серия Вестника ЕНУ им. ЛН Гумилева.*, 3, 127-138.
9. Gallego, J., Rubalcaba, L., Hipp, C. (2013). Services and organisational innovation: the right mix for value creation. *Management Decision*.
10. Gao, D., Xu, Z., Ruan, Y.Z., Lu, H. (2017). From a systematic literature review to integrated definition for sustainable supply chain innovation (SSCI). *Journal of Cleaner Production*, 142, 1518-1538.
11. Göpfert, I., Wellbrock, W. (2016). Innovation management in logistics: an empirical study. *International Journal of Logistics Systems and Management*, 25(2), 227-244.
12. Grawe, S.J., Autry, C.W., Daugherty, P.J. (2014). Organizational implants and logistics service innovation: A relational social capital perspective. *Transportation Journal*, 53(2), 180-210.
13. Gu, B., Fu, Y., Li, Y. (2018). Fresh-keeping effort and channel performance in a fresh product supply chain with loss-averse consumers' returns. *Mathematical problems in engineering*.
14. Gunasekaran, A., Irani, Z., Choy, K.L., Filippi, L., Papadopoulos, T. (2015). Performance measures and metrics in outsourcing decisions: A review for research and applications. *International Journal of Production Economics*, 161, 153-166.
15. Heaslip, G., Kovács, G., Haavisto, I. (2018). Innovations in humanitarian supply chains: the case of cash transfer programmes. *Production Planning & Control*, 29(14), 1175-1190.
16. Juchniewicz, M. (2015). Innowacje w logistyce łańcucha dostaw żywności. *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Problemy Zarządzania, Finansów i Marketingu*, 41, 473-482.
17. Keller, J., Markmann, C., Heiko, A. (2015). Foresight support systems to facilitate regional innovations: A conceptualization case for a German logistics cluster. *Technological Forecasting and Social Change*, 97, 15-28.
18. Klein, M., Gutowska, E., Gutowski, P. (2022). innovations in the T&L (transport and logistics) sector during the Covid-19 pandemic in Sweden, Germany and Poland. *Sustainability*, 14(6), 3323.
19. Kolasińska-Morawska, K., Sułkowski, Ł., Buła, P., Brzozowska, M., Morawski, P. (2022). Smart Logistics—Sustainable Technological Innovations in Customer Service at the Last-Mile Stage: The Polish Perspective. *Energies*, 15(17), 6395.
20. Kwak, D.W., Seo, Y.J., Mason, R. (2018). Investigating the relationship between supply chain innovation, risk management capabilities and competitive advantage in global supply chains. *International Journal of Operations & Production Management*.

21. Lee, H.L., Shen, Z.J.M. (2020). Supply chain and logistics innovations with the Belt and Road Initiative. *Journal of Management Science and Engineering*, 5(2), 77-86.
22. Liu, X., Zhang, K., Chen, B., Zhou, J., Miao, L. (2018). Analysis of logistics service supply chain for the One Belt and One Road initiative of China. *Transportation Research Part E: Logistics and Transportation Review*, 117, 23-39.
23. Marcucci, E., Gatta, V., Le Pira, M., Hansson, L., Bråthen, S. (2020). Digital Twins: A Critical Discussion on Their Potential for Supporting Policy-Making and Planning in Urban Logistics. *Sustainability*, 12(24), 10623.
24. Mathauer, M., Hofmann, E. (2019). Technology adoption by logistics service providers. *International Journal of Physical Distribution & Logistics Management*.
25. Orellano, M., Lambey-Checchin, C., Medini, K., Neubert, G. (2021). A Methodological Framework to Support the Sustainable Innovation Development Process: A Collaborative Approach. *Sustainability*, 13(16), 9054.
26. Ranieri, L., Digiesi, S., Silvestri, B., Roccotelli, M. (2018). A review of last mile logistics innovations in an externalities cost reduction vision. *Sustainability*, 10(3), 782.
27. Saskia, S., Mareš, N., Blanquart, C. (2016). Innovations in e-grocery and logistics solutions for cities. *Transportation Research Procedia*, 12, 825-835.
28. Shmatko, A., Barykin, S., Sergeev, S., Thirakulwanich, A. (2021). Modeling a logistics hub using the digital footprint method—The implication for open innovation engineering. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), 59.
29. Smerichevskiy, S., Kryvovyazyuk, I., Smerichevska, S., Tsymbalistova, O., Kharchenko, M., Yudenko, E. (2020). Development of the logistical support mechanism for the airline's innovation activity on the market of air transport services. *International Journal of Management (IJM)*, 11(6).
30. Song, Z., Huang, H., Ran, W., Liu, S. (2016). A study on the pricing model for 3PL of inventory financing. *Discrete Dynamics in Nature and Society*.
31. Su, S.I.I., Gammelgaard, B., Yang, S.L. (2011). Logistics innovation process revisited: insights from a hospital case study. *International Journal of Physical Distribution & Logistics Management*.
32. Sumantri, Y. (2020). Drivers of logistics service innovation in Third Party Logistics business. *IOP Conference Series: Materials Science and Engineering*, Vol. 732, No. 1, p. 012068). IOP Publishing.
33. Sundarakani, B. (2016). *Designing a framework and research model for the logistics service providers innovation and adoption*.
34. Szymańska, O., Adamczak, M., Cyplik, P. (2017). Logistics 4.0-a new paradigm or set of known solutions? *Research in Logistics & Production*, 7.
35. Tajdini, J., Tajeddini, O. (2018). Innovativeness and knowledge management in public sector enterprises. *Middle East Journal of Management*, 5(3), 271-295.

36. Trappey, A.J., Trappey, C.V., Chang, S.W., Lee, W.T., Hsu, T.N. (2016). A one-stop logistic services framework supporting global supply chain collaboration. *Journal of Systems Science and Systems Engineering*, 25(2), 229-253.
37. Wong, D.T., Ngai, E.W. (2019). Critical review of supply chain innovation research (1999-2016). *Industrial Marketing Management*, 82, 158-187.
38. Yan, T., Yang, S., Dooley, K. (2017). A theory of supplier network-based innovation value. *Journal of Purchasing and Supply Management*, 23(3), 153-162.
39. Zhang, K., Cang, P., Song, F., Geldermann, J. (2010, August). *Research on STOF-model-based innovation of e-waste recycling service system*. 2010 International Conference on Management and Service Science, IEEE, pp. 1-5.
40. Zhang, Z.Y., He, J.S., Gui, S.P., Shi, Y.Q. (2008, October). *Research on the impetus of logistics Innovation in the Industrial Evolution*. 2008 4th International Conference on Wireless Communications, Networking and Mobile Computing, IEEE, pp. 1-4.

PRIORITY TARGET GROUPS FOR ENVIRONMENTAL MARKETING OF CITIES IN POLAND

Małgorzata KOSZEMBAR-WIKLIK

Silesian University of Technology, Faculty of Organisation and Management;
malgorzata.koszembar-wiklik@polsl.pl, ORCID: 0000-0002-8603-1646

Objective: The cognitive objective of the paper is to present the target groups for the environmental marketing of cities. The research objective was to identify the priority audiences for the green marketing of cities in Poland and to indicate what activities are undertaken regarding these most important groups.

Design/methodology/approach: The primary research used the CAWI method, using a proprietary questionnaire. The research was conducted in Q1 2022. The subjects surveyed were cities in Poland. The questionnaire was sent out to all cities, and 414 returned and correctly completed questionnaires were analysed. The presented results represent a section of the entire research.

Findings: The interviewed stakeholders indicate that, of the many groups mentioned, residents are the key audience for green city marketing activities. Residents were divided into three groups - young residents, middle-aged residents and older residents. According to the statements, the key audiences are young residents - 95% of indications. Next are middle-aged residents with 67% of indications and older residents with 63%. The least frequently mentioned key audiences are those associated with the scientific community - 4.6% of indications and foreign tourists - 6.3% of indications. Activities undertaken to promote ecology in the city are mainly based on creating pro-environmental attitudes among the youngest groups of residents.

Research limitations/implications: The research was quantitative research, in the future the research could be extended to include qualitative research that would indicate the motives for selecting specific groups for urban green marketing activities.

Practical implications: The results of the survey indicate that cities mainly focus on promoting environmental activities among their inhabitants. However, cities in most cases do not carry out surveys of their citizens about their environmental needs. It is worth considering conducting such a survey among residents in order to identify expectations and the most pressing issues.

Originality/value: The research is aimed at all those interested in the subject of environmental marketing and in particular the target groups targeted by green city marketing activities.

Keywords: urban environmental marketing, target groups, city stakeholders, green marketing, urban ecology.

Introduction

Today, the world is facing a serious threat to sustainability due to the economic crisis, energy crisis, pollution and greenhouse gas emissions that are causing global warming. Our resources are limited, but human needs are unlimited, so our resources must be used economically and in an environmentally friendly manner (Mohajan, 2012). We live in a world where we are overwhelmed with information about threats affecting the environment and our lives.

In order to prevent this, more and more people are expressing the desire and conviction to make drastic changes in their daily lives in order to reduce the ecological footprint (Bostrom, Klintman, 2011). For sustainable human development, 'green' marketing practices in society are needed. This leads to the fact that also in marketing the green trend is taken into account by offering green products as well as building the image of the company as environmentally friendly. The development of green marketing is linked to a change in consumer awareness and attitudes.

Environmental marketing

Back in 1993, J. Ottman, an expert in environmental marketing, first introduced a new group of consumers. According to Ottman, consumers are environmentally conscious, aware of the health and social problems affected by the industry and are prepared to act to protect their quality of life. As such, he sees environmental marketing as the wave of the future. He argues that companies that focus on 'green' products are more likely to reach these conscious customers (Ottman, 1993). In 1994 K. Peattie defined environmental (green) marketing more broadly as a holistic management process responsible for identifying, anticipating and satisfying the requirements of customers and society in a cost-effective and sustainable manner. According to this definition, green marketing is a tool for a company to conduct economically, socially and ecologically responsible activities (Peattie, 1995). The holistic orientation of a company towards the environment is referred to as green marketing orientation (Papadas, Avlonitis, Carrigan, 2017). Current various marketing concepts emphasise that companies need to engage in broad pro-social and environmental activities (Hunt, 2011). Similarly, management concepts, including marketing, can be applied to public administration and city management (Anderson, Nielsen, 2009). The idea of green cities itself is not new and its place in urban policy has been evident for a long time, with the term green cities gaining popularity worldwide in the 20th century, when industrialisation and urbanisation led to severe environmental pollution. The genesis of the concept can be traced back to E. Howard's idea of 'garden cities', which were

supposed to combine the advantages of the city (entertainment, access to work, high wages) with the benefits of living in the countryside (clean air, natural beauty, low rents) (Howard, 2015). The concept she presented in her 1898 book radically changed thinking about the city and the countryside, and although it seemed like a social utopia to many, it quickly gained great popularity. Today, the term green cities is used to describe cities that focus on environmentally friendly solutions. A separate issue is marketing activities that promote pro-environmental attitudes and build the image of a green city. However, it is important to recognise that territorial marketing is somewhat different from corporate marketing. Territorial marketing is a targeted and regular activity of the local government administration and separate services and institutions. In this activity, the desires and needs of the local community are identified, shaped and satisfied. Activities are aligned with the interests of residents, other groups of people and economic actors (Szromnik, 2016). This alignment means taking into account the trends that occur in stakeholder groups, but also influencing their attitudes towards the environment. In the case of a city, the product is not only the tangible (streets, parks, buildings, roads) but also the intangible. The activities that make up territorial marketing should be understood relationally. This is because they include 'the creation of one's own image, the value of achievements and resources, as well as the creation of one's own relations between entities and the territory in which they function' (Duczkowska-Piasecka, 2013). Of particular relevance to the relationship with the territory is the *genius loci*, the spirit of place, which is influenced by all experiences of the city (Lenartowicz, 1997). *Genius loci* enriches man's spiritual sphere, enhances his artistic sensitivity, intellectual and creative capacities. Therefore, it is a potential source of inspiration for the shaping of urban space. A proper reading of the spirit of the place and inspiration by it result in interesting landscape compositions (Dąbrowska-Budziło, 2011). Undoubtedly, the approach to the environment influences the spirit of the place. Therefore, the 'green' challenges are not only about the mere promotion of the city's environmental activities, but also about shaping the environmental attitudes of different stakeholder groups, shaping the landscape and creating positive experiences with the city.

City stakeholders

Stakeholder theory has been transferred to cities from business management theory and practice. The creator of one of the most well-known stakeholder theories is R.E. Freeman, who recognises that stakeholders are those without whom no organisation could function, it is any group or individual that is influenced or likely to influence the achievement of the organisation's objectives (Freeman, 1984). Stakeholders are therefore most often defined as individuals, groups of individuals, institutions that have an interest in the performance of an organisation. From this point of view of the city, stakeholders are defined as "all individuals

and organisations that are important to the functioning of the city" (Braun, 2008). This is a very broad definition that indicates the complexity of the audience of the city's offer. Three groups of customers of a city are most often mentioned in the literature: its residents, entrepreneurs and tourists. L. Van den Berg and E. Braun distinguish four general categories of city customers: residents (inhabitants), entrepreneurs, visitors and investors (van den Berg, Braun, van Winden, 1999). The following can be regarded as the city's partners, also referred to as local development actors: entrepreneurs, business organisations, investors, NGOs, public institutions, representatives of various professions, opinion leaders, and residents (Duczowska-Piasecka, 2013). In another conception, the city's stakeholders are divided into internal (those making up the organisation, e.g. employees) and external (those located in both its closer environment, e.g. residents, community organisations, and remote, e.g. climate policy makers at the national or EU level, scientists, supra-local leaders, climate activists, other cities) (Legutko-Kobus, 2017). Despite the different approaches, there are common elements in all of them: residents, entrepreneurs and visitors (tourists). What is the importance of these different groups for the city? Residents are the backbone of the city without which the city could not function. From a marketing perspective, residents are the city's brand ambassadors (Kavaratzis, 2004). The views of residents are important to others who do not know the city, as their views are considered authentic and as an internal source of information about the place (Braun, 2012). In terms of visitors, the more visitors a city has, especially foreign visitors, the more well-known the city's brand will be, and this reputation can help a city compete with other well-known cities for a place on the world stage (Hanna, Rowley, 2008). Tourists also represent tangible revenues for cities. Companies and investors, especially foreign ones, can improve the overall economic development of a city and help a city to capitalise on its competitive advantage (Turnock, 1997). In addition to those mentioned above, students are also an important group. Students can also be residents, visitors (tourists), entrepreneurs, which consequently creates an overlap of customer groups. However, it is argued that they should be explicitly included because the student community is essential for cities that want to protect their competitive position in the knowledge-based economy (van den Berg, Russo, 2004). The above groups are users of the city. However, not every stakeholder is necessarily a user, hence it is also worth mentioning the group of investors who invest capital in the city, but do not necessarily locate in a particular place. These investors are very important for the development of new housing projects, new office developments, new urban attractions or infrastructure.

The process of identifying and classifying stakeholders is carried out first and foremost in order to know their expectations and to properly manage the relationship with them. Maintaining good relations with the city's various stakeholders is also key to building the city's brand. The basis for stakeholder relations management is the mapping of a city's stakeholders, including key stakeholders, and identifying their relationships and impact on the city. At the same time, it is important to bear in mind that such a city stakeholder map is not fixed,

but depends on the specifics of the city and the aspect in which it is considered. From the point of view of city branding, other groups may be key than in the case of green marketing. Stakeholder groups may have conflicting expectations, for example environmental issues may be a priority for some, but not for others. Residents looking for a 'place to live' prefer a clean environment, tourists want to enjoy the natural environment, often without seeing it degraded, entrepreneurs will be interested in exploiting the environment to realise a profit. Emphasis should be placed on the word "may", as the interests of the different groups often coincide. There is a growing environmental awareness and understanding of the impact of their activities on the environment among residents, tourists and entrepreneurs alike. Cities are faced with the task of balancing the interests of different groups, and in doing so, they must take into account environmental considerations that express the interests of future generations of stakeholders. The realisation of these interests should, however, always coincide with the overarching goal of city functioning, which is to satisfy the collective needs of the citizens. The demand to reconcile the interests of all is often difficult or impossible to fulfil. It can be said that the realisation of the interests of one group may have consequences, direct or indirect, in the realisation of the interests of another group.

Method and results of the study

The overriding objective of the local authority's activities should be to know and meet the needs of the different users of the city (both as individuals and as social groups). However, as noted earlier, the key target groups for each area of local government activity may vary, e.g. tourist cities may prioritise tourists and/or residents, industrial cities entrepreneurs, non-polarised cities all groups or only residents. Hence, the question is which groups are most relevant to a city's green promotion activities?

The results presented below are from our own research. The survey covered a wide range of questions on green marketing in the city. The survey was conducted in Q1 2022, using the CAWI method. Questionnaires were distributed online to all 954 cities¹, 414 returns were received. The sample is therefore representative. The data presented here cover only a slice of the survey on green marketing in cities, concerning the target groups. The question posed in the survey was who is the main target audience for green marketing promotional activities in a city? This question was intended to show whether the city's green city promotion would be targeted at selected groups or whether all groups would be equally important recipients?

¹ The list was compiled in December 2021, when there were 954 cities in Poland. As of 1 January 2022, there are 964 cities in Poland, <https://www.gov.pl/web/mswia/10-nowych-miast-na-mapie-polski-od-1-stycznia-2022-roku>.

The multiple-choice question listed 12 stakeholder groups, with the additional opportunity to add other groups. The first three groups relate to residents, with a division into young, middle-aged and elderly. The next groups are:

- students - this group was singled out because encouraging people to stay in or study in a particular city after graduation is also related to its environmental conditions. It should be remembered that students can be recruited from different groups (this was written about in the literature section);
- teachers - this group was singled out because they have a significant influence on the attitudes of the younger generation;
- tourists divided into domestic and foreign tourists - the range of marketing activities aimed at tourists residing in Poland is different from that of foreign tourists;
- entrepreneurs already operating in the city, divided into micro, small and medium-sized enterprises (SME sector) and large enterprises - the interest and impact on the city's ecology of these entities will be of a different scale;
- new investors whose investments are linked to, among other things, environmental requirements and the state of the environment in the area;
- non-profit organisations that can partner with environmental marketing activities undertaken by the city;
- representatives of the scientific community - scientists can assist in the development of pro-environmental measures (expertise, advice or specific technological, logistical solutions, etc.), and have an influence on the younger generation.

The results of the survey indicate that cities place different emphasis on different groups when promoting ecology.

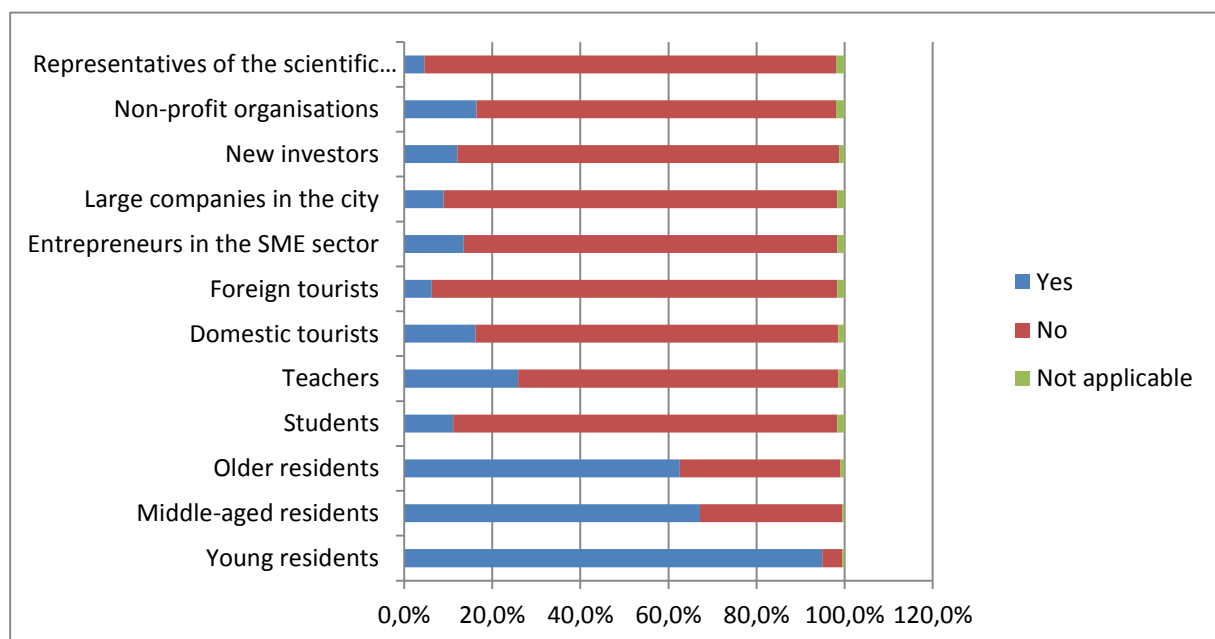


Figure 1. Who are the main targets of green marketing activities in the city?

Source: own research.

The responses indicate that residents are the priority target groups for green urban marketing activities. The highest percentage, as much as 95% of the responses, indicated young residents, followed by 67% of middle-aged residents and almost 63% of older residents. In addition, in a few cases other responses indicated that the youngest residents were the target group - pre-schoolers and pupils in the younger grades of primary school were mentioned.

One in four towns also stated that teachers are an important group for activities promoting ecology. The fewest responses came from the scientific community, which was mentioned by only 4.6% of the cities. This may be due to the fact that many cities do not have academic and scientific centres. Foreign tourists came second from last, with only 6.3% indicating them as the most important in promoting ecology. There are few cities attractive to foreign tourists in Poland, and ecology is not the main deciding factor for tourists when choosing destinations. Few cities indicated large companies operating in the city as a priority - 8.9% of indications. A slightly larger number of cities, as an important group, select domestic tourists - slightly more than 16.2%, non-profit organisations - 16.4% and entrepreneurs from the SME sector - 13.5%.

The research also formulated questions (in the form of statements) about the activities aimed at the various target groups of the cities. The statements included those concerning residents and activities to promote and shape pro-environmental attitudes. The responses, in which it was necessary to indicate to what extent a given statement was consistent with the actual state of affairs in the city, were included on a five-point scale based on a Likert scale. Below are the results of those actions taken towards priority groups, i.e. residents.

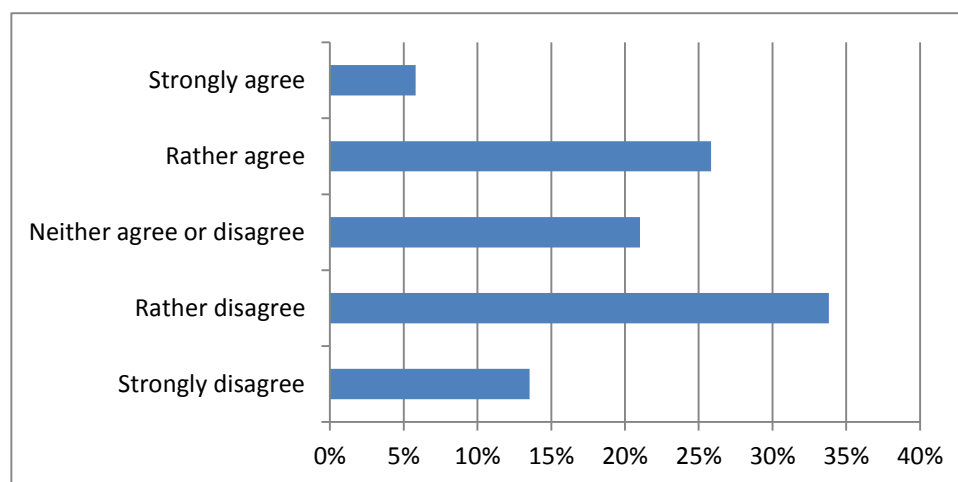


Figure 2. Residents are surveyed about environmental needs in the city.

Source: own research

According to the responses, the majority of cities do not survey their residents about their environmental needs - 48%. In the survey, a large group (21% of cities) was unable to say whether such surveys are conducted and chose the option - do not have an opinion. However, in one in three towns such surveys are conducted, of which 6% chose the answer - strongly agree. Conducting a resident survey is obviously a burden on a city's budget, but it could indicate the main areas that are important to residents and that are worth including in

an environmental strategy, as far as the city is able to do so. Surveys can be carried out in conjunction with other surveys or public consultations. Having an environmental policy that takes residents' expectations into account would help to increase their identification with the city. Engaging at the level of dialogue about the city's ecology can have a measurable impact on residents' actions and involvement.

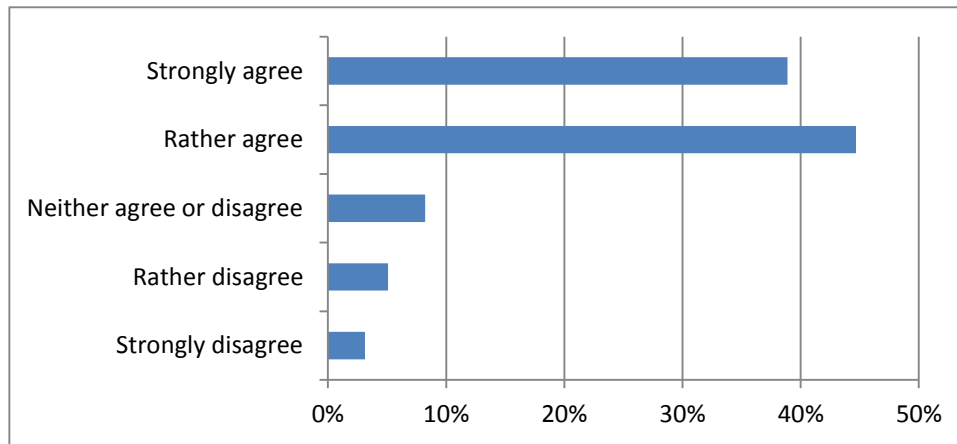


Figure 3. The city runs educational programmes on environmental protection (ecology) in kindergartens, schools.

Source: own research.

The cities' declarations that young inhabitants are the main audience for environmental marketing coincide with the actions taken by the cities. A vast majority of 84% of cities run educational programmes aimed at kindergartens and schools. Only 8% indicated that they do not conduct such activities.

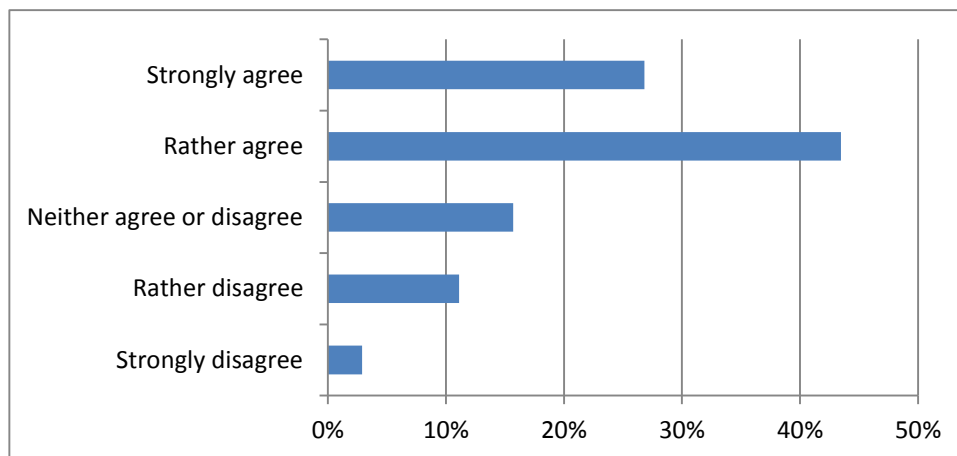


Figure 4. The city conducts awareness-raising campaigns on the importance of environmental protection (ecology) activities aimed at older residents.

Source: own research.

Also in case of older residents, the cities are active in making them aware of the importance of environmental activities - 70% of cities. Only 14% do not undertake any activity in this area towards older groups. 16% have no opinion.

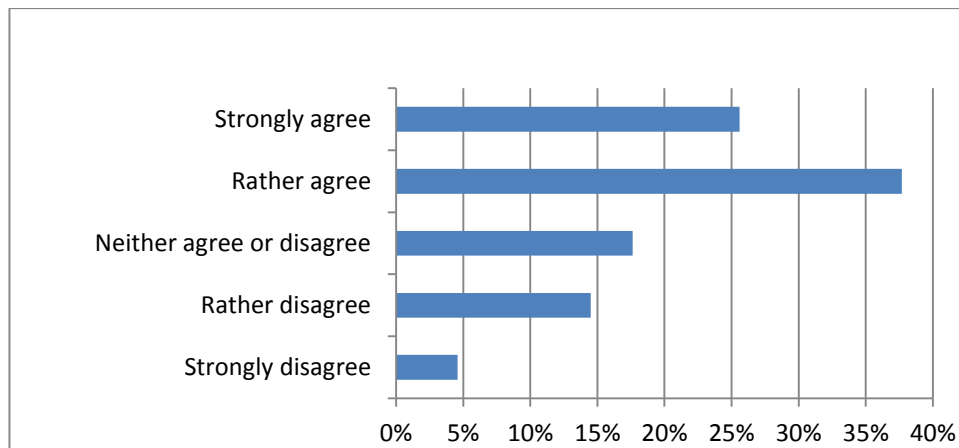


Figure 5. The city organises outdoor events, festivals aimed at promoting environmentally friendly lifestyles and farming among its residents.

Source: own research.

In an effort to promote pro-environmental lifestyles and farming among residents, a large percentage of cities 64% organise festivals and outdoor events. Thanks to such events, residents can learn not only about environmental problems in the city, but also about ways to solve them or reduce their negative effects. It is also an opportunity to meet and activate residents. 19% of the cities surveyed do not organise this type of event. 18% could not specify whether such events take place in their city.

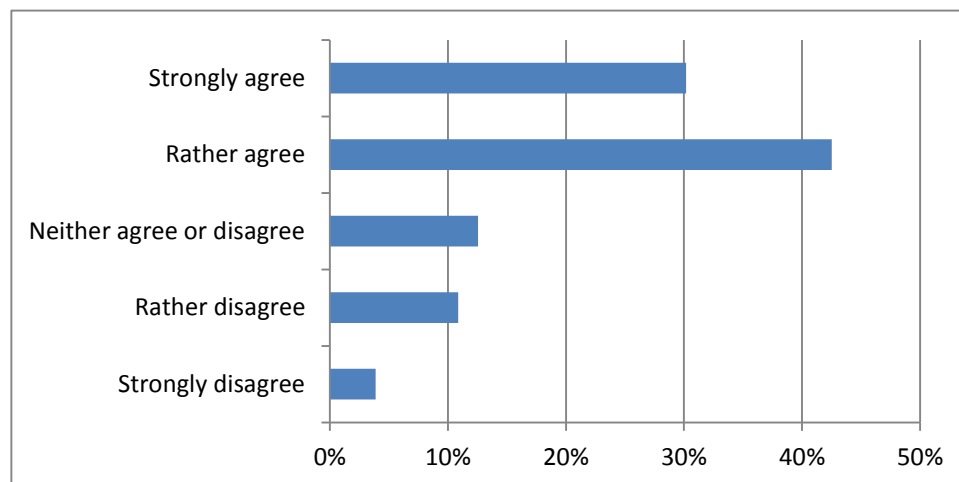


Figure 6. The city promotes environmental attitudes through social media (Facebook, Instagram, Twitter and others).

Source: own research.

To promote attitudes, cities use communication tools that are primarily characteristic of the young and middle-aged generation, i.e. social media. As many as 73% declare that they promote pro-environmental attitudes using media such as Facebook, Instagram or Twitter, for example. 15% do not use social media platforms for this purpose.

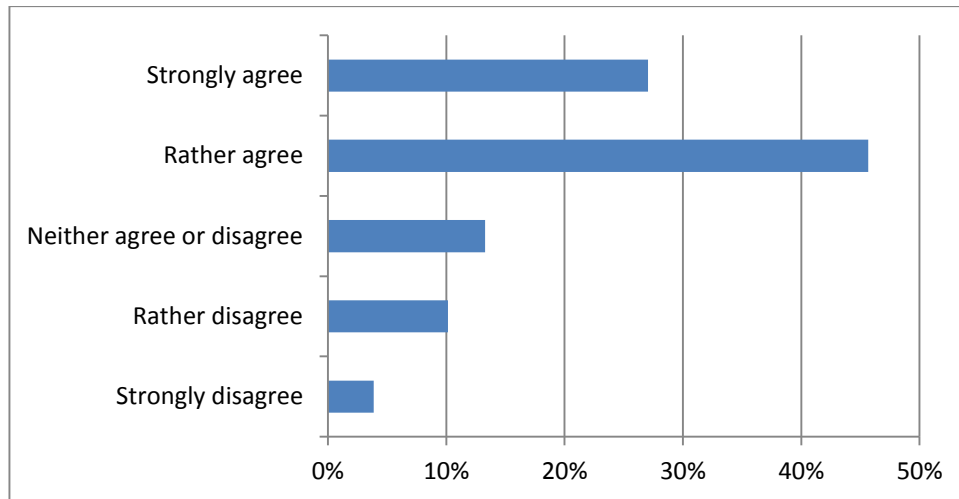


Figure 7. The city often initiates social actions to mobilise residents for environmental activities in the city - e.g. tree planting, cleaning the Earth, litter clean-up, etc.

Source: own research.

In addition to promoting attitudes and awareness-raising activities, cities declare that they initiate various actions in which residents participate. 73% carry out actions to mobilise residents, such as planting trees or cleaning up litter in the city. This approach certainly increases the residents' sense of empowerment and impact on the immediate environment around them.

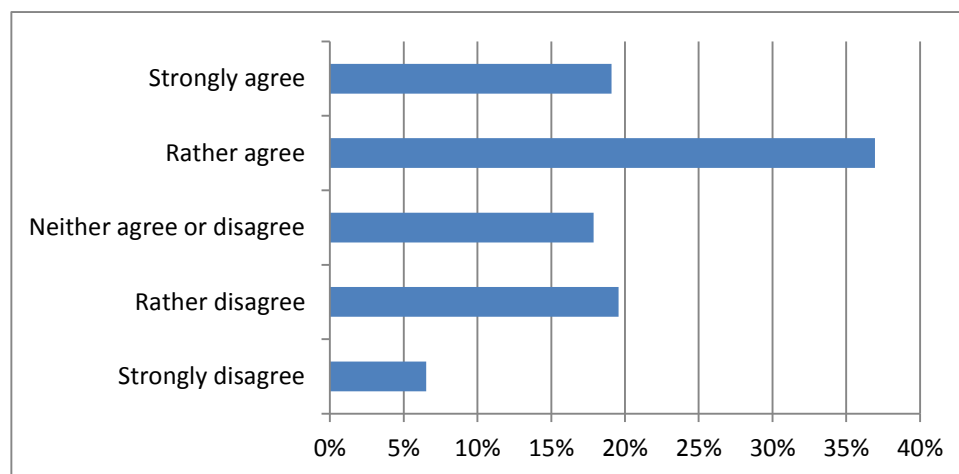


Figure 8. The city organises competitions for residents for environmental action projects (ideas).

Source: own research.

Another activity allowing inhabitants to participate in activities for the benefit of ecology are competitions organised for inhabitants, in which they can submit projects to improve the environment in the city. According to declarations, such competitions are organised by more than half of the cities surveyed - 56%.

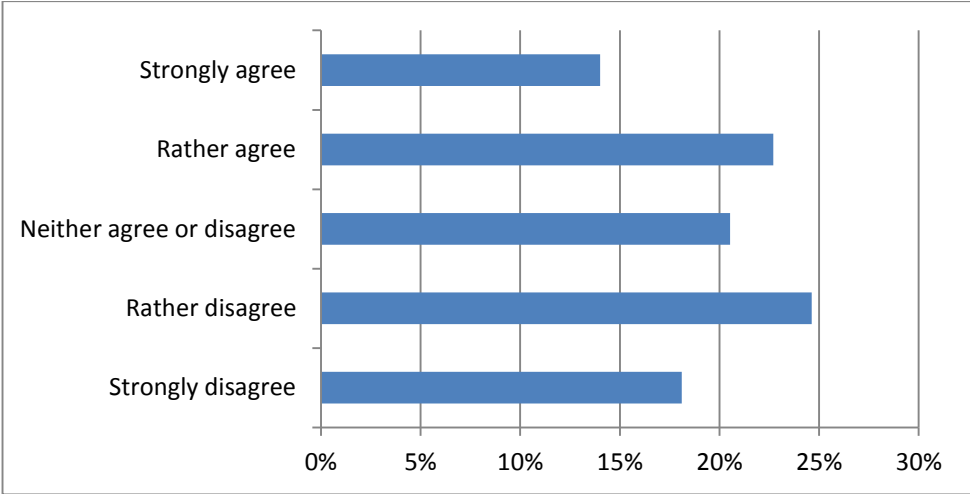


Figure 9. Green personal transport - city bikes and/or scooters - is strongly promoted in the city.

Source: own research.

A measure taken by cities to change the habits of their inhabitants is to promote clean individual transport by providing and promoting city bicycles or electric scooters. Promotion of such means of transport is declared by 37% of cities, but the vast majority do not offer such solutions to inhabitants.

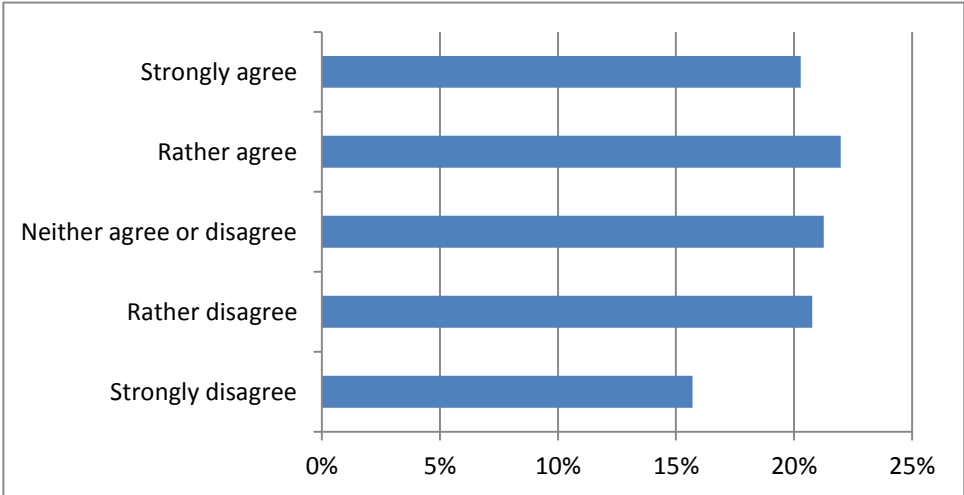


Figure 10. The city runs a programme to subsidise households to switch to green energy (participates in the 'Green Energy' programme).

Source: own research.

Cities also offer dedicated assistance to residents. 42% of cities have a programme whereby it is possible to subsidise households to switch to green energy. Such subsidies not only change air quality, but also build, albeit to a limited extent, environmental awareness.

It should also be mentioned that, in Poland, cities are increasingly deciding to impose solutions on residents in order to improve the state of the environment. Examples include a ban on combusting solid fuels or restrictions on driving old cars into city centres (so-called clean transport zones).

Conclusion

In the case of a city, the product is not only the tangible (streets, parks, buildings, roads), but also the intangible. Environmental marketing is a value that falls into both the tangible sphere (the shaping of the environment in a city) and the mental sphere of the inhabitants (manifested in environmental awareness or compliance with environmental standards). This gives cities an individual quality. Different cities face different environmental problems. Dealing with such problems is reflected in the way the city is experienced by different audiences, and this translates into the *genius loci* of a place. Residents feel the *genius loci* to the highest degree, as they often carry out a large part of their activities in the city. The awareness of the importance of residents' attitudes towards the environment makes them the most attractive target group for promotional activities undertaken by cities.

Taking residents as the main (priority) audience for marketing the city's ecology and targeting them with various programmes is correct for several reasons:

- Residents are to a large extent the unique fabric of the city, creating an atmosphere in the city that is part of its identity. Among other things, the attitudes of residents and their environmental awareness determine the state of the city's environment, which translates into the opinions of other stakeholders. Residents are therefore the environment that influences the creation of the city's image among various groups - in line with the principle that good public relations start from within.
- Marketing activities to involve residents in green initiatives and to make them aware of the importance of environmental protection make it possible to involve residents in efforts to adapt cities to climate change. Greater awareness and pro-environmental attitudes on the part of residents means lower costs for the city.
- A problem that many cities are facing is depopulation. Taking specific action and showing the city as caring about ecology and improving environmental living conditions will allow it to retain some of its residents, for whom this issue is important. Of course, it should be borne in mind that this is not the most important aspect of residents' attachment to the city, as there are a number of factors which determine this, e.g. jobs, opportunities to study, safety in the city, housing prices, access to entertainment, etc. However, the importance of the environment and its condition is increasingly important, especially when looking for a place 'to live'. By promoting the environment, it can therefore not only influence the attachment of residents to the city, but also attract new residents. Cities are interested in population growth. Tax revenues then increase and the unit cost of living decreases.
- The issue of depopulation is also linked to another problem: the ageing population. Targeting ecological measures at the youngest, as declared by the cities, makes sense, since it is the young who most often migrate out of the city. The environmental

awareness of the young also seems to be higher than that of older people. Ecologically clean cities, when viewed from a perspective, may be one of the criteria for young people to evaluate a city as a place to live and build a future.

- A key task for local authorities is to ensure a high quality of life for their residents and this must be done while taking into account observed climate change and environmental concerns. Addressing this issue in local policy and marketing plans is becoming a driver for development.
- By activating residents, through marketing activities, for environmental protection, we increase their sense of responsibility for their own city. It makes them partners of the local authorities and not just passive recipients of top-down decisions. This translates into a stronger sense of local identity. By involving users in processes related to adaptation to environmental problems, cities achieve tangible benefits: they can more accurately diagnose local environmental problems and expectations, strengthen the city's adaptation potential, and generally increase the involvement of various stakeholders in environmental adaptation activities.

The declaration that residents are the priority groups for promoting green attitudes and actions in the city does not mean that other stakeholder groups are not important. It does, however, indicate that cities recognise the importance of this group as an audience for environmental marketing. Residents want an attractive environment to live in the city, but they are also the ones who influence the quality of this place through their behaviour and decisions. According to the survey, city authorities are aware of this and are undertaking a range of green marketing activities. Many cities do not carry out a survey on the environmental needs of their citizens. It is worth planning such a survey, especially as it is becoming a necessity and a challenge for cities to adapt to environmental changes already occurring or expected. The problem of the urban population's exposure to the consequences of climate change and environmental degradation will grow. Actions taken directly by city authorities, especially those involving citizens, therefore play a major role for the future of the city. Passivity on the part of municipal authorities in relation to environmental change can have irreversible consequences, such as a mismatch between public services and the needs of users. This results in the depopulation of the city and, with increasing maintenance costs, can lead to urban decay (fall).

Reference

1. Anderson, S.E., Nielsen, A.E. (2009). The City at Stake: "Stakeholder Mapping" the City. *Culture Unbound, Vol. 1*, pp. 305-329.
2. Bostrom, M., Klintman, M. (2011). *Eco-standards, product labeling and green consumerism*. Basingstoke: Palgrave Macmillan.
3. Braun, E. (2008). City Marketing: Towards an Integrated Approach. *Series Research in Management. Erasmus Research Institute of Management, No. EPS-2008-142-ORG*. Retrieved from: <http://hdl.handle.net/1765/13694>.
4. Braun, E. (2012). Putting city branding into practice. *Journal of Brand Management, 19(4)*, pp. 257-267.
5. Dąbrowska-Budziło, K. (2011) Genius loci, jako potencjalne źródło inspiracji dla kształtowania krajobrazu, niematerialne wartości krajobrazów kulturowych. *Prace Komisji Krajobrazu Kulturowego, Nr 15*. Sosnowiec: Komisja Krajobrazu Kulturowego PTG, <https://krajobrazkulturowy.us.edu.pl/publikacje.artykuly/niematerialne/dabrowska-budzilo.pdf>.
6. Duczkowska-Piasecka, M. (2013). *Marketing terytorialny. Jak podejść do rozwoju z korzyściami dla wszystkich?* Warszawa: Difin.
7. Freeman, R.E. (1984). *Strategic Management: A stakeholder approach*. Boston: Pitman.
8. Hanna, S., Rowley, J. (2008). An analysis of terminology use in place branding. *Place Branding and Public Diplomacy, 4(1)*, pp. 61-75.
9. Howard, E. (2015). *Miasta – ogrody jutra*. Instytut Kultury Miejskiej.
10. Hunt, S. (2011). Sustainable marketing, equity, and economic growth: a resource-advantage, economic freedom approach. *Journal of the Academy of Marketing Science, Vol. 39, No. 1*, pp. 7-20.
11. Kavartzis, M. (2004). From city marketing to city branding: Towards a theoretical framework for developing city brands. *Place Branding, 1(1)*, pp. 58-73.
12. Legutko-Kobus, P. (2017). Adaptacja do zmian klimatu jako wyzwanie polityki rozwoju miast w kontekście krajowym i europejskim. *Biuletyn Komitetu Przestrzennego Zagospodarowania Kraju PAN, z. 268*, pp. 83-97.
13. Lenartowicz, J.K. (1997). *Słownik psychologii architektury dla studiujących architekturę*. Kraków: Politechnika Krakowska.
14. Mohajan, H. (2012). *Importance of Green Marketing at Present and Future*. Saarbruecken: Lap Lambert Academic Publishing GmbH KG
15. Ottman, J. (1993). *Green marketing*. Lincolnwood: NTC Business Books.
16. Papadas, K.K., Avlonitis, G.J., Carrigan, M. (2017). Green marketing orientation: Conceptualization, scale development and validation. *Journal of Business Research, 80*, 236-246. doi: 10.1016/j.jbusres.2017.05.024.

17. Peattie, K. (1995). *Environmental marketing management: meeting the green challenge*. London: Pitman Publishing.
18. Szromnik, A. (2016). *Marketing terytorialny. Miasto i region na rynku*. Warszawa: Wolters Kluwer.
19. Turnock, D. (1997). Urban and regional restructuring in Eastern Europe: The role of foreign investment. *GeoJournal*, 42(4), pp. 457-464.
20. van den Berg, L., Braun, E., van Winden, W. (1999) *Growth clusters in European metropolitan cities: a new policy perspective*. Rotterdam: European Institute for Comparative Urban Research, Erasmus University.
21. van den Berg, L., Russo, A.P. (2004). *The Student City; Strategic Planning for Student Communities in EU Cities*. Aldershot: Ashgate Publishing Ltd.

DIGITAL MATURITY OF CLUSTER ENTERPRISES AND THE IMPLEMENTATION OF INDUSTRY 4.0 SOLUTIONS ACCORDING TO THE RESULTS OF SELECTED STUDIES

Irena ŁĄCKA^{1*}, Przemysław WOJDYŁA²

¹ West Pomeranian University of Technology Szczecin; irena.lacka@zut.edu.pl, ORCID: 0000-0003-0762-8856

² West Pomeranian Chemical Cluster “Green Chemistry”; przemek@zielonachemia.eu

* Correspondence author

Purpose: This article presents the limitations and opportunities for implementing Industry 4.0 solutions in cluster enterprises in the context of the results of studies of their digital maturity.

Design/Methodology/Approach: The article uses the following research methods: the analysis of domestic and foreign literature on the subject, the analysis of secondary sources (the results of research by other authors, the results of a study of digital maturity of enterprises belonging to several clusters in Poland and enterprises outside the clusters, the data of the Digital Economy and Society Index 2022 report), induction and deductive reasoning.

Findings: Compared to EU countries, companies in Poland (especially SMEs) show a low level of digital maturity necessary to implement Industry 4.0 solutions (including big data technologies, cloud solutions, and artificial intelligence). In fact, this is a solid barrier to improving and maintaining the competitiveness of companies in the conditions of the fourth industrial revolution. Moreover, it stems from certain exo- and endogenous barriers. The research on behalf of the Future Industry Platform among companies participating in clusters revealed that their members show a higher degree of digital maturity than those outside such forms of network cooperation. It indicates more significant opportunities for cluster companies to implement Industry 4.0 solutions. Membership in a cluster represents an opportunity for them to reduce barriers to digitisation. The research results confirm that companies that are members of clusters are more innovative and competitive entities that can function more effectively and efficiently in the digital economy.

Practical implications: The article discusses a unique methodology for measuring the digital maturity of enterprises from several clusters in Poland, which business entities can use and apply for self-assessment. The presented research results and information on the barriers and limitations of digitisation will allow government representatives and other institutions to choose appropriate tools to support enterprises in Poland (especially in the SME sector), facilitating the implementation of Industry 4.0 solutions.

Originality/value: The study presents research results on cluster enterprises' digital maturity using an innovative method. It discusses them in the context of existing limitations in implementing Industry 4.0 solutions in Poland. It highlights the importance of clusters for improving the ability of enterprises to effectively use digital technologies for the success of the enterprise in the conditions of the fourth industrial revolution.

Keywords: digital economy, industry 4.0, digital maturity, enterprise, cluster.

Category of the paper: general review/viewpoint.

1. Introduction

Since the beginning of the 21st century, humanity has been participating in massive civilisational changes under the influence of the fourth industrial revolution, which is marked by advanced digital technologies, artificial intelligence and huge data sets as the most critical factors of production. „This 4th industrial revolution is characterised by a confluence, convergence, and fusion of technologies that is blurring the lines between the physical, digital, and biological spheres” (Hoque, 2019).

They lead to the transformation of the entire world economy and national economies toward the so-called digital economy. K. Schwab notes, “We are witnessing massive changes in all industries; new business models are emerging, disruptive breakthroughs to the existing order are occurring that will revolutionise production, consumption, transportation and delivery systems. On the social front, a paradigm shift is taking place that defines how we work and communicate, as well as how we express ourselves, convey information and seek entertainment. Governments and institutions are being transformed, as well as education, health care, transportation and many other systems. New ways of using technology affect our behaviour and our production and consumption systems [...]” (Schwab, 2018, pp. 17-18). It proves the scale and depth of the observed changes - they cannot be identified only with the sphere of production or service provision. Although one of the names of the fourth industrial revolution is industry 4.0, its essence is not only about changes in manufacturing processes. It is associated with much more profound and broader transformations in society and the economy (Janikowski, 2017; Gagnidze, 2022). They refer to the transformation of markets, production, consumption, labour and globalisation processes (Śledziwska, Włoch, 2020). Unlike the impact of the first three industrial revolutions, the current one is occurring much more rapidly and non-linearly, permeating all socioeconomic systems (the changes are more comprehensive), and new technological solutions are emerging in high-tech and traditional industries.

One aspect of these changes is the transformation in production processes, referred to as Industry 4.0 (Production 4.0). Their basis is the use of information and communication technologies in industry and services to communicate between people and machines to create links between suppliers, producers and customers, i.e. cyber-physical production systems and smart factories (Gajdzik, 2022; Suleiman et al., 2022). For companies, Industry 4.0 creates new development opportunities and offers them the possibility to improve their competitiveness in domestic and international markets through economies of scale and increased efficiency in the use of resources. As a result, it offers excellent opportunities for the growth and economic development of the country, improving the quality of life, and increasing the availability of goods, knowledge and information. Nevertheless, the digital transformation of the economy, causing substantial socioeconomic changes and creating many development opportunities, also raises numerous challenges and risks in micro, macro and mega-economic terms (Schwab, 2018; Harari, 2018; Zervoudi, 2020; Bikse et al., 2022).

The digitisation of the economy and society has, until recently, been advanced primarily in highly developed countries. In 2022, the most digital economies were reported to be: Denmark, the US, Sweden, Singapore, Switzerland, the Netherlands, Finland, South Korea, Hong Kong (SAR), Canada, Taiwan, Norway, and the United Arab Emirates (Statista, 2022; CEDA, 2022).

However, the challenges of the COVID-19 pandemic have greatly accelerated the transformation of socioeconomic systems in less developed countries as well. Limiting interpersonal contacts, the need to maintain social distance, prohibitions on conducting business and other social and economic restrictions have caused negative effects on the economies of all countries (Zhu, Chou, Tsai, 2020; Balcilar, 2020; Mishra, 2020; Kuroda, 2020; Schwab, Zahidi, 2021; Lacka, Supron, 2021). At the same time, they forced a change in the business model of enterprises and accelerated the digital transformation of not only large companies but also those from the SME sector (Almeida, Santos Monteiro, 2020; Szwajca, Rydzewska, 2022). This phenomenon has also been noted in Poland, where the digitisation of the economy had been very slow before the pandemic. Unfortunately, efforts in this area are still insufficient.

Entering the digital economy and achieving adequate competitiveness requires companies to introduce new business models and strategies to integrate all areas of the industry through advanced ICT technologies (ensure digitisation and networking) and to collaborate across the entire value-added chain (from design and research through production, management and logistics, to the distribution of final goods). This chain includes business partners and customers, with cooperation between practically all participants on a peer-to-peer basis. The new operating philosophy of the so-called “smart factory” refers to creating a fully integrated production process enabling mass production of individual products for highly personalised orders. In this case, it is not enough just to automate production; it is still necessary to have cyber-physical systems, Internet of Things (IoT), Industrial Internet of Things (IIOT), Internet of Service (IoS), Big Data analytics, Cloud Computing, horizontal and vertical integration of different levels of management structure, the use of augmented reality and 3D technology, blockchain and cybersecurity. It ensures the complete implementation of an integrated production process, the execution of a virtual design, the production of small batches in response to a personalised order, “automated logistics and production that “learns” and self-optimises” (Götz, 2018, p. 387). In this process, the so-called digital twin is used for virtual testing and optimisation of the production line and the final product. The implementation of these pillars of Industry 4.0 requires companies to achieve adequate digital maturity. This name means the state of full readiness and the highest development of an enterprise in the implementation and effective use of digital technologies to achieve its strategic goals in the digital business environment (Deloitte, 2018).

The scale of challenges arising from the implementation of Industry 4.0 solutions in the Polish economy inspired the authors to analyse the results of digital maturity studies of enterprises operating in industrial processing that are part of several national clusters. On this basis, they decided to assess the progress of digitisation in these organisations, determine the limitations and barriers to applying the Industry 4.0 concept in this group of

business entities and the chances of improving the digitisation of enterprises thanks to membership in such a cooperation network.

The purpose of this study is to present the limitations and opportunities for implementing Industry 4.0 solutions in cluster enterprises in the context of the results of studies of their digital maturity. Given the adopted objective, the following research questions were formulated:

1. What is the state of digitisation of the Polish economy and its SMEs in the opinion of experts of the European Commission (based on the Digital Economy and Society Index, 2022)?
2. What are the limitations and barriers to digitising the Polish economy and its enterprises?
3. What level of digital maturity is represented by companies in selected clusters (based on the December 2021 survey of cluster companies in Poland)?
4. What are the limitations to improving the digitisation of cluster member companies?
5. What are the possibilities for implementing Industry 4.0 solutions in the surveyed cluster enterprises?
6. How can a cluster improve the digital maturity of its enterprises?

In pursuit of answers to the above questions, various research methods were used, which are discussed later in the paper. The above study fills a certain cognitive gap, as it presents the results of a study of the digital maturity of cluster enterprises (representing, among other things, economic units of industrial processing), which are unknown to a large part of Polish society. At the same time, it highlights the possibilities of clusters (strategic networks operating in dynamically developing industries) in reducing the limitations of implementing the Industry 4.0 concept.

The structure of the article includes the introduction, research methodology, discussion of the theoretical foundations in the field of Industry 4.0, digital maturity and its measurement models, and the impact of clusters on the implementation of Industry 4.0 solutions. The following section presents the results of a study of the digital maturity of cluster enterprises in Poland and the analysis needed to answer the research questions. Subsequently, the authors included a discussion of the results, a summary and a bibliography.

2. Material and Method

The present study is a review based on the analysis of the literature on the subject (domestic and foreign) and secondary sources, both theoretical and empirical. The latter group includes mainly studies of the digital maturity of enterprises belonging to Polish clusters. They were conducted from 22.11.2021-6.12.2021 on a sample of 150 cluster enterprises using a unique tool made available by the Platform of the Future Industry Foundation for self-assessment of the digital maturity of business units (Platforma Przemysłu Przyszłości, 2020). The leader of

this research was one of the authors of the article, who was also a representative of one of the clusters. In addition, the study was based on the results of the European Commission's Digital Economy and Society Index 2022 (DESI 2022, 2022). The methods of induction and deductive reasoning were also used, as well as the authors' long experience gained from their activities in the cluster participating in the digital maturity survey.

The tool, as mentioned earlier, the enterprise digital maturity questionnaire, was created considering the most important aspects of enterprise development for the Industry 4.0 concept. It enables an independent identification of the company's development stage in more than a dozen dimensions based on three pillars: Organization, Processes and Technology. Together they form a digital maturity model, with four modules containing complex components in each of these three areas of the company. The entire model consists of three areas (pillars), 12 modules and 20 components. Each component represents a critical aspect of the company's operation, on which management should focus on preparing the organisation to act within the framework of the Industry 4.0 concept. The individual components were assigned a total of 20 questions in the questionnaire. It also includes a demographics section. The detailed design of the digital maturity model is included in Table 1.

A CAWI research technique was used to collect data, and in some cases, the survey was conducted using the CATI technique (in the situation of technical difficulties of entrepreneurs in completing the survey electronically). The authors of the study assumed that a minimum of 150 business units from 5 clusters with at least 30 enterprises would participate. Due to the difficulty of obtaining responses within the relatively short time frame of the survey (22.11.2021-6.12.2021), its organisers decided to target the questionnaire to six clusters. It enabled them to achieve the goal of the research, that is, to determine the level of digital maturity of 150 enterprises operating in clusters. However, the uneven distribution of the survey sample meant that the results obtained could not be aggregated and analysed at the cluster level but only at the level of the entire surveyed population. In the cited study, this and other research limitations are discussed in detail (Wojdyła et al., 2021).

Table 1.

Structure of the Digital Maturity Model of the Future Industry Platform

Pillar	Module	Component	Survey Question Number
Organisation	Cooperation and projects	Project management and collaboration	Q1
	Strategy	Strategy	Q2
	Employees	Training and competence development of employees	Q3
	Leadership	Leadership	Q4
Processes	Internal integration	Planning of resources and production processes	Q5A
	Product lifecycle integration	Product lifecycle management	Q5C
	Integration with the environment	Supply chain fulfilment	Q5B
		Customer collaboration	Q6
	Standardisation	Standardisation of technology purchases	Q7
Optimisation of energy efficiency		Q8	

Cont. table 1.

Technology	Automation	Manufacturing processes (industrial systems and information systems)	Q9A
		Administration and management of the company	Q9B
		Building infrastructure	Q9C
	Connectivity	OT and IT manufacturing processes (industrial and information systems)	Q10A
		Business administration and management	Q10B
		Building infrastructure	Q10C
	Autonomation	OT and IT manufacturing processes (industrial and information systems)	Q11A
		Business administration and management	Q11B
		Building infrastructure	Q11C
	Smart Product	Smart Product	Q12

Source: Wojdyła, Frankowska, Cheba, Ławicka, 2021.

The analysis of the completed questionnaires shows that two clusters - the West Pomeranian Green Chemistry Cluster (bringing together companies cooperating in several thematic platforms, such as bioeconomy, energy and materials recovery, packaging, healthy food, and education and qualification in the chemical sector) and the Metalika Metal Cluster (including companies in the metal and complementary industries) - had the highest participation in the study. Each of them provided more than 40 surveys. They were followed by: Lubuski Metal Cluster and ICT Cluster Western Pomerania. The latter's entities include companies operating in various sectors of the IT industry, such as software, multimedia, telecommunications networks, IT outsourcing, among others. More than 20 surveys were obtained from each of these two clusters. Enterprises in the Southern Wielkopolska Food Cluster (gathering food producers and distributors) and the West Pomeranian Maritime Cluster (which includes manufacturing and service entities operating in the broadly defined maritime economy) were the least involved in the survey, as each of these clusters provided up to 10 surveys. A total of 160 completed surveys were obtained and checked for reliability and completeness. Those that did not meet the required criteria were removed. Finally, for the purposes of the study, responses were collected from 150 companies, which were included in the database.

The data were subjected to statistical analysis. First, a preliminary analysis of the structure of responses to individual questions was carried out, followed by an analysis of the number of responses in each research scope. In the next stage, the average values of the digital maturity index of enterprises were analysed by pillar, module and component. Finally, a ranking of enterprises was created based on average ratings of digital maturity along with the determination of typological groups (clusters) of the surveyed business units. The tool provided by the Future Industry Platform uses a nominal rating scale (ratings from 1-6, with a rating of 1 indicating the lowest level and a rating of 6 indicating the highest). This unique model created by DELab UW (Nosalska et al. 2020) is a modification of the digital maturity model of the so-called Singapore Index (INCIT, 2022, The Smart Industry..., 2022). It was adapted to Polish conditions and expanded to include additional (relevant to Industry 4.0) areas.

On the basis of the information contained in the survey demographics, the surveyed population was also analysed with regard to the year of establishment of the enterprise, the origin of capital, affiliation to the industry and class of business conducted, employment size, the approximate value of turnover and exports in the last year.

Considering the year in which the enterprise was established, entities belonging to the following periods of business start-up were distinguished: up to 1990 under the socialist economy, in 1991-2004 (before Poland entered into the European Union), and then in 2005-2021 (during the time after integration with the Community until the time of the survey). The latter period was further divided into several more, i.e. for the years 2005-2011, 2012-2014, 2015-2018 and 2019-2021.

In the structure of 150 surveyed cluster enterprises, the following distribution can be distinguished: 89 units established in 2005-2021 (59.3%), 49 entities established in 1991-2004 (32.7%) and 12 enterprises with the most extended history, i.e. established before 1991 (8%). Among the largest group of survey participants, companies established between 2005 and 2011 accounted for the largest share. They accounted for 26% of the respondents (39 entities). It was followed by companies established in 2015-2018, with a share of 14.0% (21 units), and companies with the shortest duration (2019-2021), having an 11.3% share (17 companies). The units established in the years 2012-2014 obtained an 8% share among the respondents (12 entities). Most of the participants in the study on the digital maturity of cluster enterprises were fully owned by Polish owners (over 71%), mixed capital represented 17.3% of entities, and 11.3% of the respondents were owned by foreign capital.

Analysing industry affiliation, it was found that 59.3% of business units represented manufacturing (section C), while the rest belonged to another section of the PKD (40.7%). Within the industrial processing enterprises, the largest share was accounted for by those engaged in the manufacture of fabricated metal products, excluding machinery and equipment (26.7%), followed by: the manufacture of machinery and equipment not elsewhere classified (8.0%), manufacture of rubber and chemical products (6.7%), manufacture of chemicals and chemical products (4.7%), other product manufacturing (2.7%), manufacture of computers, electronic and optical products (2.0%), repair, maintenance and installation of machinery and equipment (2.0%), manufacture of other non-metallic mineral products (1.3%). The representatives of the remaining classes of activity in section C accounted for 0.7% of the total volume of industrial processing entities. This group included companies operating in the production of metals, production of motor vehicles, trailers, and semi-trailers, except motorcycles, the production of textile products, production of paper and paper products, production of food products, printing and reproduction of recorded media, the production of clothing, and the production and processing of coke and refined petroleum products.

Cluster companies with different employment figures participated in the survey. Micro-enterprises with up to 9 employees (32.7%), small entities with 10-49 employees (28%) and medium-sized units with 100-250 employees (25.3%) dominated. On the other hand, large

entities (over 250 employees) accounted for 7.3% of all units, while the medium-sized ones with employment in the range of 50-99 people accounted for 6.7% of the total population.

The approximate values of turnover and exports in the last year were also important features of the surveyed companies. The largest share of cluster enterprises were entities achieving turnover below PLN 5 million (43.3%) and in the range of PLN 5-50 million (30.0%). Turnover over PLN 100 million was declared by 17.3% of units. The smallest share in this category was obtained by enterprises with a turnover between PLN 50 and 100 million (9.3%).

In the case of the analysis of the structure of the surveyed companies concerning the approximate value of exports, it turned out that as many as 45.3% of the surveyed entities did not receive export revenues in the last year. Among those active in exports, the largest proportion were entities with average export revenue of less than PLN 5 million (23.3% of respondents) and between PLN 5 and 50 million in export revenue (20.0% of respondents). Higher export values in the range of PLN 50-100 million were obtained by 6.7% of cluster enterprises. The highest average export values in the last year of more than PLN 100 million were declared by 4.7% of businesses.

For comparative purposes, information was used from the Future Industry Platform Foundation's (FPPP) database of enterprises that self-assessed their level of digital maturity using a publicly available tool posted on the Foundation's website. They were treated as information from the so-called general base, which included a wide variety of enterprises, often representing different divisions of the Polish Classification of Activities (PKD) at the same time. The questionnaire for the self-assessment of digital maturity did not include the question of cluster membership, so it is difficult to determine whether the 639 businesses in the database included cluster member companies. The FPPP database includes companies and entities that are not typical production enterprises, such as universities, research institutes or business environment institutions. In addition, the Foundation's database of records contained duplicate entries, test entries and information about entities providing an incorrect tax identification number (NIP). Therefore, the research team reviewed the database before using information from this general database. The records with a false NIP, trial or duplicate entries, and related to entities other than manufacturing companies (universities, research institutes and business environment institutions) were removed. Of the initial 639 entities, 489 remained in the created general database of comparative nature.

However, the investigators of the digital maturity survey of cluster enterprises found it impossible to verify the obtained results thoroughly, and the quality of the material they received in relation to the business units in the general base may raise legitimate concerns. They decided that during the analyses, they would calculate only selected descriptive characteristics, including average ratings for pillars, modules and components. Thus, it will be possible to benchmark against the performance of cluster enterprises only in this regard as well, exercising great caution in relying on the results from this part of the study.

3. Theoretical background

3.1. Industry 4.0 and its essence, conditions and barriers to the digitisation of enterprises

Today's extremely rapid, deep and complex technological transformation poses economic, technological, social and cultural challenges for many countries and their economic systems and societies (including Poland). They require a transition to a digital economy, one element of which is Industry 4.0.

In the near future, the competitiveness of the Polish economy in the European and global markets will depend on the pace of implementation of this concept of organising production processes in enterprises. The current drivers of Poland's economic development are diminishing its long-term growth, economic development, and competitiveness (Wieczorek, 2018), as evidenced by the decline in the dynamics of total factor productivity (TFP), which was particularly acute after Russia invaded Ukraine (World Bank, 2022). In this context, only increasing knowledge and innovation in all areas of the economy can stimulate long-term growth and development of the economy. They are supported by the ubiquitous power of information and communication technologies that enable the creation of complex cyber-physical systems.

The concept of Industry 4.0 originated at the beginning of the last decade in Germany. Its creators are German scientists and engineers. They prepared it to answer the government's questions about the strategic directions and conditions for developing the national economy (Kagermann, Wahlster, Helblig, 2013). The term (in German, given as Industrie 4.0) first appeared at the 2011 Hannover Electronics Fair in Hannover, Germany (Grabowska, 2019; Bai et al., 2020). Since 2013, this concept has become extremely popular in highly developed countries. The process of spreading the new manufacturing philosophy accelerated as the global economy recovered from the crisis. Then, the concept of Industry 4.0, with the growing awareness of the digital transformation of the global economy, became recognisable worldwide (Wang et al., 2016). Today, Industry 4.0 is perceived as one of the elements of Economy 4.0 (digital economy) and one of the stages of its creation (He, 2022). The issues of progress in implementing Industry 4.0 solutions, their barriers (Glass et al., 2018; Müller, 2022; Senna et al., 2022; Yüksel, 2022) and the digital maturity of enterprises in various aspects have become an important and current research problem worldwide. It is demonstrated by the review of the global literature and ongoing research in this area contained in the study by M. Flamini and M. Naldi (2022) and the paper by Szász et al. (2021).

The concept of Industry 4.0 defined the driving forces of the new economy (physical, digital and biological megatrends), which over the years, ceased to be merely theoretical (Schwab, 2018). The technologies and socioeconomic phenomena projected for the future were coming into effect rather quickly and transforming the world in all its aspects. Initially, changes were noticed in the manufacturing processes of technologically advanced and traditional industries.

Eventually, they entered many aspects of society, changing socioeconomic relations (e.g., sharing economy, labour market functioning, platformization), public administration, education, and healthcare (Śledziwska, Włoch, 2020). As a result, business units have spearheaded the introduction of disruptive digital technologies into industrial processing following the concept of Industry 4.0, aiming to create so-called smart factories. Subsequently, these solutions permeate many other areas of economic and social life. Over time, this forms the tissue of the new digital economy, the manifestations of which are revealed in all aspects of society and the state - beyond the sphere of production, also in the areas of consumption, distribution, regulation of the social, economic and political system (Schwab, 2018; Schroeder et al., 2019; Tutak, Brodny, 2022). B. Siuta-Tokarska defines this stage of development of the ways of human life and work as “advanced digital transformation of the chains of intertwining horizontal and vertical interconnections of cooperation of units and composite devices, products, services and business models, the key elements of which are: cyber-physical systems, the Internet of Things, the Internet of Services, as well as the so-called smart factories” (Siuta-Tokarska, 2021, p. 6). The statement referred to selected pillars of Industry 4.0, enabling the achievement of the concept’s implementation goals. Among them is the ability of business owners to gain better control and understanding of every aspect of business operations. The benefits offered to entrepreneurs after the implementation of this concept also include (Wiesmüller, 2014; Wang et al., 2016; Schwab, 2018; Gajdzik, 2022; Co to jest branża 4.0, 2022):

- the optimisation of manufacturing processes and radical improvement in efficiency and automation through the use of artificial intelligence algorithms – entrepreneurs make data-driven decisions throughout their operations, improve forecast accuracy, support timely delivery, and develop profit-optimised plans;
- the resilience and flexibility of the economic entity thanks to *smart manufacturing* regardless of the market or economic situation; enterprises are shaping their future digital supply chain with modern planning;
- the increase in confidence in discovering new business models and quickly seizing opportunities; thanks to the solutions of the fourth industrial revolution, enterprises reduce costs, increase market efficiency and connect supply chains by sea, land and air;
- the preparation of “green” and sustainable products and technologies without sacrificing profitability; buyers become more efficient and profitable from the supplier’s point of view thanks to digitisation, while entrepreneurs achieve their environmental goals without limiting the possibilities of achieving other business goals, such as profitability and scalability;
- the improved individualised response to buyers’ needs – automated robotisation and interaction of various technologies create new product opportunities.

As pointed out by Suleiman et al. (2022), Industry 4.0 is based on nine technological pillars, which include: big data (Fei et al., 2019), simulation (Dalenogare et al., 2018), autonomous robots (Bahrin et al., 2016), Internet of Things (Roblek et al., 2016), additive manufacturing (Kang et al., 2016), horizontal and vertical integration (Xu, Xu, Li, 2018; Dalenogare et al., 2018), cloud computing (Liu, Xu, 2017; Alcácer, Cruz-Machado, 2019), cybersecurity (Kamble et al. 2018), augmented reality (Ghobakhloo, 2018).

Using these technologies in the enterprise allows for increased competitiveness, efficiency and productivity, reduces costs and increases the level of security (Tutak, Brodny, 2022). However, it should be borne in mind that many enterprises (especially SMEs), regardless of the country or industry in which they operate, face numerous obstacles and barriers to digital transformation (Vartolomei, Avasilcai, 2019; Styven, Wallström, 2019; Cenamor et al., 2019; Almeida, Santos, Monteiro, 2020; Peter, Vecchia, 2020; Coman et al., 2020; Civelek et al., 2020; Chen et al., 2021; Rupeika-Apoga, Petrovska, 2022). They are also indicated in the paper of D. Szwajca and A. Rydzewska (2022).

Among the many difficulties in the implementation of industry 4.0 solutions and the full digitisation of enterprises, especially of SMEs (a list of which is included in the study by Rupeika-Apoga and Petrovska (2022) among others, the following are most often mentioned: insufficient resources (including financial, human), technical, organisational and cultural barriers, lack of experts, insufficient skills and competences of employees and owners, resistance to change, difficulties in creating effective cooperation in the supply chain, lack of integration, high integration costs, inadequate data quality (lack of information or insufficient data). On the other hand, the OECD report (OECD, 2021) on the digitisation processes of small and medium-sized enterprises listed the following long-term structural barriers (Szwajca, Rydzewska, 2022, p. 296):

- “competence gap preventing managers and employees from identifying digital solution needs and adapting business processes and models,
- financial gap reducing the availability of funds from implementing cutting-edge digital technology,
- infrastructure gap concerning insufficient access to fast broadband connections”.

The strength of the indicated barriers is evidenced by the results of the DESI 2022 study for countries in the European Union. In the case of Poland, indicators informing about human capital, connectivity, and integration of digital technologies reveal the occurrence of the obstacles mentioned above in the digitisation not only of businesses but of the entire society. Consequently, this leads to a very distant 24th position in the DESI 2022 ranking. All these limitations and barriers affect the difficulties in implementing Industry 4.0 solutions and the competitiveness of the entire economy and its development opportunities (DESI 2022, 2022; Szwajca, Rydzewska, 2022).

3.2. Digital maturity and its measurement

In order to implement Industry 4.0 solutions in companies, the right level of digital maturity is required, enabling companies to effectively use advanced digital technologies to achieve market success in the new conditions of the digital economy. It requires a company to create an effective business strategy based on using digital solutions to gain a competitive advantage (Jasińska, 2021). “A company’s digital maturity is not determined solely by its possession of digital technologies, but, among other things, by how the company designs and offers its products, how it collaborates with customers and business partners, how it manages data, the extent to which it uses autonomous solutions and systems, or how it implements collaboration between partners” (Platforma Przemysłu Przyszłości, 2022).

In recent years, there has been an increase in the number of publications devoted to the digital maturity of enterprises and its impact on the ability of business entities to apply Industry 4.0 technologies. One can also find sources discussing methods for studying digital maturity. A review by the DELab UW team of existing methods to prepare a tool for studying the digital maturity of enterprises in Poland for the Future Industry Platform (Nosalska et al., 2020) showed that there are three strands of maturity assessment in the literature. One of them focuses on technologies and solutions used in production, and the other - on determining maturity in the dimension of organisational change. The latter is a mixed approach. In most of the proposed models for assessing total digital maturity, the phenomenon is first assessed in specific dimensions using partial ratings, and then, by using the arithmetic or weighted average, the assessment of total digital maturity is determined. The proposed maturity models are often closed or semi-open tools. They are offered by consulting companies, which use them to further deepen the digital maturity assessment as part of their commercial services. Most of them require participating in the research of respondents serving in the company as CEO or complementarily as CTO. The available tools do not allow for determining digital maturity in the full range of crucial capabilities for Industry 4.0. To measure digital maturity, interval scales or nominal (five-level) scales describing level-specific scenarios of a given characteristic corresponding to the digital maturity variable are most often used. It is very rare in the publicly available tools to provide a list of recommendations for action to be taken by the company’s management to achieve success through the use of digital after conducting a digital maturity assessment. In Table 2, the authors have provided a list of the most important sources dedicated to digital maturity and Industry 4.0.

Table 2.

Publications devoted to the assessment of digital maturity and preparations for the implementation of Industry 4.0 solutions

Author and date of publication	Digital maturity and potential for Industry 4.0 - assessment model
Schuh et al., 2017	The ACATECH Maturity Index
Lichtblau et al., 2015	IMPULS – Industry 4.0 Readiness
McKinsey and Company, 2015	Industry 4.0 How to navigate digitisation of the manufacturing sector
Schumacher, Erol, Sihn, 2016	A maturity approach for assessing Industry 4.0 readiness and maturity of manufacturing enterprises
Leyh et al., 2016	SIMMI 4.0 – A Maturity Model for Classifying the Enterprise-wide IT and Software Landscape Focusing on Industry 4.0
Gokalp, Sener, Eren, 2017	Development of an Assessment Model for Industry 4.0: Industry 4.0
Mittal et al., 2018	DREAMY – Digital Readiness Assessment Maturity Approach
Basil, Doucek, 2019	The Singapore Smart Industry Readiness Index
Pacchini et al., 2019	The degree of readiness for the implementation of Industry 4.0 – a structure based on the Society of Automotive Engineers (SAE) J4000 standard
Corallo, Lazoi, Lezzi, 2020	Assessing Industry 4.0 readiness in manufacturing – based on the PCA method
Dikhanbayeva et al., 2020	Assessment of Industry 4.0 Maturity Models by Design Principles
PWC, 2016	Industry 4.0: Building the digital enterprise
Bierhold, 2018	For a better understanding of Industry 4.0 – An Industry 4.0 maturity model
Nosalska et al., 2020	Support for Industry 4.0 in Poland. Prototype of the tool for assessing the digital maturity of manufacturing enterprises

Source: own elaboration pursuant: Bierhold, 2018; Williams et al., 2019; Tutak, Brodny, 2022.

3.3. Clusters and Industry 4.0

In the modern knowledge-based economy undergoing digital transformation, strengthening innovation and competitiveness in terms of macro, meso, and micro is a significant challenge for the European Union, public authorities in individual countries, business environment institutions, entrepreneurs, research institutions and cluster coordinators. In the literature since the late 1990s, many authors dealing with the issue of clusters and their importance for the economy, the region and businesses have pointed to their pro-innovation impact (e.g. Porter, 1998; Audretsch, Lehmann, 2006; Bernauer et al., 2006; Kowalski, 2013; Fundeanu, Badele, 2014, Bembenek 2017; Łacka, 2018, Bembenek, 2020; McPhillips, 2020; Guimarães, Blanchet and Cimon, 2021). It is a result of the synergy from the cooperation of the two main types of cluster members, i.e., enterprises (primarily SMEs) and units of the scientific and research sector, with the support of business environment institutions and representatives of public administration (Moszkowicz, Bembenek, 2017). This synergy is created by combining the resources, skills and competencies of cluster partners, knowledge and technology transfer and cooperation in innovative processes (Götz, 2019, 2020). It is supported by social capital with a high degree of trust between the members of this network organisation. It is of great importance that clusters use the achievements of innovative partners from the R&D sector - entrepreneurial universities and research institutions (Gagnidze, 2022).

In the European Union's strategic documents, clusters are indicated as organisations that can contribute to accelerating the digital transformation in the economy, digitising enterprises, and implementing Industry 4.0 solutions. EU experts emphasise that cluster policy in individual countries should support the building of cross-sector value chains, internalisation, stimulate entrepreneurship and the development of competencies and professional skills (European Commission, 2021a). According to the European Commission, clusters are important for developing Industry 4.0, industrial transformation, innovation and reducing barriers to implementing the smart factory concept. The development of Industry 4.0 is to be based on bottom-up initiatives with favourable state policy, which is to support the development of the digital economy (Iersel, Konstantinou, 2016). In addition, cluster enterprises implementing Industry 4.0 solutions can significantly support the "green" transformation of the European economy and ensure its resilience to the threats of the modern economy (Gagnidze, 2022).

4. Research results

4.1. The state of digitization of the economy in Poland based on the results of DESI 2022

In 2022, the European Commission published another report on the digital economy and society in the European Union member states (DESI 2022, 2022). The study presents their achievements in creating the digital economy in the second year of the COVID-19 pandemic. For this purpose, experts from the European Commission use a synthetic indicator, the so-called Digital Economy and Society Index. This indicator is based on sub-indices relating to the four pillars of the digital economy. They include:

- human capital and its digital skills - Internet user skills and advanced digital skills,
- connectivity and digital infrastructure – demand and coverage of fixed broadband, mobile broadband and the cost of broadband,
- integration of digital technologies in enterprises and e-commerce,
- digital public services, e-government.

In this report, Poland was ranked 24th among EU countries. It was followed only by Greece, Bulgaria and Romania. The position is due to obtaining a synthetic index of 40.5, while the EU average was 52.3. However, looking at Poland's achievements in 2017-2022, which describes the DESI aggregate indicator, one can notice a constant improvement in this indicator. Very slowly but effectively, Poland is managing to narrow the gap with other EU countries in building a digital economy and society. Poland achieves the best results in connectivity, while it performs worst in terms of digital technology integration. The latter aspect is essential for implementing Industry 4.0 solutions in enterprises.

The DESI 2022 Report shows that Poland also has a big problem with human capital. In this category, our country was ranked 24th among the Member States. Only 43% of people aged 16-74 have at least basic digital skills, with the EU average at 54%. Only 57% of people in Poland can create digital content, while the EU average of this indicator is 66% of the population. It indicates an inadequate level of digital competencies that employees of companies operating within a smart factory should be equipped with. Digital competencies are the ability to consciously and responsibly use digital technologies for education, work and social participation. They include skills related to information use, data analysis, communication, collaboration, problem-solving, critical thinking, digital content creation, programming, digital hygiene, ethical online behaviour and cybersecurity (DigitalPoland Foundation, 2022). Their insufficient development among Poles constitutes a substantial limitation of the transformation of the socioeconomic system towards Economy 4.0 and the digital transformation of enterprises.

Digitisation of enterprises and implementation of Industry 4.0 solutions require appropriate quality of human resources, including IT specialists. In Poland, the share of professionals in the field of digital technologies among the working population in 2021 was 16%, with the EU average of 19%. Unfortunately, this is due, among others, to the not very large number of graduates related to information and communication technologies and the digital economy. In 2021, the share of IT graduates in the total number of all graduates was 3.7%, slightly lower than the average rate for the entire EU (3.9%). The DESI 2022 report also shows a slow increase in the number of ICT specialists in the Polish labour market, but their share is approaching the average for the European Union, which is 4.5% of the total workforce. However, this is still not enough concerning the needs of the digital economy. In the countries that are EU leaders in the digital economy, i.e. Sweden and Finland, this indicator is 8% and approximately 7.5%, respectively. The deficit of such specialists in Poland affects the rate companies implement digital technologies.

In Poland, an additional constraint to the digitisation of the economy in human capital is the inadequate IT training of employees in domestic companies. According to the DESI 2022 report, in 2021, only 18% of Polish enterprises provided special IT training to employees. It should be remembered that these data refer to the second year of the COVID-19 pandemic, i.e. a period of acceleration of the processes of digitisation of the economy and implementation of numerous digital solutions worldwide into many spheres of life of societies - including production, service provision, education, health care, commerce, culture, entertainment, etc. It indicates that there are significant barriers to the implementation of digital technologies. They result from various factors, including cost and mentality. The latter aspect is related, among other things, to the attitudes of many owners of micro, small and medium-sized enterprises and a certain proportion of executives, who display a low level of digital competence, are unaware of the changes in the modern economy, display conservative attitudes and an unwillingness to change. It affects the low propensity to invest in both more advanced

digital technologies and employee-related training. This problem is complicated to overcome in micro and small businesses when there is increasing uncertainty in the economic situation, the risk of operations and the constant lack of funds for investment.

The integration of digital technologies is another crucial factor for the implementation of industry 4.0 solutions in enterprises. In this category, Poland ranked only 24th among the member states. It indicates that SMEs, compared to the EU average, are far less likely to use digital technologies on at least a basic level. In 2021, there was still a significant distance when using technologies such as social media, big data, cloud solutions, artificial intelligence or e-invoices. The DESI 2022 report also shows that despite these difficulties among Polish entrepreneurs, there is an increase in the tendency to use digital services. In 2021, 19% of enterprises used cloud solutions, and 32% participated in electronic information exchange. However, only 40% of economic entities achieved at least a basic level of digital technology use. The EU average was 55%. Thus, Poland has much catching up to do, given the European Union's assumption that in 2030 this share of the Community will be 90% (European Commission, 2021b).

Considering Poland's achievements in the Connectivity pillar, it can be noted that in areas such as the use of fixed broadband of at least 100 Mbps, fibre optic network coverage, and in terms of the broadband price index, Poland performed above the EU average in 2021. On the other hand, in the case of ultra-high-speed network coverage, Poland's score was in line with the EU average. Unfortunately, Poland appears very far behind the achievements of the EU as a whole in areas related to 5G networks. In this respect, in 2021, Poland was only 25th in this ranking. According to experts from the European Commission, the insufficient development of 5G networks (covering only 34% of populated areas in Poland with an EU average of 66%) is due to the lack of access to the C-band frequency, and this hinders the development of connectivity based on the latest infrastructure and technology. Thus, it is a significant barrier to the digitisation of businesses and the implementation of the Industry 4.0 concept.

4.2. Digital maturity of cluster enterprises

The research on digital maturity in 150 cluster enterprises was conducted in an aggregate manner, i.e. including the analysis of responses in each of the three pillars (organisation, processes, technology). Each time, the analysis was conducted first by the represented level of digital maturity of the enterprise in the pillar using a response scale of 1-6 (1 being the lowest and 6 being the most advanced). Digital maturity was then analysed within each module in the pillar.

Due to the limited framework of this article and its nature, the research results are presented synthetically. The authors focus on providing the most important results of the analysis of the digital maturity of enterprises in each pillar of the assessment model and in relation to individual components in each pillar (Wojdyła et al., 2021).

The average assessments of the cluster companies surveyed in the different pillars of the Digital Maturity Index were as follows. The highest average rating was obtained under the Organisation pillar (3.20). In contrast, the average score obtained for the analyses for the Processes pillar was 2.95. The lowest average score for the level of digital maturity of clustered units was determined for the last pillar, Technology. The average scores in each of the three analysed pillars were less than half of the possible points (median = 3.50).

The assessment of the average maturity of a digital business unit in the first of the analysed pillars: Organization, consisted of scores for four modules. In the case of two of them: Cooperation and Projects and Leadership, the average scores (3.65 and 3.66, respectively) were higher than half of the possible points. However, for the other two modules, Strategy and Employees (training and development of employee competencies), the average ratings (2.96 and 2.51) were below 3.00. In each of these modules, companies were identified in the test sample, characterised by the highest level of maturity with a rating of 6. At the same time, those that achieved the lowest level of digital maturity (rating 1) were found. The established ratings within these modules were also characterised by the highest level of variation. The coefficient of variation has taken respectively: 52.90% and 50.90%.

The analysis of respondents' answers to the evaluation of achievements in the following pillar Processes revealed that none of the analysed modules received average ratings above 3.5. The average ratings of the three modules covering: Internal Integration, Product Lifecycle Integration and Integration with the Environment were of a value above 3. In contrast, the lowest average rating of 2.42 was determined for the module: Standardisation. The rating consisted of the average scores of the surveyed cluster enterprises obtained under two components: Standardisation of technology purchases (average rating of 2.73) and Optimisation of energy efficiency (2.10). The ratings obtained for these two components also had the highest variation. It amounted to, respectively: 43.01% and 46.25%.

In the analysis of the responses of the surveyed companies, it was found that average assessments of less than 3.00 were obtained in each of the analysed modules in the case of the Technology pillar. The average ratings for the modules of this pillar ranged from 2.69 (Automation and Connectivity module) to 2.32 (Intelligent Product module). The average scores for the individual components that comprise the analysed modules were also below 3.00. The research also showed that the assessments obtained by cluster enterprises in these components were characterised by a relatively high level of variation from 36.18% (Component Administration and Management of the Company) to 56.16% (Component Smart Product). The selected descriptive characteristics for the digital maturity index for pillars, modules and components are included in Table 3.

Table 3.

Summary of the most important descriptive characteristics of the digital maturity survey of cluster enterprises

Pillar	Module	Component	Average	Median	Standard deviation	Vs (%)	Min	Max	
Organisation	Cooperation and projects	Project management and collaboration	3.20	3.65	3.00	1.40	38.32	1.00	6.00
	Strategy	Strategy		2.96	3.00	1.57	52.90	1.00	6.00
	Employees	Training and competence development of employees		2.51	2.00	1.28	50.90	1.00	6.00
	Leadership	Leadership		3.66	4.00	1.34	36.50	1.00	6.00
Processes	Internal integration	Planning of resources and production processes	2.95	3.09	3.00	1.11	35.87	1.00	5.00
	Product lifecycle integration	Product lifecycle management		3.17	3.00	1.14	35.99	1.00	6.00
	Integration with the environment	Supply chain fulfilment		3.23	3.00	1.17	36.17	1.00	6.00
		Customer collaboration		3.13	3.00	1.11	35.48	1.00	6.00
	Standardisation	Standardisation of technology purchases		2.73	3.00	1.18	43.01	1.00	6.00
		Optimisation of energy efficiency	2.10	2.00	0.97	46.25	1.00	6.00	
Technology	Automation	Manufacturing processes (industrial systems OT and information systems IT)	2.56	2.61	3.00	1.09	41.63	1.00	6.00
		Business administration and management		2.97	3.00	1.07	36.18	1.00	6.00
		Building infrastructure		2.48	2.00	1.24	49.87	1.00	6.00
	Connectivity	OT and IT manufacturing processes (industrial and information systems)		2.71	2.00	1.30	48.18	1.00	6.00
		Business administration and management		2.93	3.00	1.22	41.59	1.00	6.00
		Building infrastructure		2.45	2.00	1.37	56.15	1.00	6.00
	Autonomation	OT and IT manufacturing processes (industrial and information systems)		2.61	2.00	1.25	47.75	1.00	6.00
		Business administration and management		2.75	3.00	1.19	43.17	1.00	5.00
		Building infrastructure		2.23	2.00	1.24	55.55	1.00	6.00
	Smart Product	Smart Product		2.32	2.00	1.30	56.16	1.00	6.00

Source: Wojdyła, Frankowska, Cheba, Ławicka, 2021.

In the further part of the digital maturity studies of cluster enterprises, the results obtained by enterprises were subjected to additional analyses using the methods of multivariate statistical analysis (Wojdyła et al., 2021). The average value of the assessments obtained in each of the three analysed pillars was calculated for each company participating in the research. Then all the averages of the individual pillars were summed up by creating a digital maturity index for each surveyed enterprise. On this basis, a ranking of companies was created due to their average level of digital maturity. The surveyed entities were then divided into four clusters. The first two clusters were set up by companies that achieved the digital maturity index at a level above the average determined based on the results of all economic entities. Enterprises with the highest digital maturity index results were classified in cluster one. The following two clusters included entities with digital maturity index results at below-average levels. Cluster four, on the other hand, includes cluster companies with the lowest digital maturity index results. It can be written according to the following breakdown:

- cluster one included entities for which: $I_i \geq \bar{I} + SI$.
- cluster two included enterprises for which: $\bar{I} + SI > I_i \geq \bar{I}$.
- cluster three included enterprises for which: $\bar{I} > I_i \geq \bar{I} - SI$.
- cluster four included enterprises for which: $I_i < \bar{I} - SI$,

where:

I_i – means the value of the digital maturity index determined for each surveyed enterprise,

\bar{I} – means the average value of the digital maturity index determined from the index values obtained by individual enterprises,

SI – means the standard deviation determined based on the values of the indices obtained by individual enterprises.

During the grouping of enterprises by their digital maturity index scores, it was found that the differences in average scores between clusters were relatively significant. The most homogeneous was cluster 2, which included 42 entities. The coefficient of variation for this group was 6.6%. The most significant variation was found for cluster four, which included 25 companies with the lowest scores in the sample. In this case, the coefficient of variation was 11.9%. Table 4 provides the descriptive characteristics of all groups.

The first group included the 25 cluster enterprises with the highest digital maturity index scores in the sample. The minimum average score (the number of points) obtained by the participating entities was 3.8. In contrast, the maximum average score was 5.5. A company with the highest average score in the digital maturity index is a medium-sized entity that employs between 100 and 250 people. It started its industrial processing operations in 2017.

Table 4.*The descriptive characteristics of the concentrations determined for each group*

Cluster	Average	Standard deviation	Coefficient of variation	Max	Min	Range
Cluster 1 n = 25	4.4	0.5	10.8	5.5	3.8	1.8
Cluster 2 n = 42	3.2	0.2	6.6	3.7	2.9	0.8
Cluster 3 n = 58	2.6	0.2	8.7	2.8	2.1	0.6
Cluster 4 n = 25	1.7	0.2	11.9	2.0	1.4	0.6
Entire sample n = 150	2.9	0.9	29.9	5.5	1.4	4.1

Source: Wojdyła, Frankowska, Cheba, Ławicka, 2021.

The survey team found that no entity participating in the digital maturity assessment achieved the maximum score in each component. Four companies with varying characteristics achieved the lowest average index score of 1.4. They had different employment figures and started businesses in the following years: 1997, 1999, 2014 and 2019. The group consisted primarily of service companies engaged in providing the following services: information technology, hot-dip galvanising and powder coating, performing the repair, modernisation and investment works of the mechanical industry for the power and heating industries, and carrying out general construction work accompanying the services of this industry. Only one company determined the approximate value of its exports in the last year at the level of PLN 5 to 50 million. The remaining entities were not engaged in export activities.

When comparing the characteristics of all clusters, it can be noted that the differences in the assessments of individual components obtained by the company classified as the highest and the lowest in the created digital maturity ranking are significant. In particular, one notices the inactivity of the company ranked lowest in the built ranking for 15 of the 20 analysed components. They include:

- pillar 1. Organisation - 3 out of 4 components rated at the lowest level, i.e., Strategy, Training and development of employee competencies and Leadership,
- pillar 2. Processes - 5 out of 6 components achieved the lowest ratings, i.e. Supply Chain Execution, Product Lifecycle Management, Customer Collaboration, Technology Purchasing Standardisation and Energy Efficiency Optimization,
- pillar 3. Technology - 7 out of 10 components received the lowest ratings, i.e., Production processes (OT and IT), building infrastructure, production processes (OT and IT), Business administration and management, building infrastructure (in the Automation component), building infrastructure (in the Autonomation component), Smart product.

In the comparative analyses, the focus points noted the similarity of the results obtained by the company classified at the most in the third and fourth clusters. The same result was obtained by the surveyed units from these clusters for the components:

- pillar 2. Processes - Components: Supply Chain Execution, Customer Collaboration, Technology Purchasing Standardisation, Energy Efficiency Optimization,
- pillar 3. Technology - Components: Manufacturing processes (OT and IT), Business Administration and Management, Building Infrastructure, Smart Product.

Attention was also drawn to the similar results achieved by cluster companies ranked highest in clusters two and four. Results at the same level were identified for:

- pillar 1. Organisation - Components: Training and competence development of employees, Leadership,
- pillar 2. Processes- Components: Optimisation of energy efficiency.

Discovered similarities show that the results obtained in various components of the digital maturity index were similar in some of the enterprises, despite relatively significant differences in the level of the index itself.

The demographic criteria of the surveyed entities were also considered when analysing the level of digital maturity of cluster enterprises. One of these characteristics was seniority in the market (year of establishment). Given this criterion, the research team found that enterprises founded in 2005 and later obtained a slightly higher level of the overall digital maturity index compared to entities founded earlier. For this group of entities, evaluations of 4, 5 and 6 for individual components have appeared more frequently than in others. "In most of the analysed cases of companies established after 2005, their digital maturity was assessed at a similar level. On the other hand, a detailed analysis of the responses in the group of the most recently established entities on the market [...] indicated that they mostly rated their maturity level at 3 and 4" (Wojdyła et al., 2021, p. 8).

Considering the employment figures of the surveyed companies, it was noted that micro-enterprises (up to 9 employees) achieved low levels of digital maturity for most components (ratings of 1 or 2). Similar results were recorded for small entities with 10 to 49 employees. In the case of micro-enterprises, digital maturity was rated quite highly only for the Leadership component. The members of this group of respondents gave this component a 4 rating, emphasising that the board has a well-established and full knowledge of the latest solutions but, in their implementation, relies on external experts (N = 16; 32.65%). In the group of entities with 100 to 250 employees, the level of 2 or 3 of the digital maturity assessment was most often declared. The largest business units (over 250 employees) mostly reached level 4 or 5 in digital maturity. For most components, large enterprises rated their digital maturity quite highly. It indicates that there are significant differences compared to the ratings of SMEs. Such differences were noted for the following components: Strategy, Training and Competency Development of Employees, Planning Resources and Production Processes, and Executing the Supply Chain or Standardising Technology Purchases.

Another demographic feature used in the conducted research of business entities was the turnover value. Including this criterion in the analysis of the results of the evaluations of cluster enterprises, it was found that economic entities with the lowest turnover value rated their digital

maturity relatively low for most components (more often a rating of 1 or 2 compared to enterprises with other turnover values). They attributed the highest rating (4) to the Leadership component, highlighting the opinion that the board has a well-established and complete knowledge of the latest solutions but, in their implementation, relies on external experts (N = 19; 29.23%). Economic entities representing different turnover values “rated their level of digital maturity in the component: Customer Cooperation at Level 3 - communication with customers is carried out through online and offline channels and is personalised. Enterprises with the highest declared turnover rated their digital maturity at a very low level for the component: Energy efficiency optimisation, indicating level 2 – the company manually measures energy and other media consumption in selected areas (once a month). The company does not have an energy efficiency strategy (N = 18; 69.23%)” (Wojdyła et al., 2021, p. 80).

Analysing the results obtained in this regard, it can be concluded that among companies declaring different values of turnover, there were no significant differences in the assessment of the level of digital maturity.

Considering the value of exports of the surveyed enterprises (possibly no export revenues), it was found that non-exporting entities obtained the lowest digital maturity assessments in the Strategy component (1). At the same time, they indicated that building such a strategy is not considered an important goal in the company’s current or future plans (N = 27; 39.71%). However, the same component was rated the highest (at the rating of 5) for those entities that reached the value of exports in the last year of PLN 5-50 million. They often declared that a long-term strategy and a properly adjusted management model are implemented in more than one area of activity (N = 7; 23.33%). That said, it was noted that all groups of companies rated their digital maturity in the Energy Efficiency Optimization component equally low (at level 2). They emphasised that the entity manually measures energy and other utility consumption in selected areas (once a month). The company has no energy efficiency strategy.

The analysis of the research results also established a link between the assessment of the digital maturity of cluster enterprises and the origin of capital and belonging to the industry. The research team found that companies with domestic capital (most represented in the research group) achieved a relatively low level of digital maturity (most often a score 2 or 3). However, foreign-owned entities more often declared level 4 or 5, and even for some components, level 6. It indicates significant differences in the preparedness for the challenges of Industry 4.0 between companies owned by domestic and foreign capital.

Analysing the industry affiliation of the surveyed cluster enterprises, it was noted that entities declaring activities within Manufacturing (section C of the PKD) achieved a higher level of digital maturity than units assigned to other sections of activity.

5. Discussion

The analysis conducted by the authors of the study of Poland's performance in the ranking of the digital economy and digital society index in the latest edition of the DESI 2022 report revealed that against the background of the 27 European Union member states, Poland shows a vast distance from not only the leaders of the digital economy (Finland, Denmark, the Netherlands) but even the other post-socialist countries of the Grouping (Estonia, Lithuania, Latvia, Slovenia, the Czech Republic, Hungary and Slovakia). It ranks only 24th, although it is slowly catching up in laying the groundwork for the digital economy and its digital society. The report cited above reveals the reasons for Poland's weak position in this ranking, classified in terms of all pillars of the digital economy. All of these limitations and deficits significantly impact the ability to implement Industry 4.0 solutions in Polish companies, with the most decisive impact on micro, small and medium-sized entities. In the case of the first pillar, entitled Human Capital, these include:

- insufficient share of people aged 16-74 with digital skills at least at the basic level (only 43% in Poland compared to the EU average of 54%),
- insufficient participation of people aged 16-74 year-olds with basic skills to create digital content (57% against the EU-wide rate of 66%),
- insufficient number of ICT specialists (percentage slightly lower than the EU average),
- the low share of ICT specialists among the working population,
- the low enrolment rate in studies that educate ICT majors,
- a lower share of ICT graduates than in the EU, which has a significant impact on the uptake of digital technologies by businesses,
- a very low share of companies providing special ICT training (only 18%), which, coupled with the low level of digital skills and the low propensity of executives to invest in this area, contributes to the difficulty of Polish companies (especially SMEs) in leveraging the potential of the digital economy.

Considering the next pillar of the digital economy, namely Connectivity, Poland's distance from EU countries is also prominent. Data from the DESI 2022 report indicate that it has been possible to increase the share of households covered by fixed networks with very high capacity (70%, an increase of 5 percentage points over the previous period). However, there are still considerable limitations in developing 5G networks (Poland's 25th place in the EU ranking), which provide significantly higher network speeds and bandwidth than 4G technology. Its advantages are also high reliability and low delays, which is very often crucial in the industry. In addition, its energy efficiency is emphasised. The 5G network can transmit up to 100 times more data using a similar amount of energy than previous generations. The key element of industry 4.0 is wireless communication but at the level of LTE and 5G technologies (Polski przemysł, 2021).

The indicator describing Poland's performance in the third pillar of the digital economy, titled Integration of digital technologies, is very unfavourable. The use of digital technologies in businesses is clearly on the rise. It is evidenced by such data as the share of companies using cloud solutions (19%) and electronic information exchange (32% against an EU rate of 38%). However, EU experts notice Poland's great distance in achieving the goal set by the European Union of a strategy to implement the digitisation of the economy by 2030. It mainly concerns such issues as the use of cloud computing, big data and artificial intelligence. In Poland, in 2021, the use of these technologies ranged from 3% to 19%, compared to the EU target of 75% by 2030. Polish companies' efforts towards further digitisation and their potential in this area should be increased, as only 40% of business entities achieve at least a basic level of digital technology use, against a rate of 55% for the European Union as a whole. The goal of the Digital Decade is to get no less than 90% of SMEs to have "at least a basic level" of digital use in 2030. In the opinion of the authors of the paper, Poland can accelerate its digital transformation and have a more significant impact on the implementation of Industry 4.0 solutions by enterprises by using further incentives to invest in ICT technologies, opening up more opportunities for the development of 5G networks, continuing targeted financial assistance to those implementing these solutions, and supporting enterprises in disadvantaged regions. Measures are also needed to improve the quality of human capital to improve digital skills and competencies.

In Poland, the development of the digital economy and the ability to implement Industry 4.0 solutions in enterprises is adversely affected by the insufficient development of digital public services. It is indicated by the results on digital public services, which are below the EU average. Our country ranks only 22nd in this category. The EU strategy calls for 100% online provision of key public services to EU citizens and businesses by 2030.

The factors presented above that hinder the implementation of Industry 4.0 solutions are diverse and confirm the existence of substantial barriers to the digitisation of domestic companies. In light of these limitations, the results of the digital maturity assessment of cluster enterprises participating in the research using the digital maturity self-assessment tool prepared for the Future industry platform become understandable. They indicate a relatively low level of digital maturity of domestically-owned enterprises (ratings of 2-3 predominated). According to the article's authors, in the studied cluster companies, significant difficulties were noted in connecting individual information technology (IT) systems with *operational technologies (OT)*, i.e. industrial systems. Data generated by sensors installed in industrial machines are rarely connected to a digital database capable of analysing them and drawing conclusions from them on an ongoing basis for decision-making. It constitutes a significant constraint in developing the concept of industry 4.0 in cluster enterprises.

A significantly higher level of digital maturity was demonstrated by foreign-owned entities (scores of 4-5) for most components in the Organization and Process pillars. Cluster enterprises belonging to SMEs, other than large enterprises, non-export entities and companies established before 2005, have significantly worse results in assessing digital maturity. Therefore, these economic units face the most significant barriers to implementing industry 4.0 solutions with

various conditions. These are both the competence problems of the owners and their employees, resource constraints (insufficient human, financial, technological, and infrastructure resources), as well as organisational and cultural barriers.

Analysing the results of the digital maturity study, the authors of this paper suspect the existence of communication problems between IT specialists, OT specialists and management in the surveyed companies, which may cause difficulties in developing shared goals for the implementation of the Industry 4.0 concept. After all, the concept is supposed to deliver the goals of the business sphere - reducing costs, increasing revenues, and improving efficiency and productivity indicators. In the case of micro and small companies, probably due to the lack of in-house IT staff, one has to resort to external services, which are most often limited to basic processes. The results of the survey also indicate that some of the owners of enterprises participating in clusters are not ready to change their business model, the need to acquire new competencies, change their approach to the market, and bear the risk of new investments. It demonstrates the share of enterprises that do not include the development of digitisation in their strategic plans.

However, comparing the results obtained by the research team (Wojdyła et al., 2021) for cluster enterprises with the digital maturity assessments obtained by enterprises from the general base, it can be concluded that cluster members obtained higher levels of average digital maturity assessments for the vast majority of components from all pillars (Organisation, Processes, Technology). It indicates that joining a cluster can be an important factor in accelerating a company's digital transformation.

In this type of network, organisations that strongly influence the innovation of their members not only promote the need to respond to the trends and challenges of the modern economy. Educational activities are also underway to raise awareness and knowledge about the transformation of the digital economy and the essence of Industry 4.0. Cluster members can cooperate in research projects, make it easier to use public financial support for projects related to the implementation of industry 4.0 solutions, and benefit from the organisational support of the cluster coordinator during this process. Entities cooperating in the cluster from the sphere of enterprises, science and research, public administration, and business environment institutions can obtain additional value through the possibility of optimising operational activities and reducing transaction costs, establishing solid relationships between cluster members, the occurrence of the network effect and the possibility of fast and effective learning (Frankowska, 2012). Their cooperation creates a so-called value chain in the cluster, which can also be seen in digitisation processes in its enterprises. A cluster's value chain of the digital economy can include business units operating within an ecosystem that will provide digital content and applications, digital services to consumers, businesses, science and research institutions, and government institutions (Kowalski, 2022). Implementing Industry 4.0 solutions across all cluster entities will achieve economies of scale and reduce unit costs. It will also strengthen cooperation between cluster partners and provide a more significant advantage to competitors resulting from using the new business model.

Conclusion

For over a decade, the digital economy and one of its elements, Industry 4.0, have been a significant and current research problem. They are also an important issue for public stakeholders both globally (e.g., The European Commission) and nationally (national governments). In the case of Poland, the government and its ministries and subordinate agencies are tasked with creating appropriate economic policies to support the digital transformation of the country and its business entities, which will condition the level of Poland's competitiveness in the following decades and the possibility for its companies to join global value chains.

The issues of the digital economy and Industry 4.0 have also been of increasing importance to businesses in Poland for several years. Their owners saw the acceleration of the transformation of the fourth industrial revolution in all countries, including those less innovative ones, which have so far benefited from other sources of competitiveness than the implementation of modern technologies in all industries. Due to legal or restrictive industry requirements, some industrial companies in Poland already used specific IT solutions to "track" and analyse information from the production process (companies in the food or chemical industries). These operators have been using some industry 4.0 solutions for a long time. They are now extending them with additional elements while moving toward a new business model.

The second group of economic operators includes those companies that choose digital transformation in a conscious way to increase their competitiveness in international markets. Only by improving efficiency, reducing costs, optimising the use of resources, and personalising their offerings will they be able to compete with foreign competitors.

Some companies see development opportunities in implementing the concept of Industry 4.0 by applying their solutions to improve product quality, better reach buyers, expand their offerings using more data, and then produce personalised mass products. Unfortunately, they do not have sufficient capital for major investments in this direction and a complete change in the business model.

Sadly, the companies in Poland already implementing Industry 4.0 solutions and wishing to introduce them represent a small proportion of business entities. The paper's authors aimed to study the limitations and barriers to developing this concept in domestic enterprises, the possibilities of implementing digital solutions in business entities and the impact of clusters on accelerating the digitisation of business entities in the country.

In this paper, the authors presented the limitations and opportunities for implementing Industry 4.0 technologies in cluster member enterprises in the context of studying their digital maturity and the overall state of development of the digital economy and digital society in Poland. Guided by the posed research questions, they assessed the state of digitisation of the Polish economy and its SMEs based on the data from the European Commission's DESI 2022

report. It provided an opportunity to identify constraints and barriers to the digital transformation process of the Polish economy, society and enterprises, including entities belonging to the SME sector. Using the results of the December 2021 survey of the digital maturity of cluster enterprises in Poland (performed for the Future Industry Platform), they determined the level of digital maturity of business units belonging to several selected clusters.

After analysing the results of this study, they found that cluster enterprises tend to have a low level of digital maturity (average ratings were around 3 on a scale of 1-6). However, their performance is higher than that of the companies in the general base. The results obtained in the digital maturity research prove the existence of strong barriers and obstacles to the digitisation of enterprises in Poland. They result from various external and internal conditions. These factors were revealed by the European Commission's DESI 2022 report and the analysis by the article's authors of the results of a study of the digital maturity of cluster companies. Among them are problems related to the quality of human capital and its digital competencies and skills, the inadequate number of IT specialists in the economy and its entities, and insufficient resources needed to implement the concept of Industry 4.0. In addition, they diagnosed connectivity infrastructure barriers in Poland, regulatory gaps in the digitisation of the economy and its businesses, and insufficient support for the digital transformation of business entities. They also noted organisational and competence limitations to implementing the Industry 4.0 concept in units owned by Polish capital, especially in the case of micro, small and medium-sized enterprises that were not engaged in export activities and had the longest market experience.

However, the authors' research has shown that clusters, on the one hand, bring together business entities that are more innovative, more and more responsive to the challenges of the modern economy, recognising earlier than others the need to digitise their activities in the face of the fourth industrial revolution. On the other hand, joining them increases the opportunities for business entities to implement Industry 4.0 solutions and achieve higher competitiveness in relation to companies outside the cluster. It is due to the numerous benefits offered by this network form of business organisations.

References

1. Alcácer, V., Cruz-Machado, V. (2019). Scanning the Industry 4.0: A literature review on technologies for manufacturing systems. *Engineering Science and Technology, an International Journal*, Vol. 22, Iss. 3, pp. 899-919, doi:10.1016/j.jestch.2019.01.006.

2. Almeida, F. (2020). The Challenges and Opportunities in the Digitalization of Companies in a Post COVID19 World. *IEEE Engineering Management Review*, Vol. 48, Iss. 3, pp. 97-103, doi:10.1109/EMR.2020.3013206.
3. Audretsch, D.B, Lehmann, E.E. (2006). The role of clusters in knowledge creation and diffusion: an institutional perspective. In: B. Asheim, P. Cook, R. Martin (Eds.), *Clusters and regional development: critical reflections and explorations* (pp. 188-198). London-New York: Routledge.
4. Bahrin, M.A.K., Othman, F.M., Azli, N.H.N., Talib, F.M. (2016). Industry 4.0: A review on industrial automation and robotic. *Jurnal Teknologi*, No. 78(6-13), pp. 137-143. doi:10.11113/jt.v78.9285.
5. Bai, C., Dallasega, P., Orzes, G., Sarkis, J., Sarkis, J. (2020). Industry 4.0 technologies assessment: A sustainability perspective. *International Journal of Production Economics*, Vol. 229, 107776, doi:10.1016/j.ijpe.2020.107776.
6. Balcilar, M. (2020). *COVID-19 Recession: The Global Economy in Crisis*. International Conference on Euroasian Economics, 2-4 September 2020, Baku, Azerbaijan, doi:10.13140/RG.2.2.18258.17608.
7. Basl, J., Doucek, P. (2019). A metamodel for evaluating enterprise readiness in the context industry 4.0. *Information*, Vol. 10(3), 89, doi:10.3390/INFO10030089.
8. Bembenek, B. (2017). Klastry Przemysłu 4.0 w zrównoważonej gospodarce opartej na wiedzy. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, nr 491, pp. 31-44, doi:10.15611/pn.2017.491.03.
9. Bembenek, B.P. (2020). Hackathon dla rozwoju otwartych innowacji w klastrze. *Zeszyty Naukowe Politechniki Poznańskiej. Organizacja i Zarządzanie*, Nr 82, pp. 5-20, doi:10.21008/j.0239-9415.2020.082.01.
10. Bernauer, T., Engels, S., Krammerer, D., Seijas, K., Seijas, J. (2006). Explaining Green Innovation, Ten Years after Porter's Win-Win Proposition: How to Study the Effects of Regulation on Corporate Environmental Innovation? *Center for Comparative and International Studies (CIS), Working Paper, No 17*, pp. 1-16, doi:10.3929/ethz-a-005389056.
11. Bierhold, T. (2018). *For a better understanding of Industry 4.0 – An Industry 4.0 maturity model*. Retrieved from: https://essay.utwente.nl/75330/1/Bierhold_BA_BMS.pdf, 15.12.2022.
12. Bikse, V., Grinevica, L., Rivza, B., Rivza, P. (2022). Consequences and Challenges of the Fourth Industrial Revolution and the Impact on the Development of Employability Skills. *Sustainability*, Vol. 14, 6970, doi:10.3390/su14126970.
13. CEDA (2022). *World Digital Competitiveness Ranking 2022*. Retrieved from: <https://www.ceda.com.au/ResearchAndPolicies/Research/Technology-Innovation/World-Digital-Competitiveness-Ranking-2022>, 29.12.2022.

14. Cenamor, J., Parida, V., Wincent, J. (2019). How entrepreneurial SMEs compete through digital platforms: The roles of digital platforms capacity, network capability and ambidexterity. *Journal of Business Research*, Vol. 100, pp. 196-206, doi:10.1016/j.jbusres.2019.03.035.
15. Chen, Ch.-J., Lin, Y.-Ch., Chen, W.-H., Chao, Ch.-F., Pandia, H. (2021). Role of Government to Enhance Digital Transformation in Small Service Business. *Sustainability*, Vol. 13(3), 1028, doi:10.3390/su13031028.
16. Civelek, M., Gajdka, K., Světlík, J., Vavrečka, V., (2020). Differences in the usage of online marketing and social media tools: evidence from Czech, Slovakian and Hungarian SMEs. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, Vol. 15(3), pp. 537-563, doi:10.24136/eq.2020.024_
17. *Co to jest branża 4.0*. Retrieved from: <https://www.sap.com/poland/insights/what-is-industry-4-0.html>, 21.12.2022.
18. Coman, C., Papica, M.M., Rezeanu, C.I. (2020). The Adoption of Digital Marketing by SMEs Entrepreneurs. In: T. Antipova, Á. Rocha (Eds.). *Digital Science 2019. DSIC 2019. Advances in Intelligent Systems and Computing*, Vol. 1114 (pp. 431-441). Cham: Springer, doi:10.1007/978-3-030-37737-3_37.
19. Corallo, A., Lazoi, M., Lezzi, M. (2020). Cybersecurity in the context of industry 4.0: A structured classification of critical assets and business impacts. *Computers in Industry*, Vol. 114, Iss. C, 103165, doi:10.1016/j.compind.2019.103165.
20. Dalenogare, L.S., Brittes, B.G., Fabián, A.N., Germán, F.A. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, Vol. 204, pp. 383-394, doi:10.1016/j.ijpe.2018.08.019.
21. Deloitte (2018). *Digital Maturity Report 2018*. Retrieved from: <https://www2.deloitte.com/pl/pl/pages/deloitte-digital/Articles/Raport-Digital-Maturity.html>, 21.12.2022.
22. DESI 2022 (2022). Retrived from: <https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2022>, 12.12.2022.
23. Dikhanbayeva, D., Shaikholla S., Suleiman, Z., Turkyilmaz, A. (2020). Assessment of Industry 4.0 Maturity Models by Design Principles. *Sustainability*, Vol. 12(23), 9927, doi:10.3390/su12239927.
24. European Commission. Directorate-General for Research and Innovation (2021a). *Horizon Europe: strategic plan 2021-2024*. Retrieved from: <https://data.europa.eu/doi/10.2777/083753>, 11.11.2022.
25. European Commission (2021b). *2030 Digital Compass: the European way for the Digital Decade*. COM(2021) 118 final. Retrieved from: <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021DC0118&rid=4>, 11.11.2022.

26. Fei, T., Qinglin, Q., Wang, L., Nee, A.Y.C. (2019). Digital twins and cyber–physical systems toward smart manufacturing and Industry 4.0: Correlation and comparison, *Chinese Academy of Engineering, No 5(4)*, pp. 653-661, doi:10.1016/j.eng.2019.01.014.
27. Flamini, M., Naldi, M. (2022). Maturity of Industry 4.0: A Systematic Literature Review of Assessment Campaigns. *Journal of Open Innovation: Technology, Market, and Complexity*, 8, 51. <https://doi.org/10.3390/joitmc8010051>.
28. Frankowska, M. (ed.). (2012). *Tworzenie wartości w klastrze*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.
29. Fundacja DigitalPoland (2022). *Stan cyfryzacji Polski na tle regionu_2022*. Warszawa.
30. Fundeanu, D.D., Badele, C.S. (2014). The impact of regional innovative clusters on competitiveness. *Procedia – Social and Behavioral Science, Vol. 124*, pp. 405-414, doi:10.1016/j.sbspro.2014.02.502.
31. Gagnidze, I. (2022). Industry 4.0 and industry 5.0: can clusters deal with challenges? (A systemic approach). *Kybernetes*, doi:10.1108/K-07-2022-1005.
32. Gajdzik, B. (2022). Steel Company in Industry 4.0: Diagnosis of Changes in Direction to Smart Manufacturing based on Case Study. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 160*, pp. 193-211, doi:10.29119/1641-3466.2022.160.13.
33. Ghobakhloo, M. (2018). The future of manufacturing industry: a strategic roadmap toward Industry 4.0. *Journal of Manufacturing Technology Management, Vol. 29(6)*, pp. 910-936, doi:10.1108/JMTM-02-2018-0057.
34. Glass, R., Meissner, A., Gebauer, Ch., Stümer, S., Metternich, J. (2018). Identifying the barriers to Industrie 4.0. *Procedia CIRP, Vol. 72*, pp. 985-988, doi:10.1016/j.procir.2018.03.187.
35. Gökalp, E., Şener, U., Eren, P.E. (2017). Development of an Assessment Model for Industry 4.0: Industry 4.0-MM. In: A. Mas, A. Mesquida, R. O'Connor, T. Rout, A. Dorling (Eds.), *Software Process Improvement and Capability Determination. SPICE 2017. Communications in Computer and Information Science, Vol. 770*. Cham: Springer, doi:10.1007/978-3-319-67383-7_10.
36. Götz, M. (2018). Przemysł czwartej generacji (przemysł 4.0) a międzynarodowa współpraca gospodarcza. *Ekonomista, nr 4*, pp. 385-403.
37. Götz, M. (2019). The Industry 4.0 induced agility and new skills in clusters. *Foresight and STI Governance, Vol. 12, No. 2*, pp. 72-83, doi:10.17323/25002597.2019.2.72.83.
38. Götz, M. (2020). Primer on the cluster impact on internalisation in the form of FDI in the time of Industry 4.0. *European Spatial Research and Policy, Vol. 27, No. 1*, pp. 195-220, doi:10.18778/1231-1952.27.1.09.
39. Grabowska, S. (2019). Industry 4.0 Challenges for business model. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 136*, pp. 137-144, doi:10.29119/1641-3466.2019.136.11.

40. Guimarães, L.G.A., Blanchet, P., Cimon, Y. (2021). Collaboration among Small and Medium-Sized Enterprises as Part of Internationalization: A Systematic Review. *Administrative Sciences, Vol. 11(4)*, pp. 153, doi:10.3390/admsci11040153.
41. Harari, Y. (2018). *21 lekcji na XXI wiek*. Kraków: Wydawnictwo Literackie.
42. He, L. (2022). Industry 4.0 Oriented Distributed Infographic Design. *Hindawi, Mobile Information Systems*, doi:10.1155/2022/4743216.
43. Hoque, A.K.M.F. (2019). *4th Industrial Revolution: Impact and Challenges*, Conference: National Conference on Electronics and Informatics jointly organized by Bangladesh Electronics Informatics Society and Bangladesh Atomic Energy Commission held at Atomic Energy Centre, Dhaka during 4-5 December 2019, Retrieved from: https://www.researchgate.net/publication/337830441_4th_Industrial_Revolution-Impact_and_Challenges, 21.12.2022.
44. Iersel, J., Konstantinou, N. (2016). Opinion of the European Economic and Social Committee on 'Industry 4.0 and digital transformation: where to go'. *Official Journal of the European Union* (COM(2016) 180 final). Retrieved from <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52016AE1017>, 12.12.2022.
45. INCIT. (2022). *The Smart Industry Readiness Index*. Retrieved from: <https://incit.org/services/siri/>, 12.12.2022.
46. Janikowski, R. (2017). Środowiskowe aspekty czwartej rewolucji przemysłowej, *Studia i Prace WNEIZ US, nr 47/2*, pp. 67-76, doi:10.18276/SIP.2017.47/2-06.
47. Jasińska, K. (2021). The Digital Chasm between an Idea and Its Implementation in Industry 4.0 – The Case Study of a Polish Service Company. *Sustainability, Vol. 13*, 8834, doi:10.3390/su13168834.
48. Kagermann, H., Wahlster W., Helbig J. (2013). *Recommendations for Implementing the Strategic Initiative Industrie 4.0: Final Report of the Industrie 4.0*. Berlin: Working Group Forschungsunion.
49. Kamble, S.S., Gunasekaran, A., Gawankar, S.A. (2018). Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. *Process Safety and Environmental Protection, Vol. 117*, pp. 408-425. doi:10.1016/j.psep. 2018.05.009.
50. Kang, H. S., Yeon Lee, J., Choi, S., Kim, H., Hee Park, J., Yeon Son, J., Hyun Kim, B., Do Noh, S. (2016). Smart manufacturing: Past research, present findings, and future directions. *International Journal of Precision Engineering and Manufacturing - Green Technology, Vol. 3(1)*, pp. 111-128, doi:10.1007/s40684-016-0015-5.
51. Kowalski, A.M. (2013). *Znaczenie klastrów dla innowacyjności gospodarki w Polsce*. Warszawa: Oficyna Wydawnicza Szkoła Główna Handlowa.
52. Kowalski, A.M. (2022). *Uwarunkowania i metody cyfryzacji łańcuchów wartości w klastrach*. Warszawa: Platforma Przemysłu Przyszłości.

53. Kuroda, H. (2020). COVID-19 and the Global Economy: Impact and Challenges - From Asia's Perspective. Speech at the 62nd Annual Meeting of the National Association for Business Economics. Retrieved from: <https://www.bis.org/review/r201007d.pdf>, 8.11.2022.
54. Leyh, Ch., Schäffer, T., Bley, K., Forstehäusler, S. (2016). SIMMI 4.0 – A Maturity Model for Classifying the Enterprise-wide IT and Software Landscape Focusing on Industry 4.0. *Proceedings of the Federated Conference on Computer Science and Information Systems, Vol. 8*, pp. 1297-1302, doi:10.15439/2016F478.
55. Lichtblau, K., Stich, V., Bertenrath, R., Blum, M., Bleider, M., Millack, A., Schmitt, K., Schmitz, E., Schröter, M. (2015). *IMPULS—Industrie 4.0 Readiness*. Aachen-Köln: Impuls-Stiftung des VDMA. Retrieved from: <https://www.industrie40-readiness.de>, 15.12.2022.
56. Lin, T.-Ch., Wang, K.J., Sheng, M.L. (2020). To assess smart manufacturing readiness by maturity model: a case study on Taiwan enterprises. *International Journal of Computer Integrated Manufacturing, Vol. 33, Iss. 1*, pp. 102-115, doi:10.1080/0951192X.2019.1699255.
57. Liu, Y., Xu, X. (2017). Industry 4.0. and cloud manufacturing: A comparative analysis. *Journal of Manufacturing Science and Engineering, Vol. 139*, 034701, doi:10.1115/1.4034667.
58. Lacka, I., Supron, B. (2021). The Impact of COVID-19 on Road Freight Transport Evidence from Poland. *European Research Studies Journal, Vol. 24, Special Iss. 3*, pp. 319-333, doi:10.35808/ersj/2431.
59. Łacka, I. (2018). Industrial clusters as a device of stimulation of cooperation and innovation of small and medium-sized enterprises in the area of bio-economy. *Acta Scientiarum Polonorum. Oeconomia, Vol. 17, No. 2*, pp. 68-78, doi:10.22630/ASPE.2018.17.2.22.
60. McKinsey and Company (2015). *Industry 4.0 How to navigate digitization of the manufacturing sector*. Retrieved from: <https://www.mckinsey.com/capabilities/operations/our-insights/industry-four-point-o-how-to-navigae-the-digitization-of-the-manufacturing-sector>, 12.12.2022.
61. McPhillips, M. (2020). Innovation by proxy – clusters as ecosystems facilitating open innovation. *Journal of Entrepreneurship, Management and Innovation, Vol. 16(3)*, pp. 101-128, doi:10.7341/20201634.
62. Mishra, M.K. (2020). *The World after COVID-19 and its impact on Global Economy*. Kiel-Hamburg: ZBW - Leibniz Information Centre for Economics. Retrieved from: <http://hdl.handle.net/10419/215931>, 10.11.2022.
63. Mittal, S., Khan, M.A., Romero, D., Wuest, T. (2018). A critical review of Smart Manufacturing & Industry 4.0 maturity models: Implications for small and medium size enterprises (SMEs). *Journal of Manufacturing Systems, Vol. 49*, pp. 194-214, doi: 10.1016/j.jmsy.2018.10.005.

64. Moszkowicz, K., Bembenek, B. (2017). Innowacyjność polskich klastrów - strategiczne wyzwanie w zarządzaniu klastrami. *Organizacja i Kierowanie*, nr 4, pp. 27-45.
65. Müller, J.M. (2019). Assessing the barriers to Industry 4.0 implementation from a worker's perspective. *IFAC PapersOnLine*, Vol. 52(13), pp. 2189-2194, doi:10.1016/j.ifacol.2019.11.530.
66. Nosalska, K., Śledziwska, K., Włoch, R., Gracel, J. (2020). *Wsparcie dla Przemysłu 4.0 w Polsce. Prototyp narzędzia oceny dojrzałości cyfrowej przedsiębiorstw produkcyjnych*. Warszawa: Ministerstwo Rozwoju Przedsiębiorczości, DELab UW.
67. OECD (2021). *The Digital Transformation of SMEs. OECD Studies on SMEs and Entrepreneurship*. Paris: OECD Publishing, doi:10.1787/dbd9256a-en.
68. Pacchini, A.P.T., Lucatoa, W.C., Facchini, F., Mummolo, G. (2019). The degree of readiness for the implementation of Industry 4.0. *Computers in Industry*, Vol. 113, Iss. C, <https://doi.org/10.1016/j.compind.2019.103125>.
69. Peter, M.K., Vecchia, D.M. (2020). The Digital Marketing Toolkit: A Literature Review for the Identification of Digital Marketing Channels and Platforms. In: R. Dornberger (Ed.), *New Trends in Business Information Systems and Technology. Studies in System, Decision and Control*, Vol. 294. Cham: Springer, doi:10.1007/978-3-030-48332-6_17.
70. Platforma Przemysłu Przyszłości (2020). *Samoocena dojrzałości cyfrowej*. Retrieved from: <https://przemyslprzyszlosci.gov.pl/formularze/samoocena-dojrzalosci-cyfrowej/>, 29.12.2022.
71. Platforma Przemysłu Przyszłości (2022). *Dojrzałość cyfrowa*. Definicja. Retrieved from: <https://przemyslprzyszlosci.gov.pl/tag/dojrzalosc-cyfrowa/#desc-bottom>, 21.12.2022.
72. Polski Przemysł (2021). *Technologia 5G filarem rozwiązań Przemysłu 4.0 w zakładach produkcyjnych*. Retrieved from: <http://polskiprzemysl.com.pl/it-dla-przemyslu/siec-5g-w-infrastrukturze-przemyslowej>, 27.12.2022.
73. Porter, M. (1998). Clusters and the New Economics of Competition. *Harvard Business Review*, Vol. 76, No. 6 (November-December), pp. 77-90. Retrieved from: <https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition>, 2.12.2022.
74. PWC (2016). *Industry 4.0: Building the digital enterprise*. Retrieved from: <https://www.pwc.com/gx/en/industries/industrial-manufacturing/publications/assets/pwc-building-digital-enterprise.pdf>, 10.11.2022.
75. Roblek, V., Meško, M., Krapež, A. (2016). A complex view of Industry 4.0. *SAGE Open*, Vol. 6(2), 215824401665398, doi:10.1177/2158244016653987.
76. Rupeika-Apoga, R., Petrovska, K. (2022). Barriers to Sustainable Digital Transformation in Micro-, Small-, and Medium-Sized Enterprises. *Sustainability*, Vol. 14, 13558. doi:10.3390/su142013558.
77. Schroeder, A., Bigdeli, A.Z., Zarcos, C.G., Baines, T. (2019). Capturing the benefits of industry 4.0: A business network perspective. *Production Planning & Control*, Vol. 30, Iss. 16, pp.1305-1321, doi:10.1080/09537287.2019.1612111.

78. Schuh, G., Anderl, R., Gausemeier, J., Hompel, M., Wahlster, W. (Eds.), *Industrie 4.0 Maturity Index. Managing the Digital Transformation of Companies. The acatech STUDY series*. Retrieved from: https://www.acatech.de/wp-content/uploads/2018/03/acatech_STUDIE_Maturity_Index_eng_WEB.pdf, 2.12.2022.
79. Schumacher, A., Erol, S., Sihn, W. (2016). A maturity approach for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia Cirp*, Vol. 52, pp. 161-166. doi:10.1016/j.promfg.2021.07.007.
80. Schwab, K. (2018). *Czwarta rewolucja przemysłowa*. Warszawa: Wydawnictwo Studio Emka.
81. Schwab, K., Zahidi, S. (Eds.) (2021). *The Global Risks Report 2021*. Geneva: World Economic Forum.
82. Senna, P.P., Ferreira, L.M.D.F., Barros, A.C., Roca, J.B., Magalhaes, V. (2022). Prioritizing barriers for the adoption of Industry 4.0 technologies. *Computers & Industrial Engineering*, Vol. 171, 108428, doi:10.1016/j.cie.2022.108428.
83. Siuta-Tokarska, B. (2021). Przemysł 4.0 i sztuczna inteligencja: szansa czy zagrożenie dla realizacji koncepcji zrównoważonego i trwałego rozwoju? *Nierówności Społeczne a Wzrost Gospodarczy*, nr 65, pp. 7-26, doi:10.15584/nsawg.2021.1.1.
84. Statista (2022). *Country-level digital competitiveness rankings worldwide as of 2022*, <https://www.statista.com/statistics/1042743/worldwide-digital-competitiveness-rankings-by-country/>, 29.12.2022.
85. Styvén, M.E., Wallström, A. (2019). Benefits and barriers for the use of digital channels among small tourism companies. *Scandinavian Journal of Hospitality and Tourism*, Vol. 19(1), pp. 27-46, doi:10.1080/15022250.2017.1379434.
86. Suleiman, Z., Shaikhollata, S., Dikhanbayeva, D., Shehab, E., Turkyilmaz, A. (2022). Industry 4.0: Clustering of concepts and characteristics. *Cognet Engineering*, Vol. 9:1, 2034264, doi:10.1080/23311916.2022.2034264.
87. Szász, L., Demeter, K., Rácz, B.-G., Losonci, D. (2021). Industry 4.0: a review and analysis of contingency and performance effects. *Journal of Manufacturing Technology Management*, Vol. 32, No. 3, pp. 667-694, doi:10.1108/JMTM-10-2019-0371.
88. Szwajca, D., Rydzewska, A. (2022). Digital transformation as a challenge for SMES in Poland in the context of crisis relating to COVID-19 pandemic. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, No. 161, pp. 289-305, doi:10.29119/1641-3466.2022.161.20.
89. Śledziewska, K., Włoch, R. (2020). *Gospodarka cyfrowa. Jak nowe technologie zmieniają świat*. Warszawa: Wydawnictwa Uniwersytetu Warszawskiego.
90. *The Smart Industry Readiness Index*. Retrieved from: <https://www.edb.gov.sg/en/about-edb/media-releases-publications/advanced-manufacturing-release.html>, 12.12.2022.

91. Tutak, M., Brodny, J. (2022). Business Digital Maturity in Europe and Its Implication for Open Innovation. *Journal of Open Innovation: Technology, Market and Complexity*, Vol. 8, 27, doi:10.3390/joitmc8010027.
92. Vartolomei, V.C., Avasilcai, S. (2019). Challenges of digitalization process in different industries. Before and after. *IOP Conference Series: Materials Science and Engineering*, No. 568, 012086, doi:10.1088/1757-899X/568/1/012086.
93. Wang, S., Wan, J., Li, D., Zang Ch. (2016). Implementing smart factory of Industrie 4.0: An outlook. *International Journal of Distributed Sensor Networks*, Vol. 12, No. 1, pp. 1-10, doi:10.1155/2016/3159805.
94. Wieczorek, P. (2018). Czwarta rewolucja przemysłowa. *Państwo i Społeczeństwo*, nr 3, pp. 89-115.
95. Wiesmüller, M. Industrie 4.0: surfing the wave? *E&I Elektrotechnik und Informationstechnik*, Vol. 131, 197, doi:10.1007/s00502-014-0217-x.
96. Williams, Ch., Schallmo, D., Lang, K., Boardman, L. (2019). Digital Maturity Models for Small and Medium-sized Enterprises: A Systematic Literature Review. *The ISPIM Innovation Conference – Celebrating Innovation: 500 Years Since da Vinci, Florence, Italy on 16-19 June 2019*, https://www.researchgate.net/profile/Christopher-Williams-61/publication/334108295_Digital_Maturity_Models_for_Small_and_Medium-sized_Enterprises_A_Systematic_Literature_Review/links/5d1721e2299bf1547c872612/Digital-Maturity-Models-for-Small-and-Medium-sized-Enterprises-A-Systematic-Literature-Review.pdf, 21.12.2022.
97. Wojdyła, P., Frankowska, M., Cheba, K., Ławicka, M. (2021). *Badanie dojrzałości cyfrowej przedsiębiorstw klastrowych. Raport z badań*. Warszawa: Fundacja Platforma Przemysłu Przyszłości.
98. World Bank (2022). *Living Up to Potential in the Wake of Adverse Shocks: PART 2 - Growth Over the Next Decade*. Washington: International Bank for Reconstruction and Development/The World Bank.
99. Xu, L.D., Xu, E.L., Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal Production Resources*, Vol. 56, pp. 2941-2962, doi:10.1080/00207543.2018.1444806.
100. Yüksel, H. (2022). Industry 4.0 transformation: factors affecting adoption and impacts on companies. *International Journal of Industrial Engineering and Operations Management*, Vol. 4, No. 3, pp. 63-89, doi:10.1108/IJIEOM-06-2022-0020.
101. Zervoudi, E.K. (2020). Fourth Industrial Revolution: Opportunities, Challenges, and Proposed Policies. In: A. Grau, Z. Wang (Eds.), *Industrial Robotics - New Paradigms* (pp. 1025), Intechopen, doi:10.5772/intechopen.90412.
102. Zhu, G., Chou, M.C., Tsai, C.W. (2020). Lessons Learned from the COVID-19 pandemic exposing the shortcomings of current supply chain operations: A long-term prescriptive offering. *Sustainability*, Vol. 12(14), 5858, doi:10.3390/su12145858.

DYNAMIC INNOVATION CAPABILITIES OF ENTERPRISES

Joanna MACHNIK-SŁOMKA

Silesian University of Technology, Faculty of Organization and Management, Department of Management,
Zabrze; joanna.machnik-slomka@polsl.pl, ORCID: 0000-0001-5387-5909

Purpose: The aim of the article is to characterise and identify the role of dynamic innovative capabilities in enterprise development.

Design/methodology/approach: The research was conducted using a standardised structured interview questionnaire with managers of aviation companies in Poland.

Findings: The results of the study indicate the importance of dynamic innovation capabilities in improving competitiveness as well as coping with a dynamic environment.

Research limitations/implications: A limitation of the research conducted is the size of the research sample. This may provide an indication of the direction of future research concentrating on cross-sectional studies in companies from other sectors. This would provide a basis for formulating conclusions with a higher degree of generalisability.

Practical implications: The theoretical considerations presented and the conclusions drawn from the research can provide enterprise managers with valuable information on the use of dynamic capabilities to integrate, reconfigure and renew their resources for innovation.

Social implications: Enterprise managers should be aware of the importance and relevance of dynamic innovation capabilities in the context of contemporary challenges and enhancing innovation and competitiveness.

Originality/value: Due to its cognitive value and high practical relevance for business managers, the paper contributes on the role of dynamic innovative capacity by providing a voice in the ongoing discussion.

Keywords: dynamic innovation capabilities, innovation management, innovation, dynamic capability, competitive advantage.

Category of the paper: Research paper.

1. Introduction

The issue of dynamic innovative capacity is part of the current discussion focusing on finding new and better ways for companies to overcome emerging problems. It is an important issue in view of the contemporary challenges faced by enterprises struggling with the need to respond dynamically and flexibly to fast-moving changes, unexpected events that are difficult

to predict the so-called “black swans”. This is particularly relevant in a turbulent environment marked by economic crisis (Ledesma-Chaves, Arenas-Gaitán, 2022). This implies the need for a creative and innovative approach to find the best solutions and make bold decisions with the right capabilities. It also seems important for companies to adopt strategies that are geared towards exploiting the opportunities provided by these unpredictable events.

Dynamic innovative capacity fits in with the assumptions and strategic goals of EU innovation policy related to enhancing the innovativeness and competitiveness of EU countries. Indeed, innovation is an important factor in enhancing competitiveness. Thus, having the right dynamic innovative capabilities as evidenced by many authors translates into increased efficiency and competitive advantage (e.g. Calantoe et al., 2002; Tsai, Tsai, 2010; Zhang et al., 2013; Cheng, Chen, 2013; Breznik, Lahovnik, 2014; Han, Li, 2015; Saunila, 2016; El Bassiti, 2018).

The concept of dynamic innovation capability is based on the *dynamic capabilities concept* (DCC), *resource-based view* (RBV) and innovation theory. Despite the growing interest in this topic, both by practitioners and researchers, dynamic innovative capability is a construct that is poorly recognised and crystallised. It is a complex and multidimensional concept that, as an analysis of the literature shows, is associated with many concepts and models. This is indicated by many authors such as, for example, Stawasz (2014); Ledesma-Chaves, Arenas-Gaitán (2022). Besides, the very concept of dynamic capabilities on which the analysed construct is based is full of ambiguities, contradictions based on heterogeneous theory (Barreto, 2010; Matwiejczuk, 2016; Stańczyk-Hugiet, 2017). Therefore, tackling the topic related to deepening the knowledge of dynamic innovation capabilities and its role in the context of competitive advantage seems an interesting and necessary cognitive and research endeavour. In particular, the focus has been on its ability to integrate, renew and reconfigure resources for innovation management, creation and implementation of different types of innovations. In the face of contemporary challenges, the importance of the capacity for *innovation ambidextrous* was also recognised. The considerations presented and the results of the research carried out are part of a broader study that focused on the creation of a model of the innovative capacity of enterprises (Machnik-Słomka, 2020).

2. The role of dynamic innovative capacity in enterprise development

Dynamic capability, as indicated in the literature, is often exposed in the context of a turbulent environment as the capacity for an organisation to behave in a way that promotes competitiveness (Stańczyk-Hugiet, 2017). Due to the perception of the environment, Ambrosini, Bowman, Collier (2009) propose to divide dynamic capabilities into three levels: incremental dynamic capabilities (level one); renewing dynamic capabilities (level two) and

regenerative dynamic capabilities (level three). When implementing innovation processes, it is therefore worth taking into account the relevant dynamic innovation capabilities depending on the dynamics of the environment (Bessant, Philips, 2013). Stańczyk-Hugiet (2017) concludes that *dynamic capabilities as a general idea fit into the dream of perfect adaptability*.

In the literature, many authors (Lawson, Samson, 2001; Wang, Ahmed, 2007; Breznik, Hisrich, 2014) emphasise the link between the concept of dynamic capabilities and the concept of innovative capabilities. Although, as Alves et al. (2017) argue, this relationship is under-recognised and requires identifying which capabilities of firms actually drive innovation. In view of this, the construct of dynamic innovation capability, against the background of the recognition of the general concept of dynamic capabilities, appears to be fragmented and ambiguous. Cheng, Chen (2013) identify dynamic innovation capabilities as capabilities created and used to manage the innovation process. Wang, Ahmed (2007) treat innovation capability as an important component of dynamic capabilities. Teece et al. (1997) indicate that innovation results from the capabilities of a given enterprise in coping with a turbulent and constantly changing environment. Cheng, Lin (2012). following Yam et al. (2011) assume that innovation is a dynamic capability understood as a stable pattern of collective action through which an organisation, aiming to improve performance, can systematically create and improve operational routines. Ledesma-Chaves and Arenas-Gaitán (2022), on the other hand, advocate viewing the concept of innovation capability as an independent capability, highlighting that there is not always a relationship between a company's possession of dynamic capabilities and the achievement of competitive advantages and the innovativeness of these firms. Identifying these relationships is therefore an interesting direction for further research that needs to be deepened.

It is generally recognised that dynamic capabilities are the capacities to *integrate, build and reconfigure internal and external resources/competencies to accommodate and shape a rapidly changing business environment* (Teece et al., 1997). This is emphasised in the work of many other authors such as Lawson, Samson (2001); Cheng, Chen (2013); Breznik, Lahovnik (2014); Han, Li (2015); Ledesma-Chaves, Arenas-Gaitán (2022). The integration of resources used for innovation activities can foster synergies through which innovation processes can be more efficient and translate into greater competitiveness of the firm. Reconfiguration of resources may involve proactive or reactive adaptation to internal and external changes (Wojcik-Karpacz, 2014).

Enterprise capabilities, according to M. Bratnicki (2008), concern the ability and skills to perform specific tasks and implement processes. Similarly, Forsman (2009) argues that innovation capability is based on activities. Relating this to innovation capability in the sphere of innovation management according to the OSLO Manual (2018), these activities can be referred primarily to:

- the creation of strategies, the setting of goals, the establishment of appropriate structures, processes, roles and ways of evaluating them for innovation,
- systematic planning, management and control of resources (internal and external) focused on innovation,
- allocating resources to innovation activities related to the organisation, internal and external collaboration supporting learning processes and performance monitoring.

Innovation capability is therefore a certain set of diverse capabilities that use resources for the implementation of innovation management tasks, which are focused on the achievement of the set outcomes, competitive advantage.

Based on a literature analysis based on the concept of dynamic capability, innovation theory, the following characteristics of dynamic innovation capability can be identified (e.g. Teece et al., 1997; Cheng, Chen, 2013; Matwiejczuk, 2014; Wijekoon, Galahityawe, 2016; Wojcik-Karpacz, 2017):

- strategic orientation,
- development orientation,
- capacity to create and implement innovations (both product and business process),
- rapid detection and exploitation of emerging opportunities,
- creating stakeholder value in response to identified needs,
- capacity to integrate, reconfigure and renew resources to manage innovation processes in response to changes in the environment,
- fostering effective systemic innovation management,
- capacity to raise and renew competitive advantages in the long term,
- increasing the role of capabilities in a turbulent environment.

Increasing attention in the literature focuses on ambidextrous innovation, often understood as the capacity to simultaneously implement radical innovation and incremental innovation (e.g. He, Wong, 2004; Zelong et al., 2011; Stelmaszczyk, 2017; Martin et al., 2017). Although it is a relatively under-recognised construct it seems to be of great importance in the context of increasing the competitiveness of companies in a dynamic environment by targeting not only incremental but also radical innovations. This creates greater opportunities for gaining competitive advantage in the long term through radical innovation.

3. Research methods

Based on the analysis of the literature, the research presented on dynamic innovative capacity considers:

- the capacity to integrate, reconfigure, renew and reconstitute its innovation resources in response to a changing environment,
- the capacity to identify market opportunities and adapt to trends,
- the capacity to simultaneously implement radical and incremental innovations.

The research was conducted in 2019-2020 with managers of aerospace companies in Poland taking into account the criterion of belonging to this industry according to PKD (30.3 PKD). It is worth emphasising in the context of the conducted research on dynamic innovative capacity that enterprises in this sector are classified as *high-tech* industries according to Eurostat or OECD (Nauka i Technika w 2017 r., 2019). This is associated with the high intensity of R&D activities carried out by these companies. This influenced the selection of the sector for research in this area.

The research used a standardised structured interview questionnaire. A random sampling method was used to select respondents for the study. The identified variables in terms of dynamic innovative capability (DIC) were assessed at five levels of maturity (from 1 meaning that a given practice does not exist to 5 - true everywhere) adopting a description of each level based on the PN-ISO 10014:2008 (2008) standard. A correlation analysis was also performed between the variables of dynamic innovative capability and competitive advantage (CA). A factor analysis of the variables of these constructs was conducted before assessing the correlation. Competitive advantage was assessed on a five-point Likert scale (1 - worst in the industry, 2 - worse than the industry average, 3 - same as the industry, 4 - better than the industry average, 5 - best in the industry).

The following methods were used during the data collection phase: PAPI (*Paper And Pen Interview*), CATI (*Computer Assisted Telephone Interview*) and CAWI (*Computer Assisted Web Interview*).

Calculations were carried out using the PS IMAGO PRO 5.1. software and the STATISTICA programme.

4. Results and discussion

The study sample comprised 53 companies in the aviation industry in Poland out of 234 active entities in this industry registered in 2019 (Główny Urząd Statystyczny, 2019). The structure of the surveyed enterprises in terms of size is presented in Table 1.

Table 1.
Structure of the surveyed enterprises in terms of size

Size of the enterprise	Micro and small enterprises (up to 49)	88.68%
	Medium-sized enterprises (50 to 249)	5.66%
	Large enterprises (over 250)	5.66%

Source: Own study.

As can be seen from the data presented in Table 1, micro and small enterprises constituted the largest group among the surveyed enterprises (88.68%), followed by medium and large enterprises at 5.66% each. Compared to the statistical data, the structure of the sample is similar to that of the whole population.

Table 2 shows the maturity levels (rated on a scale of 1 to 5) for each of the five variables of the dynamic innovative capability (DIC) dimension.

Table 2.
Maturity level of the dynamic innovation capability (DIC) dimension variables

Symbol	Variables	Average level
DIC_1	The firm has the capacity to integrate resources for innovation in response to a rapidly changing environment	3.91
DIC_2	The firm has the capacity to renew and recreate its resources for innovation in reaction to a changing environment	3.79
DIC_3	The firm has the capacity to reconfigure its innovation resources in reaction to a changing environment	3.72
DIC_4	The firm has the capacity to react and adapt to trends and identify market opportunities	4.13
DIC_5	The firm has the capacity to simultaneously realise (develop and implement) radical innovation and incremental innovation	3.64

Source: Own study.

From the data presented in Table 2, it can be seen that the highest value for maturity level was obtained by the variable DIC_4 on having the capacity to react and adapt to trends and identify market opportunities (4.13). This capability is strongly emphasised in the literature by many authors in the context of the role of dynamic innovation capability. The next variable assessed in terms of the value obtained was the DIC_1 variable related to the capacity to integrate resources for innovation in response to rapid changes in the environment (3.91). On the other hand, the lowest value obtained was the DIC_5 variable related to the capacity to implement radical and incremental innovations simultaneously.

Descriptive statistics are presented for the individual variables of the DIC dimension in Table 3.

Table 3.*Descriptive statistics of the dynamic innovation capability (DIC) dimension variables*

Symbol	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile	Standard deviation	Coefficient of variation
DIC_1	3.91	4.00	1.00	5.00	3.00	5.00	1.08	27.62
DIC_2	3.79	4.00	2.00	5.00	3.00	5.00	0.95	24.99
DIC_3	3.72	4.00	1.00	5.00	3.00	5.00	1.15	30.93
DIC_4	4.13	4.00	2.00	5.00	3.00	5.00	0.98	23.75
DIC_5	3.64	4.00	2.00	5.00	3.00	4.00	0.96	26.44

Source: Own study.

The results presented in Table 3 show that the minimum value of the DIC maturity level is 1.00 (for the variables DIC_1 and DIC_3) and the maximum value is 5.00. The median value for all the variables assessed is 4.00. The highest coefficient of variation can be observed for the variable DIC_3 concerning the capacity to reconfigure its resources for innovation in reaction to a changing environment (30.93) which is associated with the highest variation in values. The lowest variability is for the DIC_4 variable related to the capacity to react and adapt to trends and identify market opportunities (23.75).

The study measured competitive advantage and also examined the relationships between the variables of dynamic innovative capability and competitive advantage (CA).

Table 4 shows the basic descriptive statistics of the competitive advantage construct.

Table 4.*Descriptive statistics of competitive advantage (CA)*

Symbol	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile	Standard deviation	Coefficient of variation
CA	3.66	3.67	2.17	4.83	3.33	4.00	0.57	15.57

Source: Own study.

As can be seen from Table 4, the value of the average competitive advantage is 3.66. In order to examine the correlations between the variables of dynamic innovation capability and competitive advantage (CA), Pearson correlation coefficient values were analysed. The results of the analysis showed a positive correlation between the variables of the capacity to integrate, renew, recreate and reconfigure its resources in the area of innovation and the capacity to react and adapt to trends and identify market opportunities. A less correlated variable with competitive advantage was found to be ambidextrous innovation capability related to the capacity to simultaneously implement radical innovation and incremental innovation.

5. Conclusion

Dynamic innovative capability is an increasingly popular research topic due to its high cognitive and practical value. As the literature on the subject and the research results of many authors indicate, this is due to its widely recognised role in the context of company development, increasing competitiveness in a turbulent environment. The activity of enterprises in conditions of high uncertainty and dynamics of change requires appropriate capabilities for coping with difficult conditions.

The study shows that the assessed level of dynamic innovation capability variables is at a relatively high level. This is reflected in the statistical data on aerospace enterprises characterised by higher R&D and innovation intensity. These capabilities, as highlighted in the literature, are particularly important due to the importance of dynamic innovative capability in the context of performance and competitive advantage. This has been confirmed by studies that show positive, positive correlations between dynamic innovative capability variables and competitive advantage. The results complement and confirm existing considerations and research on innovation capability and its role in the context of competitive advantage. These correlations are pointed out by, among others, Guan, Ma (2003); Zhang et al. (2013); Breznik, Lahovnik (2014).

With regard to the research carried out, limitations can be identified that are related to the sample size. At the same time, this points in the direction of future research, which could focus on comparative studies with other companies included in the high-tech industry or cross-sectional studies taking into account different industries. This would allow more general conclusions to be drawn.

The research carried out is a contribution to future in-depth research as part of the ongoing discussion on dynamic innovative capacity.

References

1. Alves, A.C., Barbieux, D., Reichert, F.M., Tello-Gamarra, J., Zawislak, P.A. (2017). Innovation and dynamic capabilities of the firm: Defining an assessment model. *RAE Revista de Administracao de Empresas*, 57(3), 232-244. <http://dx.doi.org/10.1590/s0034-759020170304>.
2. Ambrosini, V., Bowman, C., Collier, N. (2009). Dynamic capabilities: an exploration of how firms renew their resource base. *British Journal of Management*, Vol. 20(1), pp. 9-24.
3. Barreto, I. (2010). Dynamic capabilities: A review of past research and an agenda for the future. *Journal of Management*, Vol. 36, no. 1, 256-280.

4. Bessant, J., Phillips, W. (2013). Innovation management and dynamic capability. In: C. Harland, G. Nassimbeni, E. Schneller (Eds), *The SAGE handbook of strategic supply management* (pp. 353-371). London: Sage Publications Ltd.
5. Bratnicki, M. (2008). Strategiczne dynamizowanie organizacji. Problem i rozwiązanie. In: R. Krupski (ed.), *Zarządzanie strategiczne. Podstawowe problemy*. Prace Naukowe Wałbrzyskiej Wyższej Szkoły Zarządzania i Przedsiębiorczości, s. Zarządzanie (pp. 321-333). Wałbrzych.
6. Breznik, L., Hisrich, R.D. (2014). Dynamic capabilities vs. Innovation capability: Are they related? *Journal of Small Business and Enterprise Development*, 21(3), 368-384. <http://dx.doi.org/10.1108/JSBED-02-2014-0018>.
7. Breznik, L., Lahovnik, M. (2014). Renewing the resource base in line with the dynamic capabilities view. *Journal of East European Management Studies*, Vol. 19(4), pp. 453-485.
8. Calantone, R.J., Cavusgil, T.S., Zhao, Y. (2002). Learning orientation, firm innovation capability and firm performance. *Industrial Marketing Management*, Vol. 31, pp. 515-524.
9. Cheng, C.C., Chen, J.S. (2013). Breakthrough innovation: the roles of dynamic innovation capabilities and open innovation activities. *Journal of Business & Industrial Marketing*, Vol. 28(5), pp. 444-454.
10. Cheng, Y.-L., Lin, Y.-H. (2012). Performance Evaluation of Technological Innovation Capabilities In Uncertainty. *Procedia Soc. Behav. Sci.*, 40, 287-314.
11. El Bassiti, L. (2018). Multi-dimensional view of innovation performance from knowledge dynamics to maturity matrix. *Management Dynamics in the Knowledge Economy*, Vol. 6(1), pp. 67-85.
12. Forsman, H. (2009). Improving innovation capabilities of small enterprises: cluster strategy as a tool. *International Journal of Innovation Management*, Vol. 13, No. 2, pp. 221-243.
13. Główny Urząd Statystyczny (2019). <https://bip.stat.gov.pl/dzialalnosc--statystyki-publicznej/rejestr-regon/liczba-podmiotow-w-rejestrze-regon--tablice/>.
14. Guan, J., Ma, N. (2003). Innovative capability and export performance of Chinese firms. *Technovation*, Vol. 23(9), pp. 737-747.
15. Han, Y., Li, D. (2015). Effects of intellectual capital on innovative performance: the role of knowledge-based dynamic capability. *Management Decision*, Vol. 53(1), pp. 40-56.
16. He, Z.L., Wong, P.K. (2004). Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science*, Vol. 15(4), pp. 481-494.
17. Lawson, B, Samson, D. (2001). Developing Innovation Capability in Organisations: A Dynamic Capabilities Approach. *International Journal of Innovation Management*, Vol. 5, No. 3, pp. 377-400.
18. Ledesma-Chaves, P., Arenas-Gaitán, J. (2022). Dynamic innovation capabilities and their impact on export performance in times of economic crisis. *Revista Brasileira de Gestão de Negócios*, 24(2), pp. 351-365. <https://doi.org/10.7819/rbgn.v24i2.4172>.

19. Machnik-Słomka, J. (2020). *Model zdolności innowacyjnej przedsiębiorstw*. Toruń: TNOIK „Dom Organizatora”.
20. Martin, S.L., Javalgi, R.G., Cavusgil, E. (2017). Marketing capabilities, positional advantage, and performance of born global firms: Contingent effect of ambidextrous innovation. *International Business Review*, Vol. 26, Iss. 3, 527-543.
21. Matwiejczuk, R. (2014). *Kompetencje logistyki w tworzeniu przewagi konkurencyjnej przedsiębiorstwa*. Opole: Wydawnictwo Uniwersytetu Opolskiego.
22. Matwiejczuk, R. (2016). Koncepcja dynamicznych zdolności jako podstawa rozwoju kompetencji przedsiębiorstwa. *Zeszyty Naukowe Politechniki Śląskiej, Organizacja i Zarządzanie*, z. 93. Gliwice.
23. Nauka i technika w 2017 r. (2019). Warszawa-Szczecin: GUS.
24. PN-ISO 10014:2008 (2008). *Zarządzanie jakością. Wytyczne do osiągania korzyści finansowych i ekonomicznych*. Warszawa: Polski Komitet Normalizacyjny
25. Saunila, M. (2016). Performance measurement approach for innovation capability in SMEs. *International Journal of Productivity and Performance Management*, Vol. 65(2), pp. 162-176.
26. Stańczyk-Hugiet, E. (2017). Zdolności dynamiczne – w poszukiwaniu Świętego Grała? In: K. Krzakiewicz, S. Cyfert (eds.), *Strategiczny wymiar dynamicznych zdolności polskich przedsiębiorstw* (pp. 27-45). Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
27. Stawasz, E. (2014). Dynamiczna zdolność innowacyjna – wybrane zagadnienia. *Acta Universitatis Lodzianis Folia Oeconomica*, nr 4(305), pp. 97-105.
28. Stelmaszczyk, M. (2017). Zdolność innowacyjna a „Innovative Ambidexterity”: Rola czynników dzielenia się wiedzą i procesu dzielenia się wiedzą. *Marketing i Rynek*, No. 7, pp. 705-720.
29. Teece, D.J., Pisano, G., Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, No. 18(7).
30. Tsai, M.T., Tsai, C.L. (2010). Innovation capability and performance in Taiwanese 80 science parks: Exploring the moderating effects of industrial clusters fabric. *The International Journal of Organizational Innovation*, Vol. 2(4), pp. 80-103.
31. Wang, C.L., Ahmed, P.K. (2007). Dynamic Capabilities: A Review and Research Agenda. *International Journal of Management Reviews*, Vol. 9, No. 1, pp. 31-51.
32. Wijekoon, A., Galahityawe, N. (2016). Innovativeness of IT Entrepreneurial Firms: The Roles of Knowledge Management and Dynamic Innovation Capabilities. *Sri Lankan Journal of Management*, Vol. 21, No. 2, pp. 37-64.
33. Wójcik-Karpacz, A. (2014). Uzależnienie kontekstualne narzędziowej roli zdolności dynamicznych. In: A. Stabryła, S. Wawak (eds.), *Problemy zarządzania organizacjami w społeczeństwie informacyjnym* (pp. 271-283). Kraków: Mfiles.

34. Wójcik-Karpacz, A. (2017). Zdolności dynamiczne versus zdolności operacyjne. *Organizacja i Kierowanie, nr 1(175)51*, pp. 51-70.
35. Yam, R.C.M., Lo, W., Tang, E.P.Y., Lau, A.K.W. (2011). Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy, 40*, 391-402.
36. Zelong Wei, Yaqun Yi, Changhong Yua (2011). Bottom-up learning, organizational formalization, and ambidextrous innovation. *Journal of Organizational Change Management, Vol. 24, No. 3*, pp. 314-329.
37. Zhang, J.A., Garrett-Jones, S., Szeto, R. (2013). Innovation capability and market performance: The moderating effect of industry dynamism. *International Journal of Innovation Management, Vol. 17(2)*.

THE WINE MARKET IN POLAND AND THE MAIN DETERMINANTS OF ITS DEVELOPMENT – SELECTED ASPECTS

Daria MACIEJEWSKA^{1*}, Dawid OLEWNICKI², Marcin TYMINSKI³, Tomasz KRUPA⁴

¹ Department of Pomology and Horticultural Economics, Institute of Horticultural Sciences, Warsaw University of Life Sciences, Warsaw; daria_maciejewska@sggw.edu.pl, ORCID: 0000-0002-3724-5533

² Department of Pomology and Horticultural Economics, Institute of Horticultural Sciences, Warsaw University of Life Sciences, Warsaw; dawid_olewnicki@sggw.edu.pl, ORCID: 0000-0002-3096-3882

³ Department of Plant Physiology, Institute of Biology, Warsaw University of Life Sciences, Warsaw; marcin_tyminski@sggw.edu.pl, ORCID: 0000-0002-1882-8506

⁴ Department of Pomology and Horticultural Economics, Institute of Horticultural Sciences, Warsaw University of Life Sciences, Warsaw; tomasz_krupa@sggw.edu.pl, ORCID: 0000-0002-2252-250X

* Correspondence author

Purpose: The aim of this study was to assess the changes that occurred in grape production and the wine market in Poland in the years 2009-2021. In addition, an attempt was made to assess the impact of thermal conditions on the development of grape cultivation in Poland.

Design/methodology/approach: Changes in the number of vineyards, grape cultivation areas, grape harvests and the production and sale of wine in Poland were analysed in detail. The analysis was conducted based on data from the National Support Centre for Agriculture (KOWR) and the Institute of Meteorology and Water Management (IMiGW).

Findings: The research indicated that grape cultivation and wine production developed dynamically throughout the period in question. It is worth noting that most of the observed changes took place in the form of an exponential trend, which also points out the level of interest shown among producers and consumers in this industry and its potential. The study also showed that the distribution of vineyards registered at KOWR relative to the thermal conditions in a given region is relatively proportional across voivodeships (provinces). The voivodeships in which, based on the average sum of active temperatures from 2009-2021, relatively conducive conditions for the development of grape cultivation existed were also indicated.

Research limitations/implications: The research period covered only 11 years, this type of research requires further analysis to determine in the long-term further possibilities for the development of wine production in Poland.

Keywords: wine market, vineyards, climate changes, grapes.

Category of the paper: research paper.

1. Introduction

Although Poland is not strongly associated with viticulture in Europe and around the world, its tradition of wine production extends over 1000 years. The first wine region in Poland at that time was found in the area of Kraków, where grapes had been cultivated in the tenth century. Artefacts found on the slopes of Wawel Hill bear witness to this fact. The intensification of viticulture was connected with the spread of Christianity and the use of wine for liturgical purposes (Radziejewicz, 2019). Monks and priests established the first vineyards in the twelfth century in the areas of Gniezno, Poznań, Wrocław and several other episcopal towns. The most prosperous grape cultivation period in the history of our country occurred in the fifteenth and sixteenth centuries. The vineyards of that time were very extensive, and wine produced in them enjoyed such great popularity that it was exported abroad (Kaplan, Suszyna, 2015). Production flourished to such an extent that ordinary settlers began to plant their own vineyards, thanks to which grape cultivation spread throughout the country (Estreicher, 2004). Interestingly, the names of many newly-established settlements were inspired by the word “wine”. Cities such as Winiary, Winnica, Winniki and many others serve as examples (Jaros, 2015). In the seventeenth and eighteenth centuries, there was a so-called “ice age”, during which a significant cooling of the climate occurred, contributing to a decline in grape production throughout the Republic at that time (Kaplan, Suszyna, 2015). Moreover, the economic crisis caused by the wars and policies pursued at the time only exasperated the problem experienced by winemakers (Yiou et al., 2012). Wine production was also out of the question in nineteenth-century Poland due to the several wars and partitions that overcame this country for 123 years (Dobrowolska-Iwanek et al., 2014). The Second World War and the implementation of a new economic system in Poland ruined wine production. In the 1960s, various institutions and oenological centres, including the Grape Factory in Skierniewice, were liquidated (Pink, 2015). It was only in 1984 that a breakthrough took place in this industry when Roman Myśliwiec established the Golesz Vineyard in Jasło. His aim was to revive Poland’s historic wine tradition. Roman Myśliwiec also developed the first native grape variety which was named *Jutrzenka*. The grower himself was awarded the Commander’s Cross of the Order of Polonia Restituta (Wawro, 2011). Poland is a country that has favorable conditions for the cultivation of vines and wine production, with potentially 100,000 hectares of land that can be planted with vines (Poczta, Zagrodzka, 2016).

Climatic changes observed in recent years in Poland may have significantly impacted the acclimatisation and growth of plants typically cultivated in warmer regions in Europe (Olewnicki, 2018). According to Lisek (2008), the average annual temperature in recent decades has indicated an upward trend (around 0.5°C per decade), transitional periods have shortened, warm periods have lengthened, and winters have become milder which allows for the cultivation of several grape varieties. In addition, of all the climatic changes noted over the last few decades, the most significant include changes in annual air temperatures in growing seasons, expressed as the so-called average sum of active temperatures (SAT). The warming of

the climate in recent decades has favoured the development of viticulture and wine production and, above all, the gradual introduction of new grape varieties, immune or highly resistant to disease and with increased resistance to freezing temperatures. Vineyards have been established and developed not only in the voivodships commonly associated with this type of cultivation, i.e., voivodships in southern Poland but increasingly more frequently in the central and northern regions of Poland, which is a positive phenomenon.

The aim of this research was to assess the changes that occurred in grape production and the wine market in Poland in the years 2009-2021. Furthermore, the impact of thermal conditions on the development of viticulture in specific voivodships in Poland was also evaluated.

2. Methodology

This study was conducted based on the entries made in the wine production records kept by the National Centre for Agricultural Support (KOWR) and data obtained from the Institute of Meteorology and Water Management (IMiGW).

The main method of determining the changes occurring in wine production was the trend function, understood as the regression function relative to the time-dependent variant t . Among others, the dynamics of changes in the number of vineyards, grape cultivation areas, and the production and sale of wine in Poland were investigated (assuming 100% as the first year of the research period). The chain indices were calculated (with a variable basis) to determine the annual average rate of the studied changes, measured in a given period ($t_0; t_1$) by the difference between the average chain index of that period and the total value (Górczyński, 2004).

$$r_{t_0; t_1} = t_1 - t_0 \sqrt{\prod_{i=t_0+1}^{t_1} i_{i/i-1}} - 1 = t_1 - t_0 \sqrt{\frac{y_{t_1}}{y_{t_0}}} - 1 \quad (1)$$

For the purposes of assessing thermal conditions occurring in specific voivodeships and their impact on the location of vineyards in Poland, the average sum of active temperatures (SAT, i.e., the average daytime temperatures in growing seasons 10°C and higher, starting from 1 April to 30 October) between 2009 and 2021 were calculated based on IMiGW data. In the case of wine production, the SAT indicator is one of the most important indicators determining the possibility of producing wine in a given area (Rogowski, Kasianchuk, 2016). As many as 129 470 pieces of meteorological data obtained from the majority of meteorological stations found in specific voivodships were used to carry out the calculations. Stations located 400 metres above sea level were excluded due to the fact, as Myśliwiec (2013) indicates, it is best to plant vineyards at levels up to that altitude. The distribution of average SATs in terms of voivodeship were presented on cartograms. Cartographers point out that the most accurate method for developing maps according to this method is using relative data referring

to the entire area of the spatial unit marked on the map (Tomaszewska, 2009). As a result, the G. Jenks's optimisation method, known as the Natural Breaks Classification, was applied while elaborating the choropleth maps included in this study (Jenks, 1967). This method consists in minimising the variance within a separate class and maximising the variance between classes, in effect placing the boundaries of the intervals in the "natural breaks" in the statistical distribution. This is an iterative method that uses the sum of square deviations in particular observations. The analysed units found in a given class are similar in terms of the level of a given indicator; however, neither the same class span nor the same number of objects remains in the class (Paślowski, 1993).

As Dudek et al. (2011) emphasise, some decisions concerning local and regional markets should be taken based on knowledge of the territorial disproportion of market features in statistical terms. A research hypothesis was put forward, according to which the grape cultivation area in specific voivodships was adjusted to their thermal conditions. As the indicator of thermal conditions, a previously calculated SAT indicator was used – the average for 2009-2021. In the case of the cultivation areas, the last year in the study period was used as the current value and most representative of the development of viticulture from the moment records were kept at KOWR. Therefore, Florence's location co-efficient (F) was calculated according to the lowest formula, which may be applied, among others, to assess the distribution of businesses and farms relative to the factor that may determine its number.

$$F = \frac{\frac{1}{2} \sum_{i=1}^n (s_i - u_i)}{100} \quad (2)$$

where:

s – percentage structure of the first studied phenomenon according to spatial units,

u – percentage structure of the second studied phenomenon according to spatial units,

n – number of spatial units.

This indicator may take values ranging from $0 \leq F \leq 1$, where the value 0 signifies complete consistency in the territorial distribution of the two features compared, while the value $F = 1$ signified the territorial inconsistencies.

3. Results

Changes in the wine market

Detailed assessments of changes in Polish wine production can be conducted starting from 2009 when KOWR began to keep records. As Szymańska (2018) indicates, producers began registering themselves at the Agricultural Market Agency (currently KOWR) in 2008 and were included in the 2008-2009 marketing year. At the end of that year, 28 entities were registered. Over the following three marketing years, the number of registrations remained at a similar

level. A significant increase in businesses and producers interested in producing wine to be sold was observed in the 2012/2013 marketing year. This change was partially associated with an amendment to the Act on Production and Bottling of Wine Products, Trade in these Products and Common Organization of the Market in Wine, and further administrative facilitation. In this period, newly planted vineyards also began to enter the production phase. In the 2021/2022 marketing year, there were as many as 380 registered vineyard owners, and the total grape cultivation area encompassed 619.4 ha (Fig. 1). In relation to the 2009/2010 marketing year, the number of registered producers rose by 1709.5% while the grape cultivation areas expanded by 1620.1%. The average annual rate of changes in the number of producers was 27.3%, and in the case of grape cultivation areas, the rate similarly amounted to 26.8%. It should be emphasised that the increase in the number of producers and cultivation areas in the analysed period was exponential, resulting in consequent increases in its absolute values (Fig. 1). The high value of the coefficient of determination (adjustment), which in the case of the number of producers was $R^2=0.9788$ and $R^2=0.9800$ in the case of cultivation areas, attest to this exponential growth. A similar trend was observed in earlier years; however, according to Olewnicki's study (2018), the adjustment to the exponential trend was slightly weaker.

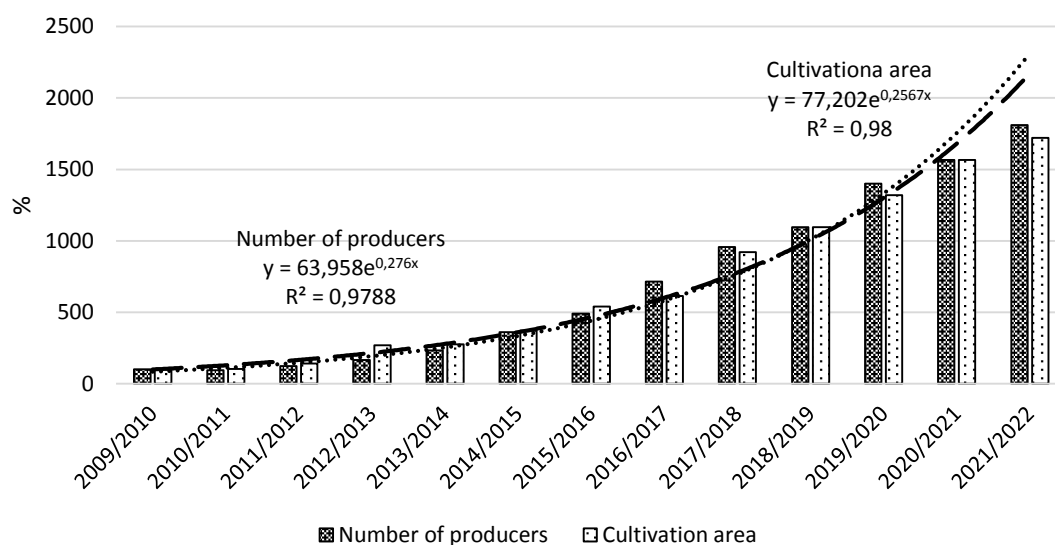


Figure 1. The dynamics of changes in grape cultivation area and the number of wine producers (registered in KOWR) in Poland in the 2009/10-2021/22 marketing years.

Source: own study based on KOWR data.

Overall, grape production has also shown an evident upward trend; however, trends have been slightly different when considering harvests of red and white grape varieties. The highest rate of changes has been noted in white grape varieties, whose harvests have grown exponentially in the analysed period. In the 2021/22 marketing year, 1953.2 tonnes of white grapes were harvested in Poland, i.e., nearly 66 times more than in the first year included in this study. In the case of red grape varieties, 967.3 tonnes were harvested, i.e., nearly 32 times more. In the case of the former, harvests took the form of an increasing linear trend (Fig. 2). The analysis presented above indicates that white grape varieties will continue to dominate over

the upcoming years of grape production in Poland since, as it is worth noting, the average annual increase of these varieties in the entire study period amounted to 41.8% and in the case of red grape varieties – 33.5%.

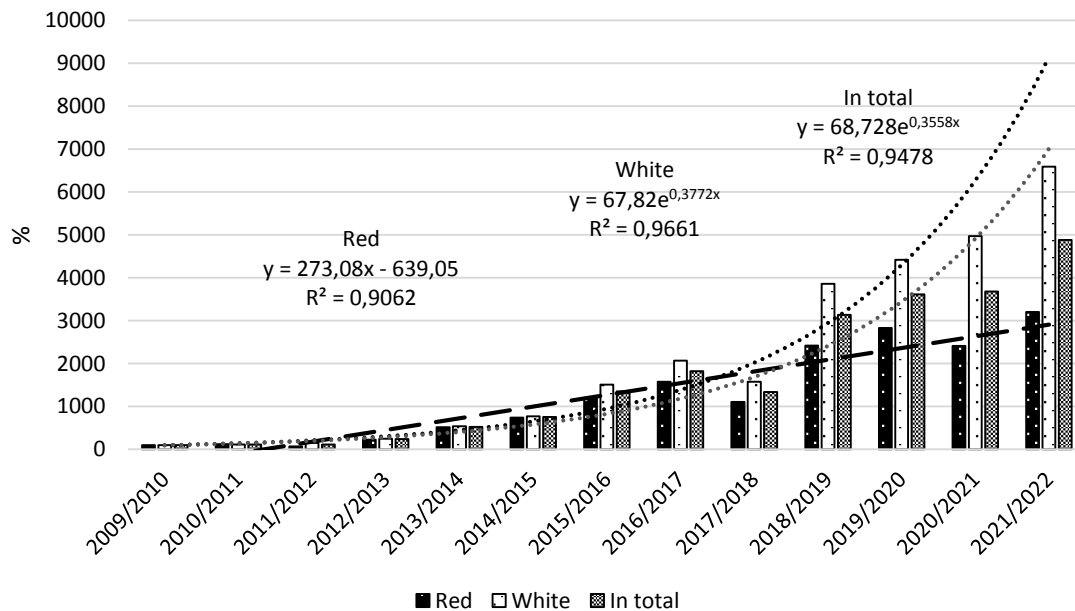


Figure 2. The dynamics of the grape harvest in total and according to red and white varieties in Poland in the 2009/10-2021/22 marketing years.

Source: own study based on KOWR data.

Larger harvests of white grape varieties and their greater dynamics directly translated into increased production of white wines in Poland. In the 2021/22 marketing year, 18 500 hL of wine were produced in Polish vineyards, of which close to 12 100 hL was white wine (approximately a 65% share). The development of viticulture in Poland and the growing fruit harvest resulted in the fact that the production of white wine in the 2021/2022 marketing year was 50 times higher than in the first year analysed (Fig. 3), with an average annual growth rate of 38.7%. Meanwhile, red wine production increased nearly 36 times, with an average annual growth rate of 34.9%. The rate of these changes would probably have been higher had it not been for the poor harvest of both white and red grape varieties noted in the 2017/18 marketing year.

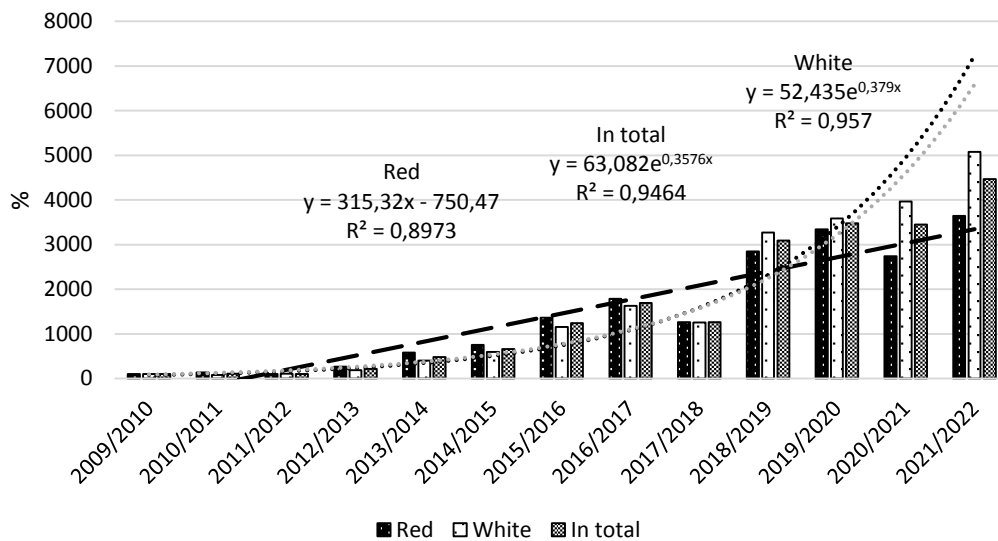


Figure 3. Dynamics of wine production in Poland in total and according to red and white varieties in the 2009/10-2021/22 marketing years.

Source: own study based on KOWR data.

As Szymańska (2018) pointed out, wine consumption in Poland was the lowest in Europe at the beginning of the second half of the last decade. It did not even reach 4 litres per resident, amounting to only 3.2 litres per person. Meanwhile, in France, it amounted to (42.5 litres); in Sweden (26 litres); in Germany (24.8 litres); in Great Britain (22 litres); in Spain (21.3 litres) and in Italy (33.3 litres). However, as the author indicates, the wine market in Poland has a strong growth potential and may accelerate. On this market, the premiumisation trend is growing in strength (i.e., a trend that more and more clearly dictates changes in the alcohol market and will dominate it in upcoming years), the amount spent on table and sparkling wines is quickly increasing, and Poles purchase wine primarily in supermarkets and hypermarkets. This trend is also evident in sales of wine produced in Polish vineyards. Although current and official data on the people who purchase Polish wine are unavailable, it may be assumed that, for the most part, Polish citizens buy Polish wine. The wine produced in Polish vineyards is featured increasingly more often in Polish stores and markets. Purchases are also made during visits to wineries and events promoting Polish winemaking. Taking into consideration the marketing years from 2010/11 to 2020/21, sales of wine produced in Polish vineyards in the last year included in the study were nearly 37 times higher relative to the first analysed year (Fig. 4). The average annual growth rate of sales amounted to 43.7% in this period. Furthermore, the dynamics of these changes took the form of an exponential trend, which is a positive phenomenon, giving an optimistic perspective for the future.

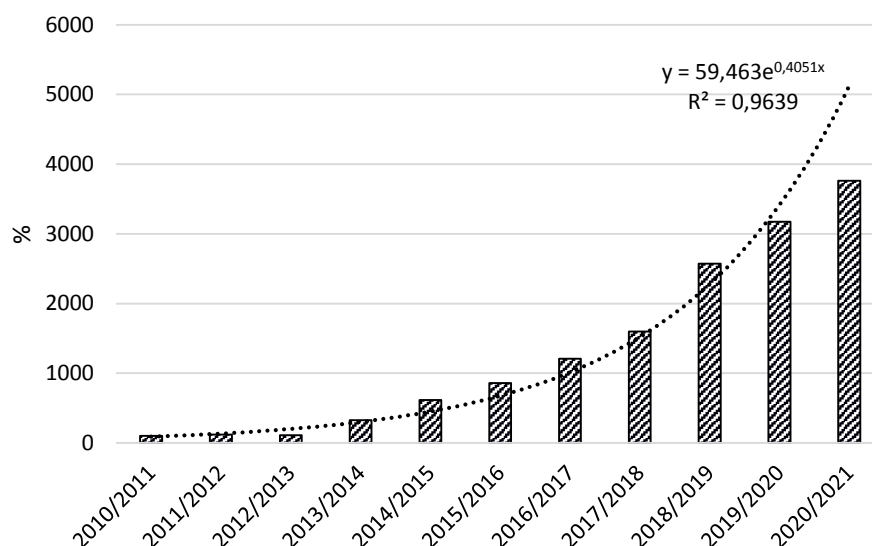


Figure 4. Dynamics of wine from Polish vineyards in given market years - 2010/11-2020/21.

Source: own study based on KOWR data.

The impact of thermal conditions on the development of wine production

It is assumed that commercial grape cultivation takes place in locations with a thermal growing season no shorter than 160 days. A growing season that is too short may be an obstacle in obtaining the appropriate grape ripeness and woody shoot, which significantly limits the possibility of cultivating certain grape varieties. As Bosak (2019) indicated, at the beginning of the last decade, not all regions of Poland had the same favourable climatic conditions needed to establish vineyards. The potential chances for successful grape cultivation were higher in the areas of Zielona Góra, Wrocław or Tarnów than in Masuria and Podlasie regions. Introducing new, early grape varieties, including ‘Solaris’ or ‘Rondo’, allow for obtaining a decent quality of wine even in north-eastern Poland; however, it would be difficult to guarantee a stable, profitable production in such local conditions. As a result, larger commercial vineyards should be established in warmer regions and in locations that ensure the best possible meso-climatic conditions. Only when these criteria are met will there be a chance to maintain constant and profitable wine production, even in less favourable vintages.

The conducted analysis made it possible to classify voivodeships according to the Jenks Natural Breaks Classification in terms of the average SAT in the years 2009-2021. Based on this analysis, three groups of voivodeships were distinguished, differing in the sum of active temperatures in the entire study period. The lowest SAT was noted in voivodeships located in the northern belt of Poland, i.e., Zachodnio-pomorskie, Pomorskie, Warińsko-Mazurskie and Podlaskie voivodeships, while the highest was found in the Lubuskie, Wielkopolskie, Opolskie, Śląskie and Małopolskie voivodeships (Fig. 5). The Dolnośląskie voivodeship deserves particular attention since it finds itself in the middle range according to the classification presented and is commonly associated with a highly developed viticulture in Poland.

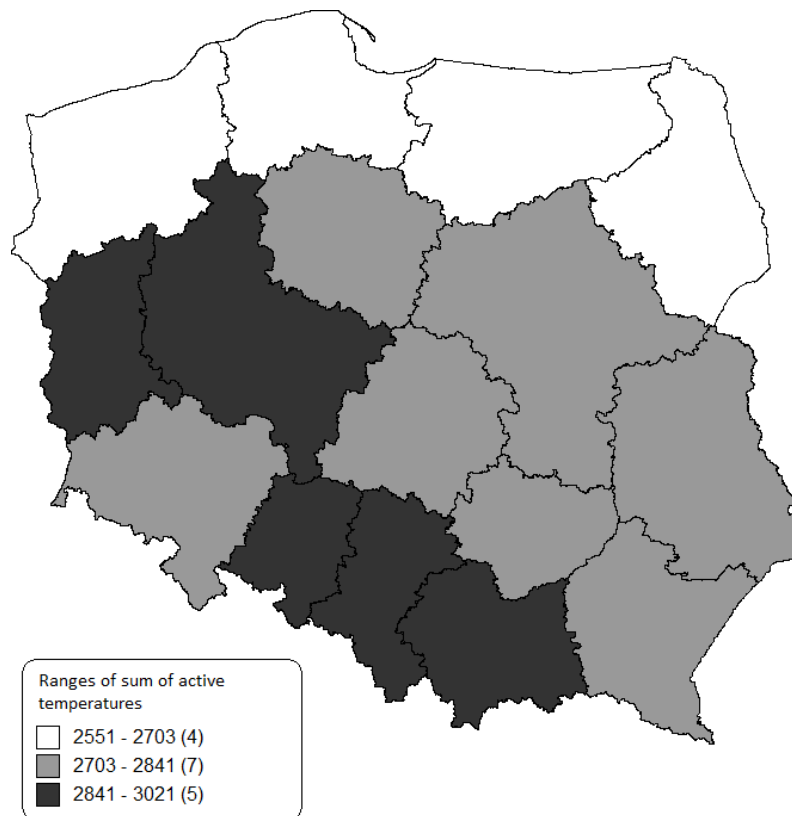


Figure 5. Classification of voivodships according to the sum of active temperatures according to the Jenks Natural Break Classification method – average from 2009-2021.

Source: own study based on IMiGW data.

The analysis presented above was supported by research on the location of grape cultivation areas in specific voivodships relative to their thermal conditions. The study results indicate that in the 2020/2021 marketing year, an average territorial concentration of cultivation areas relative to the calculated average sum of active temperatures occurred, and both of the analysed phenomena were relatively territorially compatible. This is indicated by the calculated Florence's location indicator, which in the 2020/2021 marketing year amounted to $F = 0.36$ respectively for the studied variables. As a result, the distribution of the analysed vineyards relative to the thermal conditions in a given region is relatively proportional across voivodships (provinces).

4. Summary and conclusions

This study shows that wine production in Poland is a rapidly developing component of horticultural production. The analysed statistical indicators point to this fact. The average annual growth rates deserve attention, which in the case of white grape harvests amounted to 41.8% and 33.5% for red grape varieties, while in the case of wine production, they were 38.7% and 34.9%, respectively. In general, since 2010/11, production in Poland has started to grow in

favour of white varieties, resulting in their current domination in wine production. This fact also translates into a significant share of white wines in national production, which constitutes approximately 65%. Studies on the location of vineyards in Poland indicate that their distribution relative to the thermal conditions in a given region is relatively proportional across voivodeships.

References

1. Bosak, W. (2019). *Klimat i rejonizacja upraw winorośli*. Retrieved from: https://www.winologia.pl/poradnik_klimat.htm, 26.09.2022.
2. Dobrowolska-Iwanek, J., Gąstol, M., Wanat, A., Krośniak, M., Jancik, M., Zagrodzki, P. (2014). Wine of cool-climate areas in south Poland. *South African Journal of Enology and Viticulture, Vol. 35, Iss.1*, pp. 1-9, doi: 10.5604/01.3001.0012.6698.
3. Dudek, H., Krawiec, M., Landmesser J. (2011). *Podstawy analizy statystycznej w badaniach rynku*. Warszawa: Wydawnictwo SGGW.
4. Estreicher, S.K. (2004). *Wine the past 7,400 years*. Retrieved from: http://www1.mpi-halle.mpg.de/~md_simul/data/special-data/wine-history.pdf, 19.10.2022.
5. Górczyński, J. (2004). *Podstawy ekonometrii*. Sochaczew: Wyższa Szkoła Zarządzania i Marketingu.
6. Jaros, V. (2015). *Współczesne nazwy polskich winnic*. Częstochowa: Instytut Filologii Polskiej Akademia Jana Długosza.
7. Jenks, G.F. (1967). The Data Model Concept in Statistical Mapping. *International Yearbook of Cartography, Vol. 7*, pp. 186-190.
8. Kapłan, M., Suszyna, J. (2015). Uprawa winorośli w Polsce. *Wieś i doradztwo. Pismo Małopolskiego Stowarzyszenia Doradztwa Rolniczego, Vol. 1-2*, pp. 37-41.
9. Lisek, J. (2008). Climatic factors affecting development and yielding of grapevine in Central Poland. *Journal of Fruit and Ornamental Plant Research, Vol. 16*, pp. 285-293.
10. Myśliwiec, R. (2013). *Uprawa winorośli – wydanie III poprawione i uzupełnione*. Warszawa: Powszechne Wydawnictwo Rolnicze i Leśne.
11. Olewnicki, D. (2018). Uprawa winorośli w świetle danych statystycznych. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, Vol. 10, Iss. 5*, pp. 140-145, doi: 10.5604/01.3001.0012.6698.
12. Paślawski, J. (1993). O kartogramie diagramicznym. *Polski Przegląd Kartograficzny, Vol. 25, Iss. 2*, pp. 57-65.
13. Pink, M. (2015). Polska jako kraj winiarski? Od tradycji do rodzących się możliwości. *Problemy drobnych gospodarstw rolnych, Vol. 2*, pp. 37-57.

14. Poczta, J., Zagrodzka, M. (2016). Uwarunkowania rozwoju turystyki winiarskiej w Polsce na przykładzie regionu zielonogórskiego. *Turystyka kulturowa, Vol. 5*, pp. 115-130.
15. Radziejewicz, J. (2019). *Historia produkcji wina w Polsce*. Retrieved from: <https://rme.cbr.net.pl/index.php/archiwum-rme/840-styczen--luty-nr-89/kultura-i-tradycje-ludowe/1269-historia-produkcji-wina-w-polsce>, 26.09.2022.
16. Rogowski, M., Kasianchuk, A. (2016). Atrakcyjność turystyczna winnic Lubelskiego Szlaku wina i miodu. *Zeszyty Naukowe. Turystyka i rekreacja, Vol. 2, Iss. 16*, pp.101-118.
17. Szymańska, A. (2018). *Rynek wina – branża z potencjałem*. Retrieved from: <https://rme.cbr.net.pl/index.php/archiwum-rme/751-styczen-luty-nr-83/rolnictwo-w-ue-i-na-swiecie>, 22.09.2022.
18. Tomaszewska, M. (2009). Sposoby ujęcia danych, a poprawność map opracowanych metodą kartogramu. *Polski Przegląd Kartograficzny, Vol. 41, Iss. 3*, pp. 209-220.
19. Wawro, E. (2011). *Winnice w Polsce*. Warszawa: MULTICO Oficyna Wydawnicza.
20. Yiou, P., Garcia de Cortazar-Atauri, I., Chuine, I., Daux, V., Garnier, E., Viovy, N., Van Leeuwen, C., Parker, A.K., Boursiquot, J.M. (2012). Continental atmospheric circulation over Europe during the Little Ice Age inferred from grape harvest dates Climate. *Climate of The Past Discussions*, pp. 577-588.

AUDIT FEE DETERMINANTS IN MINING SECTOR COMPANIES: FACTORS SPECIFIC TO CLIENTS, AUDITORS AND ENGAGEMENT

Mariola MAMCARCZYK^{1*}, Łukasz POPŁAWSKI², Paweł ZIENIUK³

¹ Cracow University of Economics, Department of Economics; mamcarcm@uek.krakow.pl,
ORCID: 0000-0003-0316-533X

² Cracow University of Economics, Department of Public Finance; lukasz.poplawski@uek.krakow.pl,
ORCID: 0000-0002-4147-3272

³ Cracow University of Economics, Department of Financial Accounting; pawel.zieniuk@uek.krakow.pl,
ORCID: 0000-0002-2088-8583

* Correspondence author

Purpose: Empirical studies concerning determinants which the amount of the fees for auditing a financial statement depends on are undertaken in the international literature. The review of the previous studies allowed the authors to distinguish three main groups of such factors. They concentrate around the character of a client, a category of an auditor who audits an entity and engagement in the auditing process. This paper aims to determine the factors that influence the amount of an audit fee in European mining companies.

Design/methodology/approach: The auditors' reports for 2019 were analysed. The authors formulated the main hypotheses according to which the amount of an audit fee for a financial statement of listed mining sector companies depends on the factors specific to an audited entity (H1), a category of an auditor (H2) and complexity of the process of the audit of a financial statement (H3). The collected data were a basis to construct the model of linear regression.

Findings: The results of the study carried out proved a strong statistically important relation between an audit fee for a financial statement and a size of an auditee expressed in a natural logarithm of the total assets. The essential relations were also confirmed between an audit fee for a financial statement and profitability of assets of audited companies, a category of an auditor and a number of Key Audit Matters verified during the audit and disclosed in the report by an statutory auditor. Furthermore, a relation between the amount of an audit fee for a financial statement and power of standards of reporting and auditing in a given country was confirmed.

Research limitations/implications: On the one hand, the acceptance of a research sample narrowed down to the listed companies, doing business exclusively in the mining sector is an added value of the empirical research carried out, which enabled drawing conclusions for the chosen branch. On the other hand, the small research value limits the study.

Practical implications: Our paper has some practical implications. The obtained results enable a comparison with the results of the previous empirical research and an evaluation of the determinants of the amount of audit fees of financial statements in the mining sector with other branches.

Originality/value: Our paper contributes to the literature on financial audit, as it allows new insight into better understanding of the process of selecting an auditor and negotiating his remuneration in a specific industry.

Keywords: financial audit, audit fee, key audit matters.

Category of the paper: Research paper.

1. Introduction

In an era of globalisation, standardization and harmonisation of accounting not only can the constant changes of information needs of individual recipients of a financial statement be observed but also the change in public perception of the profession of statutory auditor, who is not treated any longer as a person detecting frauds but confirming credibility of a financial statement. The aim of a contemporary audit is to confirm credibility of financial statements before making them available to the public. Currently, the audit should not be equated exclusively with the detection of accounting frauds, tax frauds and control of correctness of enterprise functioning.

In each member state of the European Union there must be a public control system concerning statutory auditors, carrying out activities during the audit, which will be independent of an auditor's profession. Regardless of the size and character of the entity for which the activities of the audit are carried out, the statutory auditor must remain independent. The independence gives freedom from suspicion of being dependent from the audited entities. According to the Code of Ethics IFAC, the inner independence is distinguished which is a state of mind allowing to express opinions without influences preventing independent judgement and allowing an honest, objective actions characterised by professional scepticism and the outer independence – connected with the avoidance of facts and circumstances which could justify a claim of the third party that honesty, objectiveness or professional scepticism were breached (Code of Ethics for Professional Accountants, 2005). One should realise that a fee for an audit of financial statements is the main source of incomes of the auditing companies, which can result in the decrease in the statutory auditors' independence.

In the amended Directive of the European Parliament and Council no. 2014/56/UE, the range and degree of depth of a financial statement carried out by statutory auditors, auditing both the public interest entities and other entities were increased. The results of the audit of a financial statement should be documented in the audit report, which are prepared in accordance with the requirements of the audit standards accepted by the EU or a given member state (Directive 2014/56/EU). The report should include the entity whose annual or consolidated financial statements are a subject of a statutory audit, if it is an annual report or a consolidated one, a period covered by it and a financial reporting framework applied while preparing it.

The report includes the description of the range of a statutory audit together with the definition of at least the audit standards according to which it was done. The crucial element of the documentation is also the audit opinion providing information if an annual financial statement presents a real and reliable image in accordance with the financial reporting framework as well as with the statutory requirements. Moreover, the audit report includes, for instance, a statutory auditor's reference to any other matters which s/he pays attention to, a statement on any doubts connected with the occurrences which are doubtful as for the continuation of the activity by an entity, and also an indication of a statutory auditor's seat.

The implementation of the EU directives and also the introduction of the International Standards on Auditing as the obligatory standards on the basis of which the audits of financial statements are carried out in the European states led to the unification of the systems of the financial review. It means that in all the countries of the European Union similar requirements concerning both maintaining statutory auditors' independence (allowing the exceptions in the regulations of the national law referring to, for example, the period of turnover for statutory auditors and audit firms) and the unified requirements relating to the final product of the audit of financial statements, which is a statutory auditor's report, are binding.

The audit fee is incurred by audited entities. The results of the work done by statutory auditors confirm credibility of financial statements and at the same time minimise the risk of taking wrong decisions by investors. Therefore, in order to obtain a high quality of auditors' work, the appropriate remuneration seems to be necessary. Its relevant level may contribute both to maintaining independence and increasing a quality of a performed audit.

The obligation to conduct an audit of a financial statement is a requirement imposed on companies by regulations binding in a given country. The sufficient condition to comply with it is to choose a statutory auditor and allow him/her to go through the auditing process. Such a limitation results in the fact that some entities may tend to use these audit entities which will offer their services at lower prices. However, on the grounds of the role which statutory auditors play in functioning of the economic system correctly, an optimal allocation of the capital and maximisation of investors' benefits, a lot of companies accept the purchase of high quality services at the higher remuneration.

The empirical research conducted by the authors was to establish determinants of the amount of a fee for an audit of the financial statement in listed companies operating in the chosen specific branch of the economy. 62 companies conducting their business in the mining industry, listed in the main European stock exchanges, taken into account in the ORBIS database, were accepted for the research sample.

The method of the content analysis was applied in the empirical research. The complete versions of financial statements and the statutory auditor's reports of the audit of individual companies for 2019 made up the empirical material. What is more, the data published in the ORBIS database, concerning the listed companies accepted for the research sample were used.

The quantitative research methodology with support of the Statistica software was employed. The analysis of linear regression was used to confirm statistical relations.

The review of the international literature on the subject allowed to distinguish three groups of the factors perceived as the determinants of the amount of fees for an audit of a financial statement. Then, it was possible for the authors to consider the characteristic factors for (1) an audited entity, (2) a category of an auditing entity conducting the process of an audit and (3) complexity of the process of an audit of a financial statement. This division is also reflected in the formulated research hypotheses, according to which:

H1: The amount of a fee for an audit of a financial statement in listed companies of the mining sector indicates a statistically essential dependence on factors characteristic of an audited entity.

H2: The amount of a fee for an audit of a financial statement in listed companies of the mining sector indicates a statistically essential dependence on a category of an auditing entity conducting the process of an audit.

H3: The amount of a fee for an audit of a financial statement in listed companies of the mining sector indicates a statistically essential dependence on complexity of the process of an audit of a financial statement.

In the model of regression, an additional explanatory variable was also suggested strength of reporting and auditing standards, characteristic of individual countries in which the chosen companies do their business and in which an audit of a financial statement is done. The greater power of a standard influence can contribute to the increase in precision of the auditing process and the identification of a higher number of problem areas by statutory auditors.

2. Literature review and hypothesis development

It is generally accepted that the audit report is not an efficient communication tool to inform the users about the audit and its process (Gray et al., 2011; Vanstraelen et. al., 2012). The term *audit expectation gap* was formulated in the international literature of the subject (Lee, Ali, Gloeck, 2009). The main cause of the existence of a gap are various beliefs on statutory auditors' obligations and on the scope and the informative value of an audit report (Koh, Woo, 1998). Whereas, the users of financial statements expect that an audit of financial statements will guarantee detection of any breaches and incorrectness (Gupta, 2005), and statutory auditors should also interpret financial statements in the way which would allow stakeholders to take a decision on investing in the entity (Salehi, Rostami, 2009).

The stakeholders should be expected to understand that the process of an audit of a financial statement is conducted taking a materiality level into account, and a statutory auditor is not able to detect all incorrectness in the audited entity. The recipients of a financial statement receive

the final version of the financial statement, taking corrections suggested by a statutory auditor into account, yet they are not informed about the amount of correction. The access to the information about the amount of the suggested correction would require a disclosure of the statutory auditor's review documentation, which remains classified. If the recipients of the financial statement do not have the access to this documentation, the statutory auditor's auditing report still remains the only communication tool of the statutory auditors with the recipients of the financial statement.

The authors' subject of interest of the empirical research, conducted since 1980, is to determine the determinants influencing the amount of a fee for auditing a financial statement. Most papers available in the international literature connects the amount of a fee for the audit of a financial statement with the quality of an audit. One of the first authors who concentrated on the determinants of the amount of fees for auditing a financial statement and created the models of linear regression, aiming at the confirmation of the statistical dependences of these determinants was D. Simunic (1980). The approach adopted in his papers was a starting point for further studies, developing research samples and taking newer and newer factors into consideration which an amount of a fee for auditing a financial statement could depend on and indirectly also the quality of an audit (for example, Palmrose, 1986; Brinn, Peel, Roberts, 1994; Craswell, Francis, Taylor 1995; Taylor, Simon, Burton, 1999; Beattie et al., 2001).

The studies on the determinants of audit fees for a financial statement often incorporate in theoretical considerations referring the principal-agent problem. The agency between management and shareholders influences the monitoring costs in general and therefore audit fees in particular. Audit fees should be higher, thus making audit fees a promising proxy for the client's risk situation (Gul, Tsui, 2001; Nikkinen, Sahlström, 2004).

The survey of the literature on the subject, summarising the empirical research concerning the above mentioned problem was undertaken, for example, in the papers of Cobbin (2002); Causholli, De Martinis, Hay, Knechel (2011) and Hay, Knechel and Wong (2006). The above mentioned authors' findings show that the most often chosen explanatory variables in the models verifying the determinants of the amount of auditing fees included a size of an audited entity expressed by the total assets of an audited company or an amount of obtained revenues from the sale, a number of consolidated entities in the financial statement, a number of foreign branches, chosen indicators of the financial analysis (profitability, liquidity) and an auditor's category. Widmann, Follert and Wolz (2021), analysing the chosen research on an amount of auditing fees for financial statements, stated that the number of independent variables in the analysed research was from 5 to 29, and their average was 13. The subject of the further analysis was the empirical research conducted in recent years, i.e. after 2015, with the use of research samples including the companies listed in stock exchanges (for instance, Reid, Carcello, Neal, 2019; Mohrmann, Riepe, Stefani, 2019; Lesage, Ratzinger-Sakel, Kettunen, 2017; Hardies, Beesch, Branson, 2015).

In order to choose the appropriate set of explanatory variables, it was necessary to recognise the classification and aggregation to individual factor groups which were taken into consideration in the previous studies and especially those which showed essential statistical relations with the amount of auditing fees for financial statements. The detailed analysis of the sets of the explanatory variables adopted in individual studies allows to classify them to one of the three categories: factors connected with a client, an auditor and engagement.

Client Attributes

The size and complexity of the auditee determines the audit fee because a large company requires a higher workload (Pong, Whittington, 1994). Larger companies generally require a more time-consuming audit than smaller ones (Widmann, Follert, Wolz, 2021). The size of an audited entity, expressed by the total assets or the natural logarithm of this total is one of the most frequently used explanatory variables in the previous studies. Moreover, it should be emphasized that the statistically essential relation between the size of the studied entity expressed in this way and the amount of an auditing fee for a financial statement was most often used.

Apart from the balance sheet total, a financial position, profitability, liquidity and other aspects that impact the inherent risk of the whole engagement were the variables which characterised the studied entities. They are the indicators which an auditor usually concentrates on, evaluating a risk of a client's situation. The evaluation of the risk influences planning an auditing process. Therefore, if on the grounds of a high risk resulting from the client's property and financial situation, an auditor has to take additional procedures into account, it may result in the increase in labour consumption of the whole audit.

The notion should be accepted from the theoretical considerations, according to which auditing companies increase the amount of auditing fees when a client obtains negative financial results. Such a relation should also be considered in the context of a risk of an audit. If an entity bears a loss, an audit can require additional procedures on the grounds of a higher risk. However, the examples of the empirical research can be provided which contradict the existence between the amount of an auditing fee for a financial statement and obtaining a negative financial result by audited entities (Vafeas, Waegelein, 2007; Ittonen, Peni, 2012; Barua, Hossain, Rana, 2019).

Adopting the indicators of the financial analysis such as a profitability index or a liquidity ratio as the variables explaining the amount of an auditing fee for a financial statement should be explained with a common belief according to which the higher profitability indexes or liquidity ratios indicate improvement of a client's situation, a lower risk and at the same time less complicated auditing procedures.

In view of the above, the hypothesis H1 was formulated according to which the amount of an auditing fee for a financial statement in listed mining sector companies indicates a statistically essential dependence on the factors characteristic of an audited entity. The size of a company expressed with the natural logarithm of the total assets, a character of a financial result (a loss or a benefit) as well as profitability indexes of assets and liquidity ratios were adopted as the variables characteristic of the audited companies. The manner of establishing these indicators will be presented further below.

Auditor Attributes

The analysis of the amount of remuneration of auditing companies usually takes the division of auditing companies into consideration on the grounds of their size and range of doing business (Francis, 2004). The belief is often found in the literature, according to which the auditing companies belonging to "BIG-4" provide better quality audits (Francis, Yu, 2009; Krishnan, 2003). However, Pong and Witthington (1994) stated that the auditing companies belonging to "BIG-8" (nowadays "BIG-4") are more expensive than smaller auditing companies so they emphasize a premium for big audit firms.

On the other hand, the higher quality of an audit of financial statements results in higher fees. There is a common view, dominating among the professional accountants and the persons conducting audits of high level standardisation of audit procedures and working papers developed during the audit in big international auditing entities. However the main reason for such a belief is the great experience of the leading auditing companies in the audit of the financial statements of the listed companies.

In case of big leading auditing entities, there is a lower risk of lack of a statutory auditor's independence, especially connected with the lower dependence on a single principal (De Angelo, 1981; Palmrose, 1986). For the auditing entities of recognised reputation conducting business in a lot of countries, there is a bigger risk connected with the mistake made during the single audit which may be hyped, and simultaneously it may cause a significant decrease in the number of next orders. Thus, the higher quality of services provided by the big auditing companies is explained by higher motivation resulting from a higher risk from making a mistake (Ferguson, Stokes, 2010).

In view of the above, the hypothesis H2 was formulated according to which the amount of an auditing fee for a financial statement in listed mining sector companies indicates a statistically essential dependence on the category of the auditing entity going through the process of an audit. The zero-one variable was adopted as a variable representing an auditor's category, taking a value "1" for big international auditing entities or "0" for other entities authorised to audit financial statements

Engagement Attributes

The complexity of the process of an audit of a financial statement can influence the amount of an auditing fee for a financial statement. Before being assigned as an auditor, a proper analysis of the company's risk structure is required before the terms of engagement are fixed (D'Aquila, 2010). The lower number of problem areas can happen in the entities with the specific structure which is less complex, which accelerates the auditing procedures. Simultaneously, the activities done by statutory auditors and their co-workers become less labour-intensive as well as less cost-consuming. Abdul-Wahab, Mat Zain and James (2011) suggest that it is reasonable to conclude that the auditor needs more audit time and more specialized audit personnel to complete the audit investigation. This in turn will result in higher audit fees (O'Sullivan, 2000; Abdul-Wahab et al., 2011). Given that audit quality is unobservable, thus prior studies suggest the use of, amongst others, audit fees to proxy for audit effort.

The more complex structure is, the more types of risk which an entity is exposed to. Complexity of an enterprise is most often expressed with the number of reported operating segments (Bedard, Hoitash, Hoitash, 2008; Markanian, Parbonetti, 2007; Pinto, Morais, 2018). Therefore, the number of reported segments of activity, possible to be established on the basis of the statement of the company, can be a variable explaining the amount of an auditing fee for a financial statement. It is emphasised in the literature of the subject that the total number of business segments is better than the total number of subsidiaries, as the score is slightly higher and the standard deviation is slightly smaller. The statistically essential dependence between the amount of an auditing fee for a financial statement and the number of reported segments of activity was proved in the chosen empirical research (Behn et al., 1999; Carcello et al., 2002; Goodwin, Wu, 2014).

The interesting variable confirming complexity of the auditing process of a financial statement is the number of days between the end of the audit and the signature of the audit opinion. This variable exists in the empirical research relatively infrequently probably owing to the difficulties in obtaining the data concerning the period of conducting an audit of a financial statement. Sometimes the level of foreign activities of the client is also a standard variable in audit fee models.

Statutory auditors are obliged to report Key Audit Matters (KAM) i.e. issues, which according to a statutory auditor's professional opinion, were the most significant while examining a financial statement for a current period. Establishing the number of KAMs reported in the audit statement depended on a statutory auditor's professional opinion. The higher number of disclosed KAMs can suggest the existence of a bigger number of problem areas in the activity of an audited company. The results of the research indicate that the amount of audit fees is positively connected with the level of strategic and operational risk (Yang, Yu, Liu, Wu, 2018). Thus, the higher auditing fee for a financial statement may result from complexity of an auditing process. The more problem areas defined as Key Audit Matters, the more labour-

intensive and at the same time cost-consuming a financial statement can be. The data collection on the number of disclosed Key Audit Matters is relatively simple as currently they are made available to the public in statutory auditors' reports.

In view of the above, the hypothesis H3 was formulated according to which the amount of an auditing fee for a financial statement in listed mining sector companies indicates a statistically essential dependence on complexity of the auditing process of a financial statement. The number of reported segments of activity and the number of disclosed Key Audit Matters were adopted as the variables representing complexity of an auditing process of a financial statement.

3. Research design

The companies listed in the main European stock exchanges were taken for the research sample. The initial research sample was established on the basis of a list of listed companies taken from the ORBIS database. In connection with the branch character of the study, the companies doing business in one of the following areas were exclusively accepted for the sample: (1) hard coal and brown coal production, (2) exploitation of oil and natural gas, (3) mining of mineral ores, (4) other mining and excavation.

The inactive companies and the companies which did not disclose financial statements and statutory auditors' reports to the public were rejected from the initial sample of 248 companies. The random selection with the constant sampling interval was applied among the other entities. Thus, the selection of the companies to the sample meets the conditions of a random selection. The final research sample consisted of 62 companies for which the analysis of the content provided in the statements was done.

The collection of the data for the empirical research required making the analysis of content both the complete versions of the financial statements for 2019 for the companies accepted for the research sample and the statutory auditors' financial statements concerning the audit. The financial statements provided the source of data such as the amount of an auditing fee for a financial statement or the number of the reported segments of activity by an audited entity. The number of disclosed Key Audit Matters were established on the basis of the independent statutory auditors' auditing reports. The other data characterising the studied entities such as a range of the activity measured with the amount of the balance sheet total, the amount of the obtained financial results or the basic indicators of the financial analysis were taken from the ORBIS database. The indicators of the standard influence power of the reports and the financial review for individual countries were taken from the study results made available to the public by the World Economic Forum, within the research of the Global Competitiveness Report (Schwab, 2018).

The collected data became a basis of the construction of the regression model, identifying the determinants of the amount of audit fee in companies from the mining sector.

In order to verify the statistical hypotheses, the following explanatory variables were adopted for regression analysis purposes:

Dependent variable

Y – natural logarithm of an amount of the audit fee. The logarithm was applied to normalize the features characterised by a big range. We use the logarithmic transformation of audit fee to capture the level of audit effort in the audit fee model. The similar approach was applied to the chosen empirical research done previously (Abdul-Wahab et al., 2011; Ishak, Abidin, 2021)

Explanatory variables

X1 – natural logarithm of the total assets,

X2 – nature of a financial result, the zero-one variable (loss = 1, profit = 0),

X3 – return on assets,

X4 – liquidity ratio,

X5 – auditor's category conducting an audit of the financial statement,

X6 – number of *Key Audit Matters*,

X7 – number of financial reporting segments,

X8 – strength of reporting and auditing standards.

The choice of the explanatory variables for the authors' linear regression model is motivated by a will to confirm the results of the previous research on the sample of the companies doing business in the specific sector of the economy – the mining industry.

The set of the variables X1-X4 were adopted as the variables characteristic of the entities whose financial statements were audited. The size of the entity was expressed by the natural logarithm of the total assets (X1). The variety X2 is a dummy variable for companies that recorded a loss in the previous year. The variable X3 is a return on assets calculated as the relation between the net profit of the company and the total assets. The variable X4 is a liquidity ration expressed with the relation between the current assets and the current liabilities.

The explanatory variable X5, representing an auditor's category conducting an audit of a financial statement is a zero-one variable, taking a value "1" for big international auditing entities (Deloitte, EY, KPMG, PwC) or "0" for other entities authorised to audit financial statements. The choice of the variable was based on the common classification of auditing entities conducting an audit of financial statements into two groups.

The variables X6 and X7 refer to the degree of complexity of the financial statements audited by the statutory auditors. The higher number of reported operating segments (X6) can show bigger complexity and a developed structure of an enterprise, which can cause the existence of a higher number of problematic issues in its business. On the other hand, the variable X7 represents the number of the disclosed Key Audit Matters. Establishing the number of KAMs reported in the audit statement depended on a statutory auditor's professional

opinion. The higher number of disclosed KAMs can suggest the existence of a bigger number of problem areas in the activity of an audited company.

Additionally, the variable X8 was adopted as strength of reporting and auditing standards. Inaccuracy of standards and their weak strength can contribute to a choice of solutions which are a client's preferences (compare for instance, Mayhew, Schatzberg, Sevcik, 2011). The indicator of standard strength used as an explanatory variable is given to the public by the World Economic Forum, within the research of The Global Competitiveness Report (Schwab, 2018). The index value is calculated for each country and it takes the values from 1 to 7.

4. Results and Discussion

The amount of the auditing fees for the financial statement in the companies of the research sample, given in the financial statements of the individual companies, was converted into the EUR currency. The average fee for the audit of the financial statement for the companies of the research sample amounted to 3.575 thousand EUR.

The variables in this study consisted of eight independent variables and one dependent variable. The dependent variable (Y) is the natural logarithm of an amount of the audit fee. To understand the characteristics of the variables in terms of a minimum value, maximum, average and standard deviation, the descriptive statistical data is presented in table 1.

Table 1.
Descriptive statistics

VARIABLE	Minimum	Maximum	Mean	Std. Deviation
Y	1,98	10,78	6,14	2,16
X1	8,00	19,70	14,04	3,19
X2	0,00	1,00	0,32	0,47
X3	-1,70	0,50	-0,02	0,29
X4	0,10	36,09	3,52	6,56
X5	0,00	1,00	0,65	0,48
X6	1,00	7,00	2,77	1,45
X7	1,00	8,00	3,06	1,68
X8	4,30	6,10	5,58	0,48

Source: own study.

The explanatory variable Y has a normal distribution, which was confirmed by the Shapiro-Wilk test done (p-value = 0,217202). The significance level of $\alpha=0.05$ was adopted. Since p-value > α , we accept the H0. It is assumed that the data is normally distributed. In other words, the difference between the data sample and the normal distribution is not big enough to be statistically significant.

The histogram of the distribution of the variable Y was presented in Fig. 1.

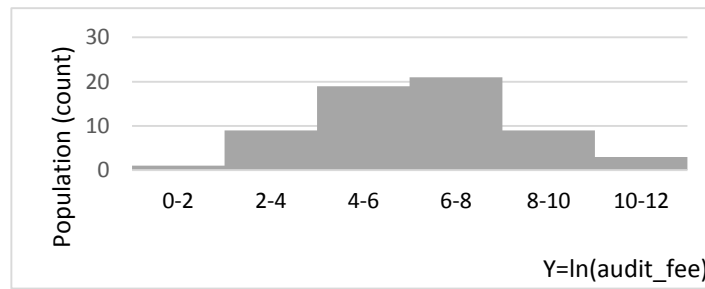


Figure 1. The distribution histogram of variable Y.

Source: own study.

In order to verify the intercorrelations between the response variable and explanatory variables, the correlation coefficients were calculated. The obtained results allowed to conclude that there is no significant correlation between the response variable (Y) and explanatory variables (X1-X9). No significant intercorrelation was stated between the individual explanatory variables. Thus, the assumptions enabling adoption of the proposed set of variables for further research and performance of linear regression analysis for the response variable and explanatory variables are met.

The linear regression analysis was performed with the use of Statistica software. The results of analysis are presented in table 2.

Table 2.
Results of linear regression analysis

Independent Variables	Coefficient	T	P > t (p-value)
Const.	-8,15291	-7,02541	0,000000
X1	0,69742	16,41400	0,000000
X2	0,26082	1,00030	0,319263
X3	-0,79795	-1,96194	0,052186
X4	0,00056	0,03750	0,970148
X5	-0,48592	-2,12031	0,036129
X6	0,12828	2,04505	0,043132
X7	0,00449	0,08259	0,934323
X8	0,77892	4,25898	0,000042
R-square	0,83133		

Source: own study.

Based on the results of regression analysis in the above table, the regression equation model obtained is as follows:

$$Y = -8,153 + 0,697 X1 + 0,260 X2 - 0,798 X3 + 0,0006 X4 - 0,486 X5 + 0,128 X6 + 0,004 X7 + 0,779 X8 + e$$

The obtained results allow to conclude that:

- there are strong significant correlations between the amount of audit fee (Y) and natural logarithm of the total assets (X1) and strength of reporting and auditing standards (X8),
- there are significant correlations between the amount of audit fee (Y) and return on assets (X3), auditor's category (X5) and number of *Key Audit Matters* (X6),

- there are no significant correlations between the amount of audit fee (Y) and nature of the financial result (X2), liquidity ratio (X4) and number of financial reporting segments (X7).

The power of the adopted model is satisfactory. The R² (R-squared) coefficient, named the coefficient of determination, specifies the level, in which the variability of response variable was explained by variability of the explanatory variables. In the performed research, the value of this coefficient is approx. 83%, which demonstrates strong power of the adopted model.

The obtained results of the study illustrate coherence with the results of a lot of previous research undertaken in the research samples including listed companies without the analysis of the sector. Similarly to the majority of the studies collected and discussed in the review papers (Cobbin, 2002; Causholli, De Martinis, Hay, Knechel, 2011; Hay, Knechel, Wong 2006), the dependence of the auditing fee for the financial statement on the size of the audited entity was proved in the conducted study. This confirms the viewpoint according to which larger companies generally require a more time-consuming audit than smaller ones. The dependence between the amount of the auditing fees for the financial statement and the existence of the negative financial result was not found in the accepted research sample. As already discussed, the similar conclusions were drawn in the previously chosen research (Vafeas, Waagelein, 2007; Ittonen, Peni, 2012; Barua, Hossain, Rana, 2019). In case of the other factors characteristic of the client, taken into consideration as the explanatory variables in the audit (profitability, liquidity), the statistical dependence was only found in case of profitability. Therefore, the property and financial situation of the audited companies expressed with the indicators of the financial analysis may be a determinant of the amount of the auditing fees for the financial statements. Notwithstanding, similarly to the previous empirical research, not every accepted variable representing the financial situation of the companies proves the essential dependence.

The essential relation between the auditing fee of the financial statement and the category of the auditing entity should be emphasised on the basis of the obtained results of the study. The cost intensity of the audit occurred to be higher if the audited company chose an auditing firm belonging to the “BIG-4”. Yet, owing to the small research sample, the introduction of the separate zero-one variables for the individual auditing entities belonging to the “BIG-4” was abandoned. In case of the empirical research done on bigger research sample, it was found, for example, that “amongst audit firms, it is evidenced that PWC and KPMG charge higher fee than the other firms” (Ishak, Abidin, 2021).

The study did not prove the essential dependences between the amount of the auditing fees for the financial statement and the number of the activity segments reported by the companies. The reached conclusion differs from the results of the chosen research (Behn et al., 1999; Carcello et al., 2002; Goodwin, Wu, 2014). Yet, it was confirmed that there is the dependence between the amount of the auditing fees for the financial statements and the number of problem areas found and disclosed by the statutory auditors expressed by the number of the Key Audit

Matters. Hence, it confirms that the complexity of the process auditing the financial statements influences the cost intensity of the audit.

The main limitation of the study was the small research sample resulting from the branch character of the study. However, it should be pointed out that the performed empirical study did not aim at the evaluation of the quality of the work of the auditing firms. It only confirms the existence of the differentiation on the level of the remuneration of the auditing entities. This differentiation can be influenced by the factors concerning both the clients, auditors and auditing process. The obtained results for the research sample of the mining sector companies confirm that the amounts of the audit fee belonging to each group separated by the authors chosen from among the previous determinants analysed in the literature of the subject are statistically essential also in the chosen specific sectorial group of the mining sector entities.

In the authors' opinion, there is still a demand for the further empirical studies concerning the potential differentiation of the quality of the provided auditing services and the identification of the factors significantly influencing the level of the perceived audit quality.

5. Conclusions

This study contributes to expanding the literature on audit fee determinants. The main objective of the study was to identify factors that influence the amount of an audit fee in European mining companies. This objective was achieved. The empirical study conducted on the sample of the European listed mining sector companies confirmed the existence of the relations between the amount of the auditing fee for the financial statement and the factors specific both for the clients, auditing firms and complexity of the audit process.

The proper remuneration of the statutory auditors is one of the guarantees of their independence and simultaneously their objectivity and reliability of the issued opinions. The modern financial review faces a lot of newer and newer challenges mainly connected with the constant expansion of information needs reported by the capital market. Therefore, it can be expected that such expectations of the market will force the further evolution of the form of the opinion and the report as well as they will be a catalyser of the changes in the manner of the information exchange between the statutory auditors and various groups of stakeholders.

The time horizon of the study included the reporting year 2019. The agreements about the audit of the financial report for this period were signed at the end of the year when there was not an epidemic situation connected with the spread of the epidemic COVID-19. The situation during the pandemic significantly made planning and doing the audit of the financial reports more difficult. What is more, uncertainty and unpredictability of the situation connected with the pandemic vitally influenced the statutory auditors' working conditions. Apart from posing threat to public health, which has economic consequences, the epidemic accelerated the

evolution of the profession of statutory auditor towards the use of remote techniques to do their tasks (Tysiac, 2020). The situation also forced the statutory auditors to work under conditions of the limitation of the range of the audit (Amato, 2020).

Uncertainty and unpredictability are the reasons why one should still take a possibility of appropriate modifications of the manner of obtaining sufficient evidence into consideration, which an opinion about an audited financial statement is based on. The hindered access to persons or information as well as the existence of risks forcing the changes in the auditing procedures may still influence the statutory auditors' working conditions. Consequently, it may influence the changes in the amount of the auditing fees for financial statements in the years to come. Therefore, it seems that the problem discussed in the article is still relevant and in the near future there will be the empirical research done taking the division into the periods before and after the epidemic situation into account. It should also be pointed out that the changes in the manner and place of conducting an audit resulting from the use of remote work on a wider scale should go hand in hand with the appropriate reaction to the changes in the working conditions and the renewed analysis of quality control procedures connected with management of and supervising the groups realizing the orders of the audit of financial statements.

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References

1. Abdul Wahab, E.A., Mat Zain, M., James, K. (2011). Political Connections, Corporate Governance and Audit Fees in Malaysia. *Managerial Auditing Journal*, 26(5).
2. Amato, N. (2020). Pandemic-specific guidance for auditors and preparers. *Journal of Accountancy*, 7.04.2020.
3. Barua, A., Hossain, M.S., Rana, D. (2019). Financial versus operating liability leverage and audit fees. *International Journal of Auditing*, 23(2).
4. Beattie, V., Goodacre, A., Pratt, K., Stevenson, J. (2001). The determinants of audit fees – evidence from the voluntary sector. *Accounting and Business Research*, 31(4).
5. Bedard, J., Hoitash, U., Hoitash, R. (2008). Audit pricing and internal control disclosures among non-accelerated filers. *Research in Accounting Regulation*, 20.

6. Behn, B., Carcello, J., Hermanson, D., Hermanson, R. (1999). Client Satisfaction and Big 6 Audit Fees. *Contemporary Accounting Research*, 16(4).
7. Brinn, T., Peel, M.J., Roberts, R. (1994). Audit fee determinants of independent and subsidiary unquoted companies in the UK: An exploratory study. *British Accounting Review*, 26(2).
8. Carcello, J., Hermanson, D., Neal, T., Riley, J.R.R. (2002). Board characteristics and audit fees. *Contemporary Accounting Research*, 19(3).
9. Causholli, M., De Martinis, M., Hay, D., Knechel, W.R. (2011). Audit markets, fees and production: Towards an integrated view of Empirical audit research. *Journal of Accounting Literature*, 29.
10. Cobbin, P. (2002). International dimensions of the audit fee determinants literature. *International Journal of Auditing*, 6(1).
11. *Code of Ethics for Professional Accountants* (2005). International Federation of Accountants.
12. Craswell, A.T., Francis, J.R., Taylor, S.L. (1995), Auditor brand name reputations and industry specializations. *Journal of Accounting and Economics*, 20(3).
13. D'Aquila, J.M., Capriotti, K., Boylan, R., O'Keefe, R. (2010) Guidance on auditing high-risk clients. *The CPA Journal*, 80(10).
14. DeAngelo, L.E. (1981). Auditor size and audit quality. *Journal of Accounting and Economics*, 3(3).
15. Directive 2014/56/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2006/43/EC on statutory audits of annual accounts and consolidated accounts, L158/196.
16. Ferguson, A., Stokes, D. (2010). Brand name audit pricing, industry specialisation, and leadership premiums post Big 8 and Big 6 mergers. *Contemporary Accounting Research*, 19(1).
17. Francis, J., Yu, M. (2009). Big 4 office size and audit quality. *The Accounting Review*, 84(5).
18. Francis, J.R. (2004), What do we know about audit quality? *The British Accounting Review*, 36(4).
19. Goodwin, J., Wu, D. (2014) Is the effect of industry expertise on audit pricing an office-level or a partner-level phenomenon? *Review of Accounting Studies*, 19.
20. Gray, G.L., Turner, J.L., Coram, P.J., Mock, T.J. (2011). Perceptions and Misperceptions Regarding the Unqualified Auditor's Report by Financial Statement Preparers, Users, And Auditors. *Accounting Horizons*, 25(4).
21. Gul, F.A., Tsui, J.S.L. (2001). Free cash flow, debt monitoring, and audit pricing: further evidence on the role of director equity ownership. *Auditing: A Journal of Practice and Theory*, 20(2).
22. Gupta, K. (2005). *Contemporary Auditing*. New Delhi: Tata McGraw Hill.

23. Hardies, K., Beesch, D., Branson, J. (2015). The female audit fee premium. *Auditing: A Journal of Practice and Theory*, 34(4).
24. Hay, D., Knechel, W.R., Wong, N. (2006). Audit Fees: A Meta-Analysis of the Effect of Supply and Demand Attributes. *Contemporary Accounting Research*, 23(1).
25. Ishak, Z., Abidin, Z. (2021). Audit Fees Determinants: A Study on the Impact of Key Audit Matters Reporting and other Factors. *Turkish Journal of Computer and Mathematics Education*, 12(3).
26. Ittonen, K., Peni, E. (2012). Auditor's gender and audit fees. *International Journal of Auditing*, 16(1).
27. Koh, H.C., Woo, E.S. (1998). The expectation gap in auditing. *Managerial Auditing Journal*, 13(3).
28. Krishnan, G. (2003). Does Big 6 auditor industry expertise constrain earnings management? *Accounting Horizons*, 17(1).
29. Lee, T.H., Ali, A., Gloeck, J. (2009). The Audit Expectation Gap in Malaysia: An Investigation into its Causes and Remedies. *South African Journal of Accountability and Auditing Research*, 9.
30. Lesage, C., Ratzinger-Sakel, N., Kettunen, J. (2017). Consequences of the abandonment of mandatory joint audit: an empirical study of audit costs and audit quality effects. *European Accounting Review*, 26(2).
31. Markanian, G., Parbonetti, A. (2007). Firm complexity and board of director composition. *Corporate Governance: an international review*, 15(6).
32. Mayhew, B.W. Schatzberg, J.W., Sevcik, G.R. (2001). The effect of accounting uncertainty and auditor reputation on auditor objectivity. *Auditing: A Journal of Practice & Theory*, vol. 20.
33. Mohrmann, U., Riepe, J., Stefani, U. (2019). Fool's gold or value for money? The link between abnormal audit fees, audit firm type, fair-value disclosure, and market valuation. *International Journal of Auditing*, 23(2).
34. Nikkinen, J., Sahlström, P. (2004). Does agency theory provide a general framework for audit pricing? *International Journal of Auditing*, 8(3).
35. O'Sullivan, N. (2000). The Impact of Board Composition and Ownership on Audit Quality: Evidence From Large UK Companies. *The British Accounting Review*, 32(4).
36. Palmrose, Z.-V. (1986). Audit fees and auditor size: further evidence. *Journal of Accounting Research*. Spring.
37. Pinto, I., Morais, A.I. (2019). What matters in disclosures of key audit matters: Evidence from Europe. *Journal of International Financial Management and Accounting*, 3(2).
38. Pong, C.M., Whittington, G. (1994). The determinants of audit fees: some empirical models. *Journal of Business Finance and Accounting*, 21(8).

39. Reid, L., Carcello, J., Li, C., Neal, T. (2019). Impact of auditor report changes on financial reporting quality and audit costs: evidence from the United Kingdom. *Contemporary Accounting Research*, 36(3).
40. Salehi, M., Rostami, V. (2009). Audit Expectation Gap: International Evidence. *International Journal of Academic Research*, 1(1).
41. Schwab, K. (ed.) (2018). *The Global Competitiveness Report*. Switzerland: World Economic Forum.
42. Simunic, D. (1980). The pricing of audit services: Theory and evidence. *Journal of Accounting Research*, 18(1).
43. Taylor, M., Simon, D.T., Burton, F.G. (1999). A survey of audit pricing in South Korea. *Research in Accounting Regulation*, 13.
44. Tysiac, K. (2020). Remote auditing comes to forefront during pandemic. *Journal of Accountancy*, 24.03.2020.
45. Vafeas, N., Waagelein, J. (2007) The association between audit committees, compensation incentives, and corporate audit fees. *Review of Quantitative Finance and Accounting*, 28.
46. Vanstraelen, A., Schelleman, C., Meuwissen, R., Hofmann, I. (2012). The Audit Reporting Debate: Seemingly Intractable Problems and Feasible Solutions. *European Accounting Review*, 21(2).
47. Widmann, M., Follert, F., and Wolz, M. (2021) What is it going to cost? Empirical evidence from a systematic literature review of audit fee determinants. *Management Review Quarterly*, 71.
48. Yang, R., Yu, Y., Liu, M., Wu, K. (2018). Corporate risk disclosure and audit fee: A text mining approach. *European Accounting Review*, 27(3).

ANTI-CRISIS AND AID MEASURES TAKEN IN POLAND FOLLOWING RUSSIA'S AGGRESSION AGAINST UKRAINE, INCLUDING ACTIVITY AT LOCAL GOVERNMENT LEVEL

Małgorzata MAŃKA-SZULIK¹, Dariusz KRAWCZYK², Krzysztof WODARSKI^{3*}

¹ Zabrze City Hall; prezydent@um.zabrze.pl, ORCID: 000-0002-5328-8736

² Silesian University of Technology; dariusz.krawczyk@polsl.pl, ORCID: 0000-0003-1823-0309

³ Silesian University of Technology; krzysztof.wodarski@polsl.pl, ORCID: 0000-0002-4725-1064

* Correspondence author

Purpose: The aim of this paper is to present the anti-crisis and aid measures undertaken in Poland during the first hundred days after the aggression of the armed forces of the Russian Federation in Ukraine, which began on 24 February 2022.

Design/methodology/approach: For the purpose of this paper, legal acts were analysed, literature was reviewed, representatives of organisations involved in refugee assistance, Polish and foreign volunteers, and officials responsible for conducting anti-crisis activities were interviewed. The result was a consolidation of various forms of activity in Poland that constituted an institutional and civic response to the war initiated by Russia's attack on Ukraine.

Findings: A study of the activity of the local government unit in the face of the situation caused by Russia's armed aggression against Ukraine was carried out by analysing the actions taken in Zabrze in the period of one hundred days after the outbreak of war.

Originality/value: The described activities - on the example of the local administration and the local community of Zabrze - confirmed that the emergency situation related to the war in Ukraine activated members of the local government community and mobilised them to directly participate in the implemented aid projects.

Keywords: war in Ukraine, assistance to refugees, local government action towards Ukrainians, refugees in Poland, benefits for refugees.

1. Introduction

Russia's armed invasion of Ukraine on 24 February 2022 resulted in nearly 3.8 million refugees (3.771 million) in the first 100 days of the war. The procedures introduced in this regard by the government and local administration were analysed. The development of the situation with regard to the transport of refugees, the organisation of their stay, the benefits provided, as well as the measures taken to channel humanitarian support to Ukraine fighting against Russian aggression were presented. Particular focus was placed on the role of local

government, whose forms of activity were presented by discussing specific initiatives implemented in Zabrze.

Anti-crisis and relief efforts were undertaken by state and local government services, NGOs and church organisations, as well as individual volunteers. The paper presents legislative initiatives and regulations introduced to regulate refugees' access to social assistance, health care and the education system. The activity of local government units was also analysed. On the example of Zabrze, the scope, form and character of undertakings implemented by the local administration and the local community to help those fighting in Ukraine and refugees residing in Poland were examined. The research question concerns the activities of central and local government administration.

2. Warfare as a cause of the refugee crisis

Russia's invasion of Ukraine began on Thursday 24 February 2022. It was preceded by an address by President Vladimir Putin, who at 3.45 am¹ announced the start of a 'special military operation' to defend the people of Donbass from 'genocide' and to 'demilitarise and denazify Ukraine' (Wilk, Domańska, 2022). According to the invader's narrative, Russia recognised the independence of the Donetsk People's Republic and the Lugansk People's Republic and concluded treaties of friendship and mutual assistance with them, and attacked because of 'the growing threat from Ukraine to Russia' (Andreev, 2022). Meanwhile, European Union leaders stated that Russia's unprovoked and unjustified military aggression against Ukraine grossly violated international law². In addition to military objectives, the war against Ukraine has also been used by the Russian authorities to further transform Russia into a totalitarian state (Legucka, 2022).

In response to the armed onslaught by the Russian Federation, Ukrainian President Volodymyr Zelenski delivered a message to the people in which he appealed for calm and assured them that the Ukrainian army was fully prepared to defend the country (Nieczypor, 2022). At the same time, the Verkhovna Rada of Ukraine adopted the President's proposal to impose martial law throughout the country. General mobilisation was also announced and diplomatic relations with Russia were severed. On the first day of the war, Russia launched more than 160 ballistic missiles towards Ukrainian targets³, the aggressor's troops were approaching Kiev, a wave of panic gripped some residents, causing queues of cars to form on

¹ 24 February 2022 at 3.45 am Polish time.

² *Statement by the Heads of State or Government meeting at Versailles on Russian military aggression against Ukraine*, 10 March 2022 published on the official website of the Council of the European Union and the Council of the European Union at <https://www.consilium.europa.eu> [accessed 2 June 2022].

³ Statement by a US Ministry of Defence representative quoted by Reuters, reported at 22:37 on 24 February 2022 by RMF FM radio on its official website at <https://www.rmf24.pl> [accessed 2 June 2022].

the border with Poland already on the day of the attack (Drabczuk, 2022).

By the evening of 24 February, it was already known that the attacking Russian troops had broken through the Ukrainian defences in the border zone on all directions of attack. Groups operating from the Belarusian side entered the Kiev and Chernihiv regions, while a grouping from Russian territory entered the northern part of the Sumy region. All were heading towards Kiev (Wolf 2022).

Ukrainian citizens fleeing from the armed conflict mostly headed towards the border with Poland. After crossing it, they reported to the reception points that were set up at the border crossings: Dorohusk-Jagodzin, Dolhobyczow-Uhrynów, Zosin-Uscilug, Hrebenne-Rawa Ruska, Medyka-Szeginie, Korczowa-Krakowiec, Krościenko-Smolnica, Budomierz-Hruszew⁴. There it was possible to receive medical assistance, obtain food, apply for international protection and obtain information for refugees.

For the Ukrainian citizens arriving in large numbers in Poland, assistance was organised by local authorities, foundations and NGOs. Numerous volunteers provided support at borders, reception points and refugee accommodation. Throughout the country, civic mobilisation could be observed immediately after the Russian aggression against Ukraine. Residents organised emergency accommodation, provided transport, helped find jobs, temporary shelter, donated clothing, food, school supplies for children, etc. Third sector associations provided legal and psychological assistance, etc.

During the first 100 days of the Russian invasion, Polish Border Guard officers cleared 3.771 million Ukrainians at border crossings⁵. The figure captures the scale of the described activities undertaken by government institutions, local governments, organisations and associations, as well as all the volunteers individually helping refugees.

3. Legislative action as a reaction to the facts caused by the armed conflict in Ukraine

On the 16th day of the aggression, the Polish Parliament adopted the Law on *Assistance to Ukrainian Citizens in Connection with the Armed Conflict on the Territory of that State*⁶.

The document set out the rules for legalising the stay of Ukrainian citizens who came to the territory of Poland from Ukraine, but only in connection with warfare, as well as Ukrainian

⁴ Reception points for Ukrainian citizens on the territory of Lubelskie Voivodeship, information of 24 February 2022 published on the official website of the Voivodeship Office in Lublin at www.lublin.uw.gov.pl [accessed 15 June 2022].

⁵ Data disseminated by the Border Guard on its official account at https://twitter.com/straz_graniczna [accessed 3 June 2022].

⁶ Law of 12 March 2022 *on assistance to citizens of Ukraine in connection with the armed conflict on the territory of the country* (Journal of Laws 2022, item 583).

citizens with the Card of the Pole⁷, who also came with their immediate family because of the Russian attack on their country. The law recognises the stay of refugees coming to Poland as legal for 18 months counting from 24 February 2022. It also sets out the conditions for refugees to continue to stay in the territory of the Republic of Poland after obtaining, pursuant to Art. 38.1 para. 3 temporary residence permit for a period of 3 years at a time. What is particularly important, the Act provided for a special mode of assigning PESEL numbers to Ukrainian citizens⁸ and obtaining a trusted profile⁹ providing remote access to public services provided by the Polish administration. After registration in the Universal Electronic Population Register System (Powszechny Elektroniczny System Ewidencji Ludności - PESEL), refugees were entitled to a single cash benefit of PLN 300¹⁰ per person for subsistence, i.e. according to Article 31.1 of the Act, in particular for: covering expenses for food, clothing, footwear, personal hygiene products and housing fees. Under Article 33.1, refugees could also be granted food aid under the Fund for European Aid to the Most Deprived. The law opened up the possibility for refugees to apply for legal work subject to Article 22.1 para. 2, that the entity employing the foreigner had to notify the relevant district labour office of this fact within 14 days. Under the conditions provided for Polish citizens, Ukrainians could also benefit from intermediation and training services on the employment market. Article 23 of the Act stated that after obtaining a PESEL number, Ukrainian citizens could undertake and carry out economic activities on the territory of the Republic of Poland on the same terms as Polish citizens. In an analogous manner¹¹, Article 31.1 also guaranteed refugees access to most health care services¹².

What is extremely important for refugees with children, the document also laid down rules for the provision of assistance and social services, shelter, education, care and upbringing, organisation of leisure time, including culture and sport, and public health. Provision was made for support provided by the governmental composite administration and local government units. In particular, this concerned collective accommodation and catering. On the other hand,

⁷ The Card of the Pole may be obtained by a person who, declaring his/her affiliation with the Polish Nation, meets the conditions set out in the Act of 7 September 2007 *on the Card of the Pole* (Journal of Laws of 2007, No. 180, item 1280).

⁸ The PESEL number in the Universal Electronic Population Register System is an eleven-digit numerical symbol that uniquely identifies a natural person in accordance with Article 15 of the Act of 24 September 2010 *on Population Register* (Journal of Laws 2010 No. 217, item 1427).

⁹ The trusted profile is an electronic tool for contacting the Polish public administration, which can be set up by a person who has been assigned a PESEL number. Thanks to the trusted profile, he or she has the possibility to confirm his or her identity in electronic administration systems and to sign documents remotely. For refugees, it was particularly important to use the trusted profile in contacts with the Social Security Office.

¹⁰ During this period, the average salary in Poland amounted to PLN 6235.22. Source: Communication of the President of the Central Statistical Office of 11 May 2022 on the average salary in the first quarter of 2022 published on the official website of the Central Statistical Office at <https://stat.gov.pl> [accessed 2 June 2022].

¹¹ That is, on the principles and to the extent to which persons covered by compulsory or voluntary health insurance were entitled to benefits under the Act of 27 August 2004 *on health care services financed from public funds* (Journal of Laws of 2021, item 1285).

¹² Under the law, spa treatment and spa rehabilitation as well as the administration of medicinal products dispensed under health policy programmes were excluded from these benefits.

for Poles who individually hosted refugees in their homes and at the same time bore the costs of accommodation and food, the Act gave the possibility in Article 13.1 to apply for a monetary benefit on this account for no longer than for a period of 120 days¹³ from the day of arrival of the Ukrainian citizen on the territory of the Republic of Poland.

3.1. Support for refugees on the example of entitlements to free travel within Poland

Citizens of Ukraine have been able to enjoy free rail travel after crossing the border since 26 February. This applied to second-class PKP Intercity trains of the TLK and IC economy categories throughout Poland. At first, journeys were made only on the basis of a passport confirming Ukrainian citizenship and included transfers on subsequent domestic connections¹⁴. It is worth noting that it was already announced on 30 March that the rules would change from 1 April. The reason given was the numerous abuses involving the extortion of free travel by 'labour migrants' rather than people fleeing the effects of hostilities. Entitlement to free transport was maintained for those with Ukrainian citizenship: (1) children and young people up to the age of 18; (2) women (regardless of age); (3) men over the age of 60; (4) men aged 18-60 with disabilities or reduced mobility¹⁵. At the same time, the presentation of a passport was required, which confirmed the crossing of the border after 24 February 2022. Another method of documenting entitlements was to present a document with a photo confirming identity (ID card, driving license, school and student ID, etc.) and, at the same time, a PESEL notification indicating the foreigner's status as a person who crossed the border after 24 February, or a registered railway ticket of the Ukrainian Railways (*Ukrzaliznytsya*) for travel from Ukraine to Poland (this possibility was introduced from 8 April 2022) or a certificate for a Ukrainian citizen to issue a railway ticket (this possibility was introduced from 14 April 2022).

The introduction of the restrictions has caused a number of problems, one of which was highlighted by the Ombudsman, who signalled the need to widen access to the concession and to simplify procedures, as the solutions adopted by the carriers do not meet all the needs of the refugee crisis, specifically, for example, men aged 18-60 with no visible or recognised disability who cannot benefit from free travel are often the only guardians of minor children. In addition, many Ukrainian citizens cross the border using a simplified procedure as they do not carry a valid passport. The Border Guard Service is then unable to confirm - to the satisfaction of the carriers - the date on which they crossed the border, which in turn often results in a de facto

¹³ Originally, a period of 60 days was set, which was changed to 120 days in accordance with Article 1 of the Act of 27 April 2022 amending the Act on Assistance to Citizens of Ukraine in Connection with the Armed Conflict on the Territory of Ukraine (Journal of Laws of 2022, item 930). The amount of the cash benefit was PLN 40 per day per 1 person hosted by the Polish applicant.

¹⁴ *PKP Intercity: There will be free rides for Ukrainians*, information dated 26 February 2022 published on the rail transport industry website at www.rynek-kolejowy.pl [accessed 20 June 2022].

¹⁵ *Free travel for Ukrainian nationals on PKP Intercity trains*, information from the carrier's service of 26 February, updated 1 June 2022, and published at www.intercity.pl [accessed 15 July 2022].

impossibility to take advantage of free travel. The problem is not solved by the possibility to obtain a PESEL number, as this requires waiting several days¹⁶. In response to the arguments presented, the Minister for Infrastructure, who was the addressee of the Ombudsman's letter, stated that - referring to the constitutional principle of equality of citizens in the face of the legislation in force - in no case is the right to a statutory discount linked to nationality or citizenship held, even in an extraordinary situation such as an armed conflict¹⁷.

Gradually, entitlements to free travel on PKP Intercity or regional railways were limited or withdrawn, and at the end of the analysed period, such a possibility existed only in strictly defined cases¹⁸. The situation was similar with free travel for cars registered in Ukraine on toll roads in Poland. In this case, too, tolls on state and concession sections were abolished after 1 March and reintroduced on 1 June 2022, albeit with the exception of vehicles carrying humanitarian aid for Ukrainian citizens (subject to prior notification of the convoy). After 24 February, Ukrainians could also count on movement assistance provided by individual cities. For example, the municipal transport operator in the capital city informed: for refugees, public transport is free of charge, and the vehicles of the Warsaw Municipal Transport run with the flags of Ukraine and Warsaw¹⁹. Moreover, this applied to all Ukrainian citizens. It was only after 15 April that a provision was introduced making the granting of free travel conditional on confirmation of arrival in Poland on or after 24 February²⁰. The entitlement for refugees was in force until 31 May 2022, after which it was abolished.

4. Anti-crisis and aid measures of the local authority on the example of Zabrze

A study of the activity of the local government unit in the face of the situation caused by Russia's armed aggression against Ukraine was carried out by analysing the actions taken in Zabrze in the period of one hundred days after the outbreak of war.

¹⁶ Letter from Ombudsman Marcin Wiśk to Minister of Infrastructure Andrzej Adamczyk dated 19 April 2022, reference V.565.69.2022.GH.

¹⁷ The constitutional principle of equality before the law was invoked by Andrzej Bittel, Secretary of State at the Ministry of Infrastructure, in a letter to Ombudsman Marcin Wiśk dated 20 May 2022, reference DTK-8.4602.124.2022.

¹⁸ *Train journeys for citizens of Ukraine / npoi3d nommoM dw opoMad^H ykpaiHu*, information dated 1 July 2022 from the website of the Railway Transport Authority at <https://utk.gov.pl> [accessed 22 July 2022].

¹⁹ *Warsaw for refugees from Ukraine*, information published on 26 February 2022 on the official website of Warsaw Public Transport at www.wtp.waw.pl [accessed 20 July 2022].

²⁰ *Free WTP rides for Ukrainian citizens - changes from / 3MiHU Bid 15.04.2022*, information published on 13 April 2022 on the official website of Warsaw Public Transport at www.wtp.waw.pl [accessed 20 July 2022].

4.1. Characteristics of the test field

Zabrze is a Polish city with county rights located in the Silesian Voivodeship, in the Silesian Highlands, on the Kłodnica and Bytomka rivers. It has a population of approximately 172,000 people in an area of 80 km² (CSO, 2019), making it the fourth most populous city in the Upper Silesian and Zagłębie Metropolitan Area. It is one of the central centres of the Upper Silesian conurbation. Before 1989, it was a coal and steel monoculture with several mines, coking plants and steelworks. The period of political transformation resulted in the restructuring or liquidation of heavy industry and mining. Today, Zabrze is a regionally recognised centre of medicine, service-based economy and transfer of modern technology, culture, sport and post-industrial heritage tourism. Visitors can explore, among other things, the globally unique underground routes (180, 320 and 355 metres underground) in the "Guido" Historic Coal Mine or the underground boat trip (approximately 1 100 metres long) in the original excavations of the former Main Key Heritage Adit. For its preservation, renovation and adaptation for tourism of post-industrial sites, the city received the European Commission's Europa Nostra Award in 2019. Zabrze is also a centre of science with, among others, faculties of the Silesian University of Technology, the Silesian Medical University, the Faculty of Medicine of the Higher Technical School, the Institute of Medical Technology and Apparatus, the Prof. Zbigniew Religa Foundation for Cardiac Surgery Development, the Institute of Fundamentals of Environmental Engineering of the Polish Academy of Sciences (PAN), the Centre for Polymer Chemistry of the PAN and the Silesian Medical Technology Park Cardio-Med Silesia, the Institute for Chemical Processing of Coal.

4.2. Local government reception and distribution point for humanitarian aid at the NGO Centre

Information about the scale of Russian aggression against Ukraine, reported by the mass media and disseminated on social media, triggered a wave of solidarity with the victims across Poland. One of its manifestations was the willingness to donate gifts for refugees. The government, together with the composite administration and the local government, became involved in coordinating the provision of support. The Silesian Governor's order No. ZKI 6330.21.1.2022 of 26.02.2022²¹ addressed to the local self-government units ordered the organisation in municipalities of ad hoc accommodation for refugees together with food and the provision of social and psychological care.

²¹ The Silesian Governor's order No. ZKI 6330.21.1.2022 of 26 February 2022 was revoked by the Silesian Governor's revocation order No. ZKI 6330.21.2.2022 of 18 March 2022 due to the entry into force on 12 March 2022 of the Act on Assistance to Ukrainian Citizens in Connection with Armed Conflict on the Territory of Ukraine (Journal of Laws 2022, item 583).

The day before, only one day after the day of the invasion, i.e. still on 25 February 2022, a central point for receiving and distributing humanitarian aid started operating in Zabrze. It was set up at the premises of the Centre for Non-Governmental Organisations, an institution functioning within the City Hall and dealing with cooperation with entities grouping citizens (in 2021, 390 such organisations were registered in Zabrze) involved in the social life of the city through their activity in associations, unions or foundations, etc. Through messages disseminated via the city's website, the city's Facebook profile and media belonging to municipal institutions, residents found out where they could donate. Throughout the first weekend of the war, the people of Zabrze filled the premises of the Centre for Non-Governmental Organisations on their own initiative with clothing, food (especially with an extended shelf life), drinks, personal hygiene products, cleaning products, etc. The points were open daily (on weekdays from 8.00 a.m. to 7.00 p.m. and on Saturdays and Sundays from 10.00 am to 3.00 pm) and in the first weeks of military operations in Ukraine enjoyed great interest from residents.

Employees of the municipal office received the donations, drew up transfer protocols, sorted them, grouped them according to product categories, described them and packed them into containers for further dispatch. At first, the addressees were the Government Strategic Reserve Depots in Lubliniec, from where the support was to reach Ukraine with funds at the disposal of the government administration. The first shipment of humanitarian aid from Zabrze (made up of 18 Europallets filled with residents' gifts) set off on 2 March 2022. Some of the gifts brought by residents were transferred directly to Ukrainian citizens who had arrived in Zabrze and needed in-kind support.

Around 70 volunteers were involved in the functioning of the NGO Centre over the following weeks. Among them were young people from the uniformed classes of Zabrze schools, members of NGOs, police officers, firefighters and municipal guards working at the reception of delivered products, their segregation, classification and subsequent loading onto trucks, which from the second transport was directed to Rivne, Zabrze's Ukrainian partner city.

4.3. Coordination of assistance for Zabrze's twin town of Rivne (Ukraine) with the involvement of Zabrze twin towns from Western Europe

Partner cities establish and maintain relationships to enhance mutual cooperation. According to the law in force, decision-making in matters of cooperation with local and regional communities of other countries is the responsibility of the local government²². A cooperation agreement between Zabrze and Rivne was signed on 25 January 2001. Cooperation in recent years has included social policy, culture, medicine, sport and ecology, including mutual participation in sectoral conferences on the exchange of good practice in the fields of tourism,

²² Pursuant to Article 18(1)(12a) of the Act of 8 March 1990 *on Municipal Self-Government* (Journal of Laws of 1990, No. 16, item 95), adoption of resolutions on twinning with foreign towns falls within the remit of the municipal council.

health care and air quality improvement, as well as the activities of the European Network of "Cities for Children" coordinated by the City of Zabrze. Rivne is a regional city in western Ukraine with a population of approximately 245,000 with an airport and a nuclear power plant. It is located on the Ustva River on the main road between Warsaw and Kiev, about 200 km from the Polish border.

The first shipment of humanitarian aid to the city of Rivne (33 pallets) was dispatched on 5 March 2022. A new quality of support was the appeal of the Zabrze authorities to their partner and friend cities. In response, more convoys of aid dedicated to Rivne arrived at the NGO Centre. The logistics of these were coordinated by the Zabrze City Council's Office for International Cooperation. Ukrainian trucks were used for transport to the war zone. Thus, among others, a transport of donations from Germany left Zabrze for Rivne on 10 March, from Portugal on 11 March, from France on 15 March, from Italy on 9 April and from Spain on 13 April. The local government's involvement in the international forum was described by the mass media: Zabrze is actively involved in helping Ukraine, which is affected by the armed conflict. It is to this city that gifts donated by the inhabitants of Zabrze's partner cities (including Essen) and friendly local authorities from other European countries are brought, and from here they are transported by collective transport directly to the Ukrainian city of Rivne²³.

Subsequent days of armed aggression in Ukraine had the effect of clarifying the list of products expected by recipients in Rivne, where there was no armed fighting. However, wounded people who had been injured by hostilities in other regions of Ukraine were being transported to the city. Therefore, medical supplies and hospital supplies, as well as food, were first on the priority list for humanitarian aid.

4.3.1. Creation of a sub-account on the local government's bank account as a method of financing the dedicated aid provided to the city of Rivne

Thanks to the creation on 4 March of a special sub-account²⁴ on the account of the Zabrze City Hall, individuals and companies interested in financially supporting Ukrainian citizens could make donations there. In the first instance, the funds collected were used to purchase medicines and dressing materials for the hospital in Rivne.

As early as 18 March, it was possible to dispatch the first transport of medical supplies purchased for the hospital in Rivne. The Zabrze-based sanitary transport company 'Eskulap' also donated an ambulance. On 11 April, an ambulance donated to Ukrainian doctors arrived at the hospital in Rivne along with another shipment of humanitarian aid. In addition, donations collected by shopping centre customers, sponsored by businesses, from the Polish Red Cross pool and deposited at the NGO Centre by local residents continued to be sent. During the period

²³ *Zabrze wspiera Ukrainę, oferując pomoc i koordynując działania na wielu płaszczyznach*, material published on 16 March 2022 in the SŁĄSK section of the ONET.PL news portal at <https://wiadomosci.onet.pl> [accessed 9 June 2022].

²⁴ An account number was activated: 03 1050 1070 1000 0090 3268 5357, where donors wrote the title of the transfer: "Donation for aid to Ukraine". Both domestic and foreign donations were possible. The account was operated by ING Bank Śląski S.A.

under review, cars filled with several tonnes of items needed there still left for Rivne on 13 and 17 May.

4.4. Support for refugees coming to Zabrze

Another area of support was assistance for refugees who arrived in Zabrze. The day after the Russian aggression in Ukraine, a telephone number²⁵ was made available within the Crisis Management Department of the Zabrze City Hall, which provided information on the forms of assistance prepared for Ukrainians. The mass media managed or cooperating with the local government (traditional and social media) published useful information for refugees, as well as news relevant for volunteers and those wishing to support Ukrainians fleeing war (e.g. by joining in the preparation of humanitarian aid).

On 1 March, however, a Consultation and Information Point for Ukrainians was set up²⁶. The point's staff provided refugees with practical information on educational and social offers, emergency assistance and housing. The point, run by the City Centre for Family Support, supported refugees in legalising their stay and also facilitated the completion of procedures to obtain a PESEL number. In Zabrze, refugees could, for example, have their photographs taken free of charge, which were necessary to submit documents. The point's staff also provided information on how to access the social support system (e.g. one-off benefits, family benefits, the 500+ programme, the possibility for children to continue schooling). Consultations related to these issues were conducted by telephone in Ukrainian and Russian. On site, official formalities related to a longer stay in Poland and the use of health benefits were completed. At the same time, the people of Zabrze were able to register there their willingness to provide accommodation for refugees. An employee of the Poviats Employment Office was on duty at the point, providing information on employment opportunities. In parallel, information on assistance for Ukrainian refugees was provided 24/7 by the Crisis Management and Civil Protection Department. This department also coordinated the distribution of more than 400 24-hour accommodation places (including food and social care). The accommodation provided by local authorities was located in hotels (the "Ambassador Hotel" owned by the Municipal Centre for Sport and Recreation), hostels (the "Guido Hostel" owned by the Coal Mining Museum), sports facilities (the "Hala Pogoń" owned by the Property Management Unit) and municipal buildings (e.g. the premises of the municipal nursery school). Shelter for refugees was also provided by Zabrze families, as well as entities administered by the Catholic Church. At the end of the period under study, the estimated number of Ukrainian citizens fleeing military action in Zabrze was around 3,000²⁷.

²⁵ The number 32/37-33-388 provided by the Crisis Management Department dedicated to helping Ukrainians could be called around the clock.

²⁶ The Consultation and Information Point for Ukrainians operated at 9 Wyzwolenia Street.

²⁷ Based on estimates from the Department of Emergency Management and Civil Protection of the Municipal Office in Zabrze.

4.5. Position of the municipality towards Russia's aggression against Ukraine

It is noteworthy that in addition to the described forms of assistance to refugees and the city of Rivne, the Zabrze local government four days after the invasion began unanimously passed a resolution in which it stood in solidarity with the struggling Ukraine and joined the protests against the unjustified aggression of the Russian Federation against an independent and sovereign country. The document, adopted during a session of the City Council on 28 February 2022, stated, among other things: "we strongly condemn President Vladimir Putin's violation of international law through the Russian Federation's support of separatist republics that are an integral part of the territory of democratic Ukraine. We are pained and compassionate to learn of the consequences of the hostilities affecting both soldiers and civilians, especially children, women and the elderly. For the sake of the refugees, we have prepared accommodation, food and social and psychological assistance (...). At the same time, we appeal to companies, institutions and all residents of our city to be open to the needs of Ukrainians seeking refuge from the Russian invasion of their homeland, as well as to be kind to the citizens of this country residing in Poland. We believe that the Russian people are opposed to a war that poses a threat to peace in Europe and the world"²⁸. Expressing their opposition to the barbaric aggression, the councillors voted during the same session to break the partnership with the city of Kaliningrad in Russia²⁹. At the same time, they declared support for the Ukrainian partner city of Rivne, providing humanitarian aid and taking action for war refugees³⁰.

5. Conclusions

According to 'Information on preliminary results of the National Population and Housing Census 2021'³¹, Ukrainian citizens accounted for 47 per cent of permanent residents of Poland with citizenship other than Polish. In 2021, there were a total of 53 000 persons (CSO, 2022, p. 8). Women predominated in this group (54 per cent). In the 10 years separating the two editions of the census, the number of permanent residents of Poland with Ukrainian citizenship increased fourfold (Kuzior et al., 2020). In 2011, it amounted to 13.4 thousand people, although Ukrainian national-ethnic identification was declared by as many as 49 thousand people during

²⁸ Resolution No. XLV/697/22 of the Zabrze City Council of 28 February 2022 *on the resolution of the Zabrze City Council*. Source: Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl> [accessed 13 June 2022].

²⁹ Resolution No. XLV/698/22 of the Zabrze City Council of 28 February 2022 *on the termination of cooperation between the City of Zabrze and the City of Kaliningrad in the Russian Federation*. Source: Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl> [accessed 13 June 2022].

³⁰ Resolution No. XLV/698/22 of the Zabrze City Council of 28 February 2022 *on support for the partner city in Rivne, Ukraine*. Source: Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl> [accessed 13 June 2022].

³¹ The information was published on 26 April 2022.

the census. In contrast, according to the previous census of 2002, there were only 5.4 thousand Ukrainian citizens.

Research published in 2012 indicated that at that time there were no strong links between Ukrainians settled in Poland and labour migrants from Ukraine. Migrants coming to Poland for temporary work functioned, so to speak, in isolation from the Ukrainian community (Brunarska, Grotte, Lesińska, 2012, p. 8). But the group of migrants was already counted in millions. The number of declarations of entrustment of work to a foreigner (the most popular legal basis for the work of Ukrainian citizens in Poland) alone increased sharply from about 220 thousand in 2013 to over 1 million 700 thousand in 2017, remaining at a comparable level in the following years.

It is worth noting that a 2016 survey of Ukrainian migrants managed to identify the main problems foreigners faced (Kindler, Górny, Jaźwińska, 2022, 123). The most common (more than half of the respondents) were: separation from family (75 per cent of the respondents), lack of good knowledge of current legislation (60 per cent) and low wages (56 per cent).

Even before Russia's military action in Ukraine began in February 2022, migration, caused not only by traditional reasons such as study, relocation to a new place of residence and the search for better paid work, but also new ones - the annexation of Crimea by the Russian Federation (March 2014) and the military conflict in the Donetsk and Lugansk regions (since April 2014), has become a major socio-economic problem (Kuzior, Lobanova, 2017, p. 226-227). According to the Kremlin leadership, without the return of Ukraine (with its territory, resources and human capital) to the bosom of Russia, any attempt to revive its imperial status is unproductive (Vasylenko, 2017, p. 22). Therefore, the removal of President Viktor Yanukovich from power in February 2014, perceived as an announcement of Ukraine's integration into the European Union and NATO, was one of the reasons for the start of the armed aggression known as 'hybrid war', which already contributed to the increase in the number of Ukrainian citizens arriving in Poland. However, the number of people arriving after 2014 was radically lower than the scale of departures triggered by the 24 February 2022 invasion.

UN data published in July 2022 shows that nearly 10 million (9,926,884) people have left Ukraine since the beginning of Russian aggression. Of this group, nearly 5 million (4,944,264) refugees have arrived in Poland, and more than 1.2 million (1,234,718) Ukrainians have applied for temporary protection³². In Poland, they were given the opportunity to benefit from the education, health and social care system, to provide work and to carry out economic activities. In the first 100 days of the Russian-induced war, refugees were also able to count on the spontaneous support of non-governmental associations, volunteers and a significant part of the

³² *Ukraine Refugee Situation*, data from the official website of the UN Refugee Agency published on 22 July 2022 at <https://data.unhcr.org> [accessed 28 July 2022].

population, in addition to the anti-crisis, intervention and assistance measures of the state and local administration. Interestingly, usually citizens only marginally benefit from the possibility to actively shape the reality around them (Szostok 2019, p. 143). The described activities - on the example of the local administration and the local community of Zabrze - confirmed that the emergency situation related to the war in Ukraine activated members of the local government community and mobilised them to directly participate in the implemented aid projects.

References

1. Act of 12 March 2022 *on assistance to citizens of Ukraine in connection with the armed conflict on the territory of the country* (Journal of Laws 2022, item 583).
2. Act of 24 September 2010 *on population registration* (Journal of Laws 2010, no. 217, item 1427).
3. Act of 27 April 2022 amending the Law on *Assistance to Citizens of Ukraine in Connection with the Armed Conflict on the Territory of Ukraine* (Journal of Laws 2022, item 930).
4. Act of 27 August 2004 *on health care services financed from public funds* (Journal of Laws 2021, item 1285).
5. Act of 7 September 2007 *on the Card of the Pole* (Dz. U. of 2007, No. 180, item 1280).
6. Act of 8 March 1990 *on municipal self-government* (Dz. U. of 1990, No. 16, item 95).
7. Andreev, S. (2022). *O rosyjskiej specjalnej operacji wojskowej w Donbasie i na Ukrainie*, speech by the Russian Ambassador to Poland at a press conference in Warsaw on 1 June 2022 published on the official website of the Russian Embassy in Poland at <https://poland.mid.ru>, 2.06.2022.
8. Brunarska, Z., Grotte, M., Lesińska, M. (2012). Migracje obywateli Ukrainy do Polski w kontekście rozwoju społeczno-gospodarczego: stan obecny, polityka, transfery pieniężne. *CMR Working Paper, No. 60(118)*, pp. 1-89.
9. *City of Zabrze*, description of the state for 2019 on the official website of the Statistical Office in Katowice at <https://katowice.stat.gov.pl>, 10.06.2022.
10. Drabczuk, N. (2022). *Inwazja Rosji na Ukrainę*, Commentary No. 530 of the Eastern Europe Team of the Central Europe Institute published on 24 February 2022 on the official website at <https://ies.lublin.pl>, 2.06.2022.
11. *Information on preliminary results of the National Population and Housing Census 2021*, material published on 26.04.2022 on the official website of the Central Statistical Office at <https://stat.gov.pl>, 2.06.2022.
12. Kindler, M., Górny, A., Jaźwińska, E. (2022). Między nami? Więzy i kontakty społeczne z Polakami w życiu codziennym osób z Ukrainy w Warszawie i okolicach. *Studia*

- Socjologiczne, No. 1(244)*, pp. 105-136.
13. Kuzior, A., Liakisheva, A., Denysiuk, I., Oliinyk, H., Honchar, L. (2020). Social Risks of International Labour Migration in the Context of Global Challenges. *J. Risk Financial Manag.*, 13, p. 197, <https://doi.org/10.3390/jrfm13090197>.
 14. Kuzior, A., Lobanova, A. (2017). Problem migracji – ukraińskie i polskie doświadczenia. *Zeszyty Naukowe Politechniki Śląskiej. Series: Organization and Management*, z. 112, pp. 219-228.
 15. Legucka, A. (2022). Wojenna cenzura i propaganda Rosji. *PISM Bulletin, No. 52(2471)*, 1 April 2022, material published on the official website of the Polish Institute of International Affairs at <https://www.pism.pl>, 3.06.2022.
 16. Nieczypor, K. (2022). *Władze Ukrainy wobec inwazji rosyjskiej*, analysis of 24 February 2022 published on the official website of the Centre for Eastern Studies at <https://www.osw.waw.pl>, 2.06.2022.
 17. Resolution No. XLV/697/22 of the Zabrze City Council of 28 February 2022 on the resolution of the Zabrze City Council. Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl>, 13.06.2022.
 18. Resolution No. XLV/698/22 of the Zabrze City Council of 28 February 2022 on the termination of cooperation between the City of Zabrze and the City of Kaliningrad in the Russian Federation. Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl>, 13.06.2022.
 19. Resolution No. XLV/698/22 of the Zabrze City Council of 28 February 2022 on support for the partner city in Rivne, Ukraine. Zabrze City Council Public Information Bulletin at <https://bip.miastozabrze.pl>, 13.06.2022.
 20. Szostok-Nowacka, P. (2019). Znaczenie poczucia podmiotowości dla aktywności społecznej w przestrzeni samorządowej. *Annales Universitatis Mariae Curie-Skłodowska. Sectio K. Politologia*, vol. 26, no. 1, pp. 141-157, doi 10.17951/k.2019.26.1.141- 157.
 21. Vasylenko, V. (2017). Przyczyna, charakter i cel zbrojnej agresji Rosji przeciwko Ukrainie. *Polish-Ukrainian Studies*, vol. 3, pp. 21-26.
 22. Wilk, A., Domańska, M. (2022). *Rosyjski atak na Ukrainę*, analysis of 24 February 2022 published on the official website of the Centre for Eastern Studies at <https://www.osw.waw.pl>, 2.06.2022.
 23. Wolf, A. (2022). *Rosyjski atak na Ukrainę (24 lutego, godz. 20.30)*, analysis of 24 February 2022 published on the official website of the Centre for Eastern Studies at <https://www.osw.waw.pl>, 6.06.2022.

DIFFERENCES IN UNDERSTANDING DYNAMIC CAPABILITIES IN DIRECT RESEARCH

Leszek PANASIEWICZ

Lublin University of Technology, Faculty of Management; l.panasiewicz@pollub.pl,
ORCID: 0000-0001-5836-6783

Purpose: The aim of the research was to identify views regarding the capability of enterprises as expressed by members of their managerial staff. The research paid particular attention to the issue of "dynamism" of capabilities, that is, the capability itself and how to distinguish dynamic capabilities from non-dynamic capabilities.

Design/methodology/approach: The research was carried out using the qualitative method, by collecting and analysing the written statements of management representatives from twenty-seven companies of various sizes and industries.

Findings: The ability to distinguish oneself from the competition is a basic issue in the formation of the company's strategy. However, as demonstrated in the literature review, the newer theory of enterprise capability, which is dynamic capabilities, is not only constantly changing, but the background is still not clear enough to be a useful tool for management practitioners. These findings have led to the formulation of questions as to what extent and how management practitioners use theories about organisational capabilities? How do they understand this issue and how do they put it into practice? Thanks to empirical research, it is possible to answer these questions. Seven clear differences were identified between dynamic and non-dynamic capability portfolios that are closer in character to distinctive capabilities or core competence. These differences are the main components of two different ways of understanding the logic of an organisation's operation.

Practical implications: Empirical research has identified the beliefs that limit the ability to perceive the role or capabilities of dynamic capabilities in practice. The research also suggests a possible scenario for the dynamisation of the capacity portfolio.

Social implications: The results of the study highlight the role of the linguistic representation of knowledge in the field of management and its impact on the pro-innovation ("prodynamics") of managerial thinking. In this way, they refer to educational strategies aimed at the professionalisation of managerial staff.

Originality/value: This study presents real ways of understanding the issue of the organisational capabilities of management practitioners. The results may be useful for practicing managers, specialists in the field of managerial education, as well as researchers exploring the issues of dynamic capabilities and organisational competences.

Keywords: dynamic capabilities, distinctive capabilities, metaphors, qualitative research.

Category of the paper: Research paper.

1. Introduction

The concept of dynamic capabilities (DC) offers a coherent explanation of the actions that organisations take to stay competitive in a turbulent environment. Contrary to "normal" organisational capabilities, dynamic capabilities are strategic in nature - they correspond to the organisation's capability to reconfigure strategic resources to generate the best possible response to dynamic changes in the environment. Their idiosyncratic (Tallot, Hillard, 2014, p. 34) nature is the result of the dynamic integration of a wide range of routines, and creativity and learning outcomes (Teece, 2012, pp. 1396-1399), and their use in generating innovation (Alves, Cherubini, 2017, p. 242) and making market-oriented decisions. The concept of dynamic capabilities offers the possibility of a flexible and comprehensive description and analysis of organisational processes, which allow the organisation to dynamically adjust its activities to the variability and uncertainty of the environment. These processes are crucial to the existence of an organisation, but they are extremely complex (Miles et al., 1978, p. 547). No wonder, then, that the founding article, considered to be the first systematic lecture on the concept of dynamic capabilities (Teece, Pisano, 1997), has received over 13,000 citations¹. However, the dynamic capabilities theory is not easy to put into practice. First of all, the concept has not yet been fully developed. This means the presence of gaps and difficulties in the application result arising from the inconsistency and ambiguity of the formulations, which leads to various interpretations of these concepts, their essence, purpose and meaning.

Peteraf and Tsoukas also draw attention to the significant change in the concept of DC expressed in the texts of its creator, David J. Teece. The explanation of DC as presented in 2012 is significantly different from that presented in the founding article in 1997. In addition to Teece's work, currents representing DC in yet other ways are being developed (Eisnehardt, Martin, 2000, p. 1106). Even the above short analysis clearly shows the axis of tension between management theory and practice in the area discussed. The developed theory corresponds to the needs of the practice, but the degree of its development does not yet facilitate the formulation of solutions that can be applied in practice, allowing the management of the dynamic capabilities of the enterprise. Despite this, thinking in terms of organisational capacity is present in management practice. The developed and specified theory of organisational abilities will be applied in an organisational reality which is already organised in a certain way of understanding and naming them. Therefore, the aim of this article is to examine the views and beliefs present in the minds of managers that define the structure and functions of the capabilities of the organisation they manage. An insight into the organisation's ability to learn from managerial experience can help identify the common ground between theory and practice and those issues where there are divergent views.

¹ According to the Web of Science, as of September 2022.

2. Capabilities, dynamic capabilities and competences of the organisation

The concept of strategic capabilities is one of the trends in the resource school of strategic management. Ansoff (1965) treated capabilities as a category of resources, along with the infrastructure, equipment and skills of their personnel, that enable enterprises to perform their functions. Andrews (1971) distinguished among the company's capabilities a group in whose implementation the company is particularly skilled. He called them "distinctive capabilities", pointing to their strategic potential. This ability can become an important resource for building a competitive advantage. A competency-based strategy is therefore an emergent strategy, because it emerges from actions and behaviours at various levels within an organisation (Mintzberg, Waters, 1985, pp. 260-261). These types of strategies, as opposed to the repetition of the sequence of planning and control of deliberate strategies, rely on learning-based flexible responses to changes in the market environment (Mintzberg et al., 1998, p. 208). For obvious reasons, these types of strategies are better suited to the current situation, which is characterised by high complexity, volatility, unpredictability, and thus also by the uncertainty of the environment. The concept that combines the organisation's capabilities with the ability to create an effective competitive response, and one which has gained enormous popularity, is the core competence concept. As in the case of distinctive capabilities, the concept of core competence assumes the existence of competences of a special character among the enterprise's many competences, constituting a competence core generating a strategic response to the challenges of the environment. Three criteria are used to identify these competences. The key competence, i.e. the strategically important: (1) allows access to various markets, (2) has the ability to create value significant for customers, and (3) is difficult to copy by competitors (Hamel and Prahalad, 1990). The identification of key competences made it possible to subject them to management, directing and thus dynamising the processes of organisational learning (Teece, Al-Aali, p. 508) and, if used, knowledge management practices (Teece, Al-Aali, p. 506). Core Competence is a unique combination of technology and knowledge (Petts, 1997, p. 552) that shapes the way a company operates and its ability to achieve strategic goals. They are complex in nature, as they are the result of the cooperation between many resources and processes, but they do not constitute a new quality in relation to the capabilities of Ansoff's work. These are "ordinary" capabilities, or "knowledge, experience and skills" (Richardson, 1972, p. 888).

The dynamic approach, as Teece and Pisano wrote in 1994, looks at competition in Schumpeterian terms. This view goes beyond the conditions of competing on the basis of resources, including competences, and also covers the processes of the active creation of new resources, or a new combination of them, inspired by fast and unpredictable changes in the market situation (Teece, Pisano, 1994, p. 552). Therefore, they define dynamic abilities as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p. 516). At the same time,

this ability is a subset of the company's abilities or competences (Teece, Pisano, 1994, p. 541)². Their dynamics results from taking into account the highly variable nature of the environment, that is, the increasing pace of the implemented innovations and the difficulties in defining the future conditions of competition (Teece, Pisano, 1994, p. 538).

However, this is not the only way to understand dynamic abilities. Peteraf and Tsoukas (2016, pp. 170-171) point to Teece's change of views in this regard. While in 1997 dynamic capabilities were defined as "the firm's ability to integrate, build (...)", by 2012 it had already become "higher level competences that determine the firm's ability to integrate, build (...)" (Teece, 2012, p. 1395). In a more recent approach, dynamic capabilities mean enriching the company's ability base with a meta-level, i.e. the ability or competence to create abilities or competences that ensure the best strategic response in a complex and dynamically changing environment. In another definition, Teece states that dynamic abilities "enable the firm to integrate, build, and reconfigure internal and external resources" (Teece, 2014, p. 329) by granting them the role of an enabler of dynamic abilities as was understood in the 1990s.

Teece's views on the role of organisational routines in dynamic abilities have also changed. In 1997, the role of non-transferable resources, such as values, culture or organisational experience, was recognised, as a result of which distinctive competences and capabilities generally cannot be acquired; they must be built (Teece et al., 1997, p. 528). However, the source of competitive advantage is indicated by high-performance routines operating 'inside the firm,' shaped by processes and positions (Teece et al., 1997, p. 528). In later works, however, he distances himself from this view. Routine actions are expected to be more common for ordinary capabilities than dynamic capabilities (Teece, 2012, p. 1396).

The latter, on the other hand, are to be original and unique, or become a source of new organisational routines (Teece, 2012, p. 1396). Apart from the changes in the views of the authors of the concept, the literature on the subject includes works arguing the need for significant changes and reformulations of the theory of dynamic capabilities. Eisenhard and Martin point to the role of best practices as a significant factor in the effectiveness of dynamic capabilities, which is not in line with Teece's views. And they understand dynamic capabilities as a strategic process consisting of typical organisational activities, enriched with not only slightly idiosyncratic elements, aimed at reconfiguration of resources. They suggest that the identification and analysis of dynamic capabilities and their transfer may be much easier than Teece's theory would suggest. Eisenhard and Martin also differentiate DC's efficiency depending on the dynamics of market changes, distinguishing, for this purpose, moderately dynamic markets and high-velocity markets (Eisenhard, Martin, 2000, p. 1115). As the market dynamics increases, so too do the requirements for the "dynamics" of dynamic capabilities. This requirement translates into the necessity to modify the methods of managing the

² Teece and Pisano treat these terms strictly synonymously, using the term "subset of the competences/capabilities" in their work.

experience accumulated by the company. In view of the diversity of opinions on dynamic abilities, the question arises about the opinions of dynamic and ordinary abilities/competences among managers. How do they perceive the competency structure that ensures the competitiveness of their companies? How dynamic are the competences they identify? These questions inspired the implementation of the research presented below.

3. Method

The aim of the research was to identify views on the capabilities of enterprises as expressed by members of their managerial staff. Practitioners were asked to provide in writing "the competences³, organisational skills⁴ and possibly dynamic abilities that allow the enterprises they manage to maintain a competitive advantage". The respondents were given complete freedom of form - the maximum or minimum number of skills was not specified, and the expected volume of responses was not determined. The only suggestion in this regard was a request to add an explanation of each of the indicated capabilities, also without any suggestions as to its volume or degree of detail. The only requirement made by the author (in the form of a sincere request) was to carry out the research independently, without the support of external sources. The aim behind such a composition of instructions was to obtain the research participants' honest, real, personal views on the competences and abilities constituting the basis for the competitive operation of the enterprises they manage. The entire study was conducted in Polish.

The dynamic capabilities test manual is an option. While the request to present the company's capabilities was clear to the respondents, the use of the term dynamic capabilities raised some doubts. During the interview, more than half of the potential study participants expressed doubts as to whether they understood the concept correctly and whether the capabilities they planned to indicate were in fact dynamic capabilities. The instructions were first delivered orally, and after obtaining consent to participate in the study, it was additionally sent by e-mail.

All respondents prepared their studies in an electronic version and sent them to the author of the study by e-mail. The preparation of the texts consisted of identifying the abilities that appear in the submitted texts. In the process of identifying and grouping

³ The concept of competence was used, defined as "the ability to perform certain activities, based on knowledge and experience" (wsjp.pl), often used in the organisational context, which is also synonymous with "skills" in Polish (synonyms.pl).

⁴ The use of the concept of abilities, apart from competences, aimed at encouraging the respondents to expand the scope of searching for competences for sources of competitive advantage when constructing responses. "Capability" in Polish is synonymous not only with "skills" (similarly to "competence"), but also with "potential" and "possibilities" (synonyms.pl). The same is true in English.

capabilities/competences, Kuuluvainen's (2012) proposal was used. This distinguishes three basic processes that are also meta-themes or classes of dynamic capabilities: opportunity search, resource acquisition and resource reconfiguration. The process of developing the texts was carried out using the Nvivo programme.

4. Research results

Responses in the form of written studies presenting the company's capabilities were received from 27 respondents, 18 women and 9 men, representing the middle management of enterprises, whose skills they described in their studies. The size distribution of these enterprises is as follows: large - 4; MSP - 14; micro - 9. The main activities of the surveyed enterprises are: banking - 1; logistics - 2; IT - 3; trade - 4; production - 6 and services - 11.

The studies ranged from 651 to 4,578 characters (including spaces). None of the responses contained information in a form other than text (drawings, diagrams, patterns, etc.). The arithmetic mean of the length of the studies was 2,011 characters, which is slightly more than a standard page of typescript. The detail of the statements was also assessed. The distribution of responses according to this criterion was as follows: full explanation of the abilities presented and their impact on the company's operations - 12; explanation of only some of the abilities listed - 1; brief explanation - 7; without explanations, or very brief explanations of individual capabilities - 7. The numbers of the enterprises' capabilities discussed in the statements ranged from 1 to 11, with the median being 5. There was no correlation between the number of distinguished abilities and the industry or company size.

The abilities mentioned or discussed also present a different degree of dynamics. According to the results of the literature research, the criterion for assessing the dynamics of abilities was, based on Teece and Pisano (1997), capabilities capable (in the sense of being able to) of integrating, building, and reconfiguring internal and external competences. The application of this criterion made it possible to distinguish three groups of answers (the number indicates the number of studies qualified for a given group): companies with standard (non-dynamic) capabilities - 14, companies with all dynamic capabilities - 3, and companies with some of the abilities dynamic, and some standard - 10. In the latter case, the fraction of dynamic capabilities in the company's capability portfolio is different. This parameter ranges from $\min = 1/8$, i.e. 1 dynamic capacity of the 8 distinguished, to $\max = 7/9$, calculated in the same way. As a result, it was possible to define three characteristics of the companies' capability portfolio - standard (non-dynamic), dynamic and mixed.

The portfolio of non-dynamic skills (non-dynamic portfolio) is characterised by a particular focus on employee skills. Employees are treated as the most important and, in most studies in this group, the only repository of skills. This also applies to managers, because the performance

of management functions in the vast majority of cases is presented as the result of the capabilities of the managerial staff.

In half of the cases from the non-dynamic portfolio of employees, skills are treated as a permanent resource of an unchanging nature. In the other half, the training policy was identified in this portfolio as a separate ability. It is interesting to note that such a solution, i.e. the recognition of training as a separate enterprise ability, appears only in cases from the non-dynamic portfolio.

In the case of this portfolio, it is possible to identify a certain standard pattern of the perception of the structure and functioning of the company's portfolio of capabilities. It can be paraphrased as follows: employees, thanks to their competences, are able to provide customers with high-quality products. Influencing the market has the character of communication - again of a personal nature - and concern for the quality of the product/service, since a satisfied customer will become a returning customer. In addition, in 8 out of 14 cases, additional measures are taken to strengthen the customer's relationship with the company. This is thinking in terms of competences or distinctive abilities. Internal resources - knowledge or skills - are treated as generators of advantage or new resources in relation to their environment: product quality, customer relations or image.

The description of dynamic capabilities (dynamic portfolio) has a completely different character than that found in the portfolio of non-dynamic abilities. Individual abilities refer to various sources of knowledge in their actions, striving to integrate them and use them in the process of creating a solution for a specific task. Apart from the knowledge and experience of employees, non-organisational sources of knowledge and artificial intelligence applications are mentioned. The overriding goal of knowledge management, and this has been strongly emphasised in the studies, is to generate innovative solutions to organisational problems by searching for rich and diverse combinations and transformations of knowledge already possessed and acquired. The sanctioning of the heterogeneous nature of knowledge, competences and organisational skills goes hand in hand with a general change in the language of studies presenting a dynamic portfolio. This change results from the release of respondents from the belief - typical for non-dynamic portfolios - of the personalised nature of competences and knowledge.

The logic of a dynamic capabilities portfolio also encompasses the perception of the company's environment. In these cases, a much more intense cooperation with the environment, taking on various forms, is emphasised. The environment is treated as a source of knowledge and opportunities for cooperation in creating innovative solutions. As one of the respondents wrote: *Cooperation allows for the acquisition of knowledge and experience, because cooperating companies share information that can be used in <company name>, the company also shares news in the industry (...). In this way, a strong, loyal relationship is created between the company and its partners* [manager in a micro-company in the IT sector]. The company acquires knowledge both from companies with which it cooperates within value chains

(suppliers and recipients), and also from competitors, business environment institutions, etc. Knowledge acquisition is carried out at the level of both employees and teams, and the organisation as a whole.

There is a visible interpretation of changes in the environment as a specific rhythm with which the company must synchronise the rhythm of its own operations. This rhythm of the reconfiguration of the environment, expressed in the changes in operating conditions, and in particular in changes in customer expectations, to which the company must quickly and creatively adapt, is presented as an integral feature of the environment. Changes in the company and its environment are treated as a natural and almost continuous phenomenon.

The mixed capabilities portfolio was represented by 10 of the studies collected. In a portfolio of this type, only part of the capacity is dynamic. The fraction of such capabilities in mixed portfolios ranged from 0.13, i.e. 1 dynamic capability out of the 8 distinguished ones, to 0.78 (7/9). Thus, it became possible to make observations about the process of the dynamisation of capabilities. The first processes that dynamised the portfolio of capabilities were the designing of new products and the establishment of cooperation with the environment in order to acquire knowledge that is to make the process of designing new products more effective. The solutions typical of a non-dynamic portfolio that remained last in mixed baskets are training and customer relationship care, distinguished as separate capabilities.

Table 1. presents the ten most common terms in each of the three sets of studies. As can be seen, in a non-dynamic portfolio the most common concepts are those of the logic of this approach: client - company - employee, while there are no concepts referring to the company's environment. On the list of popular words in the descriptions of dynamic portfolios, two such terms can be found: "market" and "industry". The term "system" is also often used, due to the higher recognition of the role of the management system than other portfolios. Table 2 summarizes the characteristic differences between the extreme portfolios - dynamic and non-dynamic, which are clearly visible in the descriptions collected.

Table 1.

The ten terms most frequently used in the descriptions of individual portfolios

No.	Non-dynamic portfolio	Mixed portfolio	Dynamic portfolio
1	client	competences	skill
2	company	company	company
3	employees	clients	client
4	competences	employees	system
5	new	skill	industry
6	products	range	possibility
7	skill	products	new
8	knowledge	sale	employees
9	job	services	production
10	activity	market	market

The terms are ordered in descending order, starting with the most frequent. During the analysis of the studies, synonyms were not taken into account. The results for the frequency of abutments have been deleted. Concepts are presented in the singular or plural.

Source: own research.

Table 2.*The characteristic differences between the dynamic and non-dynamic capacity portfolio*

Area	Non-dynamic portfolio	Dynamic portfolio
The source of competitive advantage	Competences and commitment of employees and managers	The ability to dynamically reconfigure resources at the rate and direction of changes in the environment
Knowledge localisation	Employees' and managers' skills	Written in various forms: culture, technology, routines, employee skills, databases and knowledge, available in various forms in the environment of the organisation
Acquiring knowledge from the environment	Training, cooperation with clients, industry information	A wide range of cooperation practices, environmental observation and knowledge acquisition at the level of individuals, teams and organisations
Employees	The only essential skill repository. Their knowledge is crucial and dominates all other types of knowledge and information used in the company	Holders of a specific type of knowledge (skills and experience), which is one of many types of knowledge used
Staff improvement	Training and practice. As a last resort, hiring a new employee	Training, creating conditions for self-development, searching for specialists with new types of knowledge and skills
Priorities in relations with the environment	Product quality, strengthening customer relations	Cooperation, learning, observation of changes
Changes and improvement	Improving the skills of employees and managers by solving successive instances of similar tasks and problems	Following the rhythm of changes in the environment and looking for a creative response to the direction of these changes

Source: own research.

5. Conclusions

On the basis of the research presented, three vectors can be indicated that favour the dynamisation of the company's portfolio of capabilities:

1. Noticing the role of the management system in creating the company's success. The belief in the fundamental role of the skills of the employees and managers gives way - as the ability becomes more dynamic - to the understanding of the key role of the system in all its complexity.
2. Perceiving opportunities appearing in the environment. The interior of the company is dynamised thanks to synergy with the dynamics of the surroundings. Openness to the environment grows with the inclusion of further external resources in the practice - in particular, participation in networks that cooperate with each other and co-create knowledge and innovation.
3. An important factor is also increasing the variety of sources of knowledge used by the company.

In the statements analysed, in the group of dynamic and non-dynamic portfolios, a completely different narrative is visible, which can be considered a manifestation of the adoption of various key metaphors organising the thinking of the participants in the research about their companies and their understanding of the nature of their operations (Grant, Oswick, 2008, p. 3). Descriptions of non-dynamic portfolios reflect the perception of the company as a mechanistic and hierarchical system, a situation in which the inner workings of the company and its surroundings are mutually confrontational. The studies describing dynamic portfolios suggest that their authors understand companies as networks of creative and intelligent processes. The scope and possibilities of cooperation - the richness, scope and attractiveness which the surroundings offer the company - means that there is no need to emphasise or strengthen the border between the company and the environment.

The studies, the results of which are presented in this paper, also have their limitations. Due to a relatively small research sample, only three studies presented a fully dynamic portfolio. Perhaps a larger number of studies would reveal patterns that govern the way managers identify the capabilities of the organisations they lead. However, the goal of the research, defined as the examination of the views and beliefs present in the minds of managers, and defining the structure and functions of the organisation's capabilities, was certainly achieved.

The author's particular attention was drawn to the aforementioned diametric difference in the language of the description of abilities between those studies presenting a dynamic and non-dynamic portfolio. The nature of these differences suggests that the factor that reduces the dynamics of organisational skills is the cultivation of traditional ideas about the activities of companies. The image of the organisation emerging from studies included in the group of non-dynamic portfolios is a static, hierarchical structure that strictly assigns tasks to competent and dedicated employees, and an environment consisting of customers who need to be attached to each other and competitors with whom it is necessary to fight. This observation highlights the importance of managerial education, and of a place in its structure of content devoted to resource-based views of the companies, the process approach, the network paradigm, and the contemporary theory of innovation, emphasising the role of open innovation. The ability to describe the functioning of an organisation in newer language can allow managers to see opportunities to make organisational processes more dynamic and innovative and which fully utilise the resources of the environment.

References

1. Alves, A., Barbieux, D., Reichert, F., Tello-Gamarra, J., Zawislak, P. (2017). Innovation and Dynamic Capabilities of The Firm: Defining an Assessment Model. *Revista de Administração de Empresas Vol. 57, No. 3*, pp. 232-244, doi: 10.1590/s0034-759020170304.
2. Andrews, K.R. (1971). *The Concept of Corporate Strategy*. Homewood, IL: Dow-Jones Irwin.
3. Ansoff, H.I. (1965). *Corporate Strategy: An Analytical Approach to Business Policy for Growth and Expansion*. New York: McGraw-Hill.
4. Eisenhardt, K.M., Furr, N.R., Bingham, C.B. (2010). Microfoundations of Performance: Balancing Efficiency and Flexibility in Dynamic Environments. *Organization Science, November-December, Vol. 21, No. 6*, pp. 1263-1273.
5. Eisenhardt, K.M., Martin, J.A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal Vol. 21, Iss. 10-11*, pp. 1105-1121, doi: 10.1002/1097-0266(200010/11).
6. Grant, D., Oswick, C. (1996). Introduction: Getting the Measure of Metaphors. In: D. Grant, C. Oswick (Eds.), *Metaphor and Organizations*. London: Sage Publications.
7. Kuuluvainen, A. (2012). How to concretize dynamic capabilities? Theory and examples. *Journal of Strategy and Management, Vol. 5, No. 4*, pp. 381-392, doi: 10.1108/17554251211276353.
8. Miles, R.E., Snow, C.C., Meyer, A.D., Coleman, H.J. (1978). Organizational Strategy, Structure, and Process. *The Academy of Management Review, Vol. 3, No. 3*, pp. 546-562.
9. Mintzberg, H., Ahlstrand, B., Lampel, J. (1998). *Strategy Safari: A Guided Tour through the Wilds of Strategic Management*. Upper Saddle River: FT Prentice Hall.
10. Mintzberg, H., Waters, J.A. (1985). Of Strategies, deliberate and emergent. *Strategic Management Journal, Vol. 6, No. 3*, pp. 257-272.
11. Peteraf, M.A., Tsoukas, H. (2017). Rethinking Dynamic Capabilities. In: J. Sandberg, L. Rouleau, A. Langley, H. Tsoukas (Eds.), *Skillful Performance. Enacting Capabilities, Knowledge, Competence, and Expertise in Organizations* (pp. 160-183). Oxford: Oxford University Press.
12. Petts, N. (1997). Building growth on core competencies—A practical approach. *Long Range Planning, Vol. 30, Iss. 4*, pp. 551-61.
13. Prahalad, C.K., Hamel, G. (1990) The Core Competence of the Corporation. *Harvard Business Review, May-June*, pp. 79-91.
14. Richardson, G.B. (1972). Organization of Industry. *Economic Journal, Vol. 82, No. 327*, pp. 883-896.

15. Tallott, M., Hilliard, R. (16-18.06.2014). *The Learning Organization as a Path to Developing Dynamic Capabilities in a Small Entrepreneurial Firm*. Paper presented at DRUID Society Conference, Copenhagen.
16. Teece, D.J. (2012). Dynamic Capabilities: Routines versus Entrepreneurial Action. *Journal of Management Studies*, Vol. 49, No. 8, pp. 1395-1401, doi: 10.1111/j.1467-6486.2012.01080.x.
17. Teece, D.J. (2014). The Foundations of Enterprise Performance: Dynamic and Ordinary Capabilities in an (Economic) Theory of Firms. *Academy of Management Perspectives*, Vol. 28, No. 4, pp. 328-352.
18. Teece, D.J., Al-Aali, A. (2011). Knowledge Assets, Capabilities, and the Theory of the Firm In: M. Easterby-Smith, M.A. Lyles (Eds.), *Handbook of Organizational Learning and Knowledge Management* (pp. 505-534). Chichester: Wiley.
19. Teece, D.J., Pisano, G. (1994). The Dynamic Capabilities of Firms: an Introduction. *Industrial and Corporate Change*, Vol. 3, No. 3, pp. 537-556.
20. Teece, D.J., Pisano, G., Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, Vol. 18, No. 7, pp. 509-533.

THE ROLE OF SOCIAL INNOVATION IN THE DEVELOPMENT OF THE ENERGY SECTOR

Elżbieta PAWŁOWSKA

Silesian University of Technology, Faculty of Organization and Management; Institute of Management;
elzbieta.pawlowska@polsl.pl, ORCID: 0000-0001-6863-5430

Purpose: The aim of this article is to identify initiatives related to social innovation in the area of energy. The rationale for undertaking research on this topic stemmed from the scarcity of scientific studies on social innovation in the energy sector.

Design/methodology/approach: The research used qualitative research methods to verify information from various sources. For this purpose, a case study method was used, which is particularly important when researching complex phenomena.

Findings: The results indicate that social innovations fit into the broadly understood concept of sustainable development, stimulating initiatives in the area of renewable energy sources, as well as contributing to energy savings, increased use of renewable energy systems, and improving the quality of life of residents.

Originality/value: The issue addressed in this paper concerns social innovations related to the energy sector, which play an increasingly important role in the context of energy savings and increased use of renewable energy systems (RES). Social innovations are derived from the quality of social dialogue of public, non-profit or private organizations contributing to the solution of social problems. Social innovation plays an important role in many areas including energy, especially in supporting a low-carbon society.

Keywords: social innovation, renewable energy sources (RES), energy sector.

Category of the paper: A literature review.

1. Introduction

Currently, resource consumption exceeds the capacity of the environment and climate change poses a threat to current and future generations. This situation requires innovative solutions to transform the consumer society towards sustainability (Mikkonen et al., 2020). An important role in this area is played by innovation, which is the ability and interest of society, entrepreneurs and scientists, to conduct research and search for solutions to improve efficiency, improve technology or create new products. As a result, these activities are supposed to improve the competitiveness of enterprises, which may influence the economic development of regions

or even countries. Innovations are used in every field of the economy. Their search and application is, on the one hand, very risky and unpredictable, but on the other hand, they are also an opportunity for development (Kędzierska-Szczepaniak et al., 2016).

Innovation is usually associated with technical solutions, however, for some time now, the importance of social innovation has begun to be recognized. They play a key role in those sectors where the existing models of innovation fail, are outdated or do not allow for proper use of opportunities arising in the environment (Mulgan et al., 2007). These sectors include environmental protection (Maruyama et al., 2007). Indeed, social innovation in this area can offer tools to support the transformation of existing social structures towards low-carbon societies (Eichler, Schwarz, 2019; Jaeger-Erben et al., 2015).

One of the EU's priorities is to recognize and strengthen the central role of citizens and consumers in the energy transition, to support consumer choices that reduce climate impacts, and to reap additional social benefits that improve their quality of life (European Commission, 2018). Social innovation can therefore play an important role in the energy field, as it is easily diffused at the individual and societal level, while promoting sustainable behavior or lifestyle change.

In recent decades, the energy sector has been under great pressure of transformation. Some of the major trends affecting the energy field over the past years include (Ministry of Climate and Environment, 2027):

- Pressure to reduce greenhouse gas emissions and move away from coal-based generation technologies.
- Growing public environmental awareness.
- Development of renewable energy generation technologies.
- Continuous improvement in energy storage technologies.
- Growing potential of the digital economy and the field of information and communication technology (ICT) applications.
- Breakthrough in hydrocarbon exploration and production technologies.
- The emergence of a global LNG trading infrastructure and market.
- Growing popularity and cost-effectiveness of alternative fuels.
- Role of energy in international relations and geopolitics.
- Pressure to reduce the environmental impact of the energy sector.

These changes have greatly contributed to the emergence of many innovations that enable transformation. Liberalization of the energy market, various regulatory changes and technological advances, and mass production of renewable energy technologies have influenced the emergence of new players in the energy sector. The development of RES technologies and battery solutions has created a group of prosumers - consumers who generate energy themselves. These changes have also brought about management innovations in the energy sector, as a new context for social innovation has emerged. Nowadays, social innovations are not only gaining popularity, but also contribute to building local energy security, as well as being part of environmental and climate protection efforts.

The paper formulates research questions and research hypotheses, which were verified within the framework of the conducted research. The main research problem is focused on seeking answers to the question: what key social innovations are implemented in the field of energy in Poland? As part of the research undertaken, an analysis of the problem was made and its specificity was presented. The results of the research confirmed that social innovations related to the energy sector contribute to energy savings, stimulate initiatives in the use of renewable energy, as well as contribute to a better quality of life of society.

2. Literature review of social innovations and discussion

In the literature to date, no single unambiguous definition of social innovations concept has been developed, there are various approaches to it proposed, which are often not consistent with each other (Phills et al., 2008; Caulier-Grice et al., 2012; Moulaert et al., 2017; Avelino et al., 2019). Table 1 summarizes some illustrative selected definitions of social innovation.

Table 1.
Choosing definitions of innovation

Source	Definitions
Alvord et al. (2004)	„Social innovations provide sustainable solutions to social problems by mobilising scarce resources”.
Phills et al. (2008)	„Any novel and useful solution to a social need or problem, that is better than existing approaches (that is, more effective, efficient, sustainable, or just) and for which the value created (benefits) accrues primarily to society as a whole rather than private individuals”.
European Commission (2011)	"Social innovations are those that respond to social needs that are not traditionally met by the market or existing institutions and that target vulnerable groups in society."
Mulgan (2012)	„Social innovations are innovations that are social both in their ends and in their means”.
Olejniczuk-Merta (2013)	„Social innovation can be defined as new social actions aimed at improving the quality of life for individuals, nations, and entire communities."
Bureau of European Policy Advisers (BEPA) (2013)	„Social innovation can be defined as the development and implementation of new ideas (products, services and models) to meet social needs and create new social relationships or collaborations. It represents new responses to pressing social demands, which affect the process of social interactions.”
Niekerk, L. et al. (2021)	„One key aspect of social innovation is grounded on the role of citizens and their participatoryrole, as they are the ones in the position to evolve “initiatives from a localised level to amacro-level.”
Centre for Social Innovation (2022)	„ Social innovation is a process that supports social progress by developing and implementing effective solutions to challenge social and environmental issues”
Dantas et al. (2022)	„The concept of social innovation is drawn on multiple layers and encompasses multipleelements, such as the transformation of governance arrangements, tools, and participationforms; new relationships within society and its different actors; systemic adaptation at the social level”.

Source: own study based on literature.

The term social innovation has no single definition to fully understand its essence. Social innovations are new ideas that meet social needs in a more effective way (Jędrych, 2013). They consist in solving social problems thanks to entrepreneurial initiatives that are oriented towards individual responsibility and limited role of the state. They rely on the ingenuity of citizens, NGOs, local communities, businesses or public entities. Based on a survey of the European Commission, there are three types of social innovation according to its purpose: Any kind of innovative solution, which aims at improving social and communal relationships, and the effectiveness of various communal groups and organizations can be considered social innovation.; Social innovations should concentrate on meeting societal needs and finding answers and solutions to the given societal challenges; We may think of social innovation as a process, which aims at changing the structure and operation of a certain community through the employment of new ideas and theories, thus offering a solution to the potential social problems (Oslo Manual, Guidelines for Collecting, Reporting and Using Data on Innovation, 2013). Innovation always indicates a response to some kind of problem, so it is true, that „there is no social innovation without a problem, to which it serves as an answer” Forray, Kozma, 2020). It can be concluded that social innovations tend to mitigate economic and social inequalities. Figure 1 shows the key elements and main features of social innovation.

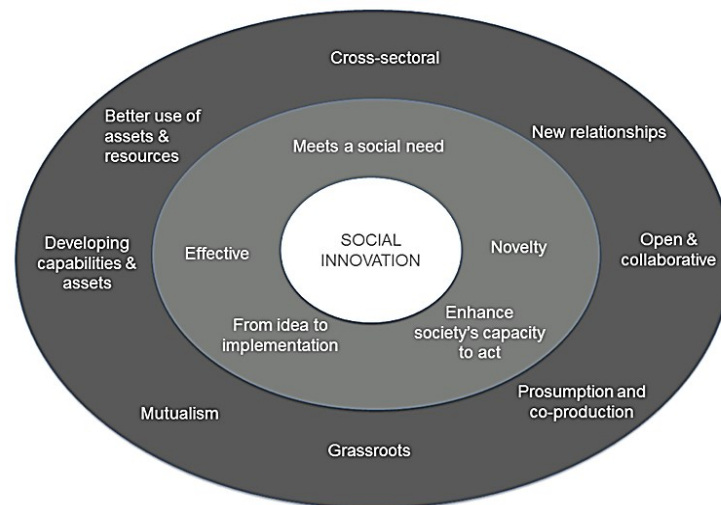


Figure 1. Core elements and common features of social innovations.

Source: Defining Social Innovation. Part 1, Tepsie Project, 2012, p. 18.

Among the main characteristics of social innovations we can point out that they are: effective, innovative, lead from idea to its implementation, increase social capacity to act and above all respond to social needs. In turn, the key elements of social innovation include: they create new relations, are open to cooperation, assume presumption and co-production, grassroots, interdependent, creating new opportunities, making better use of assets and resources, intersectoral. M. Daszkiewicz emphasizes that the main principle distinguishing this type of innovation is that in their case social welfare is a goal, not just a consequence (Daszkiewicz, 2015).

Social innovations consist of such elements as society, social well-being, culture and market, civil society, community development, social needs, social expectations, improvement of quality of life, new forms of organization, collective learning sustainable development, new rules, procedures, models (Wyrwa, 2015). Analyzing the above components, it can be pointed out that most of them emphasize two important characteristics, i.e. development and society. These two components are the foundation of social innovation.

Three main dimensions of social innovation are analyzed in the literature. The first of them concerns the satisfaction of human needs. The second - exposes processes and changes in social relations, while the third - shows the benefits of social innovations, such as, among others, greater access to resources of specific social groups or increasing their socio-political capabilities (Moulaert et al., 2005).

Social innovation occurs at the intersection of three interwoven dimensions: public, private, and nonprofit. This is illustrated in the figure 2.

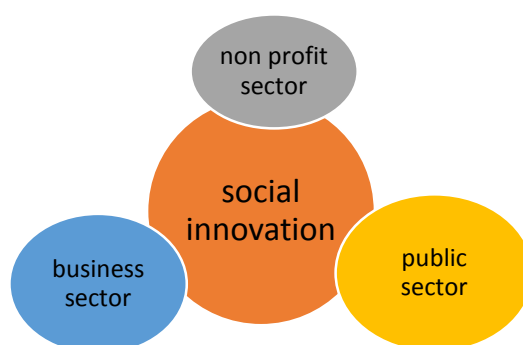


Figure 2. Social innovation.

Source: Own study.

Some researchers believe that social innovations are created between four sectors: public, non-profit, informal and private - in a quadruple helix model (Wiktorska-Święcicka et al., 2015). Nevertheless, the most important element of their emergence is the cooperation between NGOs, businesses, science or administration. At the interface of different sectors, solutions can be developed that will contribute to solving social problems.

Implementation of social innovations is important from both the economic and social point of view. For companies, they provide an opportunity to reduce costs or maintain a strong position in the market, while from the perspective of society, they contribute to the efficient functioning of those areas that are often neglected by state authorities.

3. Methodology

The research process consisted of the following stages: theoretical-cognitive research, cognitive gap identification, qualitative research formulation of research hypotheses and their verification.

As part of the theoretical-cognitive research, the methodology of literature review was used which formed the basis for the proper formulation of research questions and hypotheses, as well as the interpretation of the obtained results of empirical research (Czakoń, 2016). Based on the theoretical-cognitive research, an extrinsic gap was identified reflecting the paucity of scientific research on social innovation particularly in the energy sector.

One of the qualitative scientific research methods, the case study, was chosen for the study. A case study is an empirical inference that deals with a phenomenon in its natural context, especially when the boundary between a case and its context cannot be clearly defined (Yin, 2013). This method analyzes and evaluates phenomena occurring in reality. On the basis of the collected information, the case study method makes it possible to make an in-depth analysis of the studied problem, to present its specifics, its interaction with other elements of the organization or its environment (Kostera, 2011).

In the literature, the case study is seen as an attractive method for solving problems in institutional economics, company theory, strategy, strategic management, organizational culture, decision-making, network relationships, strategic marketing and international management (Wójcik, 2013). In this case, qualitative research provides empirical, in-depth insights into social innovation initiatives in the energy field. R. Yin recommends using the case study method in situations where there is a need to find answers to questions that are exploratory in nature, that is, about "how" and "why" a phenomenon occurs (Wójcik, 2013; Czakoń, 2016). The qualitative research focused on the main research problem formulated in the form of the following question: what key social innovations are implemented in the energy area in Poland?

As part of the qualitative research, data were collected and analyzed, using press and online sources for this purpose. Based on the collected information, an in-depth analysis of the studied problem was made and its specificity was presented. The research was also used to formulate research hypotheses.

In relation to the research problem defined on the basis of the literature analysis and the conclusions resulting from the qualitative research, the following specific research questions were formulated:

- what are the key features and elements of social innovation in Poland?
- what factors/trends influence the development of the energy sector?
- What are the opportunities and barriers to the development of social innovation in the energy area?

Seeking answers to the research questions, the following research hypotheses were formulated:

H1: the use of social innovation in the energy field contributes to the reduction of energy consumption in everyday life.

H2: social innovation in the energy area stimulates initiatives in the use of renewable energy.

H3: the use of social innovation in energy contributes to a better quality of life for citizens.

The formulated research questions and hypotheses resulted from the conducted theoretical and qualitative research. The research shows that energy-related social innovations contribute to energy savings and increased use of renewable energy systems, as well as increase and improve people's quality of life.

4. Social innovation in the energy sector

Preliminary studies worldwide on social innovation in energy include renewable energy production and energy collectives (e.g., shared purchasing, co-housing), local energy production, local and neighborhood energy systems, working with smart meters, general energy services, and energy-efficient mobility (Ooms et al., 2017).

In Poland, environmental awareness and related social innovation in the field of energy and is an area that is still evolving. Some interesting social innovation initiatives in the field of energy, which are often part of larger European projects, are presented below. The SONNET project (Social Innovation in Energy Transitions, European Union's, 2020) aims to co-create a rich understanding of the diversity, processes, contributions, successes and future potentials of social innovation in the energy sector (SIE). As part of the project, an urban experiment City Lab was conducted in Warsaw, aimed at finding ways to reduce energy consumption in everyday life. A dozen or so Warsaw households took part in the experiment, in which current energy consumption and factors affecting the indoor climate - carbon dioxide concentration, humidity and temperature - were measured. In the next stage, the participants were given recommendations on how to reduce energy consumption, and in the final stage, the scientific team processed the collected data, presented conclusions and solutions. The whole experiment allowed to gain knowledge on how to consume less energy in homes by eliminating energy inefficient behaviours. The solutions developed during the citylab can be used by other housing communities or housing cooperatives, as well as by tenants of city-owned buildings (City Council of Warsaw, 2022).

Another interesting idea, also funded by the European Union, is the Future Internet Public Private Partnership initiative, in which leading energy and ICT companies, research institutes and universities have formed an international consortium FINSENY (Future INternet for Smart ENERGY - Future Internet Public-Private Partnership). Part of this initiative is the Orange OZE (Renewable Energy Sources) energy saving project. This project consisted in installation of micro-installation based on photovoltaic panels on the roof of Orange Labs in Warsaw. The aim of this project is to check whether the renewable energy sources installations will be successful in powering telecommunication infrastructure devices in Polish climatic conditions. The project included construction of four different micro-installations consisting of photovoltaic panels and a wind turbine. Each of these installations was characterized by similar power but different technology of panels and inverters. Thanks to using several RES installations in one place, it was possible to conduct power supply tests for telecommunication devices. The RES installation allowed to estimate the savings generated by the production of own "green energy". The installed installations will power network devices tested in Orange Labs, and the knowledge developed will help to apply RES on a wider scale in the future (Kulik, Innovation in Orange Polska, Vision 2050). It is worth mentioning that Orange Labs closely cooperates with many universities and scientific units in the country and abroad, involving the local community including students in the creation of innovations.

Another example of innovation is a mobile social application, which was also developed at Orange Labs. It uses smartphones, location and Augmented Reality technology to promote ecology and development of the country in harmony with nature - eco. The Polish application provides the latest news and information on events, as well as presents the most interesting eco places. The product complements the functions of the vortal www.eco-Polska.pl, which is a place to meet and discuss eco-friendly activities (Kulik, Innovation in Orange Polska, Vision 2050).

Thanks to new technologies and greater awareness of individuals, energy production can now be done by anyone, by installing solar panels or micro-grids (Okraszewska, 2016). Any individual, society or local business can be both a producer and a consumer, i.e. they have the opportunity to sell or buy electricity and at the same time be connected to other users by a smart grid (Szwed, Maciejewska, 2014). In Poland, according to the Energy Development Agency, at the end of March 2021, the installed capacity of RES reached 13,068.8 MW and represents more than 25.15% of the power installed in the National Electricity System (Mikołajuk et al., 2021). Table 2 presents the amount of electricity generated from RES in 2018-2020.

Table 2.

The amount of electricity generated from RES in 2018- 2020, confirmed by certificates of origin, issued until 31.12.2020

Type of RES installation	Amount [MWh]		
	Electricity generation period		
	2018	2019	2020
Biogas plants	1 010 937,483	932 637,188	635 537,773
Biomass installations	4 084 445,101	4 942 446,242	2 295 923,186
Solar energy installations	95 803,210	93 661,383	66 621,733
Wind energy installations	12 793 466,739	14 990 716,052	11 412 176,088
Hydropower installations	575 731,628	466 697,556	345 403,795
Installations co-firing biomass, bioliquids, biogas or agricultural biogas with other fuels	841 994,111	1 012 975,256	702 303,064
total	19 402 378,272	22 439 133,677	15 457 965,639

Source: own study based on: <https://www.ure.gov.pl/pl/oze/potencjal-krajowy-oze/5755,Ilosc-energii-elektrycznej-wytworzonej-z-OZE-w-latach-2005-2020-potwierdzonej-wy.html>, 6.05.2022.

Based on the above table, it can be concluded that the tendency of utilization of renewable energy sources by the society is increasing, despite the fact that in 2020 the value has significantly decreased compared to previous years. Such a situation could be related to the pandemic situation, infrastructural limitations, high investment expenses or legal regulations of support.

Changing the model of energy generation from centralized to distributed with the use of renewable energy sources allows the use of local energy potential and resources and activation of local communities. Public participation has a great influence on the realization of goals set by the European Union related to the increase of RES share in electricity generation. It can be said that society expresses greater acceptance for renewable energy infrastructure and also gets involved in the process of energy production from renewable sources. Thus, social innovations understood in this way become a way to improve the quality of life of citizens as a result of their implementation (Mulgan, 2006; Pol, Ville, 2009; Vision 2050 Social Innovation, 2013).

The above presented social innovations are a certain contribution to the development of social innovations in the field of energy. It can be noted that social innovations are not necessarily bottom-up initiatives implemented by the society. Unfortunately, the creation of new ideas and breakthrough solutions is associated with high costs, high risk and therefore the support of other entities is necessary.

However, it is safe to say that social innovations bring many benefits to society. Among them we can point out, among others:

- They contribute to the democratization of society, which means the participation of the whole society in the creation of innovations (so-called cosolving), by means of idea banks, hackathons, incubators or web portals dedicated to the creation of new solutions (Kulik, Innovation in Orange Polska, Vision 2050).
- Increase the capacity of society to act.
- Contribute to better communication and cooperation between actors (companies, NGOs, public institutions).

- Provide access to innovative solutions.
- Create new jobs.
- Reduce poverty and citizens' awareness.
- Raise and improve people's quality of life.

The biggest barriers to the development of innovation include:

- Lack of cooperation, communication and culture of innovation.
- Low involvement and support of public, private and non-profit sector activities.
- Orientation mainly on technological innovations.
- Low financial support related to the risk incurred.

In order to increase the level of development of social innovations and their dissemination, it is necessary to have active cooperation of entities from the public, private and non-profit sector, as well as their support not only financial, but also infrastructural (technology parks, business incubators, clusters), and above all education of the society promoting sustainable behavior and change of lifestyle.

5. Conclusion

Energy security is a strategic issue, and the generation and transmission of electricity determines the smooth functioning of the economy. The rapid development of technology, the liberalization of the energy market and related regulatory changes, and the production of renewable energy have all contributed to attention to the potential for social innovation in the energy sector. Social innovation can support the transformation of existing social structures toward low-carbon societies.

Despite the great interest in the topic of social innovation, there is no single, universally accepted definition of the term. Many authors dealing with this issue, also do not agree on the components of social innovation. The main feature of this type of innovation is that, in their case, social welfare is a goal, not just a consequence. Social innovations in the energy field can be understood as new solutions that meet social needs and raise public awareness of the development of a low-carbon society. Most energy-related social innovations are technological innovations and are global in nature, while energy-related social innovations tend to be local and have a limited focus on scaling.

The article assumes that the use of social innovations in the field of energy contributes to reducing energy consumption in everyday life. Based on the analysis presented, it can be concluded that through the use of innovative technologies and greater awareness of individuals to eliminate energy inefficient behavior, energy consumption can be reduced.

It is also assumed that social innovation in the energy field stimulates initiatives in the use of renewable energy. This is evidenced by the increasing number of implemented projects aimed at saving energy through self-generation, as well as the use of new energy solutions through households or other entities.

The article also states that the use of social innovation in the energy industry contributes to improving the quality of life of citizens. The use of social innovation brings many benefits not only to the local community, but also nationwide. These benefits manifest themselves in the form of savings leading to a reduction in poverty, but also increased awareness of citizens or building a community focused on the process of renewable energy production.

To sum up, social innovation largely stimulates renewable energy initiatives, and contributes to energy savings, increased use of renewable energy systems and improved quality of life for residents.

In order to spread social innovation on a wider scale, it is important to undertake educational and informational activities for residents that contribute to changing their behavior and habits and promote environmentally friendly attitudes. A key aspect related to the emergence of social innovations is cooperation and partnership, which are key elements that determine their development.

The analysis presented in the article is a prelude to further extended research on the concept of innovation in the energy field.

References

1. (PDF) SHAFE *Mapping on Social Innovation Ecosystems*. Available from: https://www.researchgate.net/publication/366535866_SHAFE_Mapping_on_Social_Innovation_Ecosystems, Jan 17, 2023.
2. Alvord, S.H., Brown, L.D., Letts, C.W. (2004). Social entrepreneurship and societal transformation: an exploratory study. *The Journal of Applied Behavioral Science*, Vol. 40, No. 3, pp. 260-282.
3. Avelino, F., Wittmayer, J.M., Pel, B., Weaver, P., Dumitru, A., Haxeltine, A., O’Riordan, T. (2019). Transformative social innovation and (dis)empowerment. *Technological Forecasting and Social Change*, 145, 195-206. Available: <https://doi.org/10.1016/j.techfore.2017.05.002>.
4. Bureau of European Policy Advisers (BEPA) (2013). *Empowering people, driving change. Social Innovation in The European Union*. Available: via http://ec.europa.eu/bepa/pdf/publications_pdf/social_innovation.pdf.
5. Caulier-Grice, J., Davies, A., Patrick, R., Norman, W. (2012). *Defining Social Innovation. Part 1*. Tepsie Project.

6. Centre for social innovation (2022). *Defining social innovation Stanford Graduate School of Business*. Stanford. <https://www.gsb.stanford.edu/faculty-research/centers-initiatives/csi/defining-social-innovation>.
7. City Council of Warsaw (2022). *Let's talk about social innovation in the energy sector*. Available: <https://um.warszawa.pl/-/porozmawiajmy-o-spoecznych-innowacjach-w-sektorze-energii>.
8. City Council of Warsaw (2022). *Sonnet social innovation in transformation*. Available: <https://um.warszawa.pl/waw/europa/-/sonnet-innowacja-spoeczna-w-transformacji-energetycznej>.
9. Czakon, W. (2006). Swan Popper-case studies in management science research. *Organization Review*, No. 9, pp. 9-13.
10. Czakon, W. (2016). *Fundamentals of research methodology in management sciences*. Warszawa: Nieoczywiste, p. 120.
11. Dantas, C., Louceiro, J., Vieira, J. et al. (2022). SHAFE Mapping on Social Innovation Ecosystems. *International Journal of Environmental Research and Public Health*, 20(1), p. 118.
12. Daszkiewicz, M. (2015). *Social innovations in creating attractiveness of cities*. Logistics.
13. Eichler, G., Schwarz, J. (2019). What Sustainable Development Goals Do Social Innovations Address? A Systematic Review and Content Analysis of Social Innovation Literature. *Sustainability*, 11(2). Available: DOI: 10.3390/su11020522.
14. European Commission (2011). *Empowering People, Driving Change. Social Innovation in the European Union, BEPA*. Luxembourg: Publications Office of the European Union.
15. European Commission (2018). *A clean planet for all, a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*. Com(2018) 773 final, Brussels.
16. European Union's (2020). *Sonnet – social innovation in energy transitions*. Horizon 2020 research and innovation programme under grant agreement, no. 837498.
17. Forray, R.K., Kozma, T. (2020). *Város és egyetem találkozása. Esettanulmány egy társadalmi innovációról*. The Locals and Their New University. A Hungarian Case of social learning and innovation, https://www.researchgate.net/publication/339363985_Varos_es_egyetem_Esettanulmany_egy_tarsadalmi_innovaciorol_The_Locals_and_Their_New_University_A_Hungarian_Case_of_social_learning_and_innovation. DOI: 10.13140/RG.2.2.24830.33607.
18. *Future Internet Public-Private Partnership, Led by industry, driven by users Addressing the challenge of Internet development in Europe*. Available: <https://www.fi-ppp.eu/>.
19. Jaeger-Erben, M., Rückert-John, J., Schäfer, M. (2015). Consumption through social innovation: A typology of innovations for sustainable consumption practices. *Journal of Cleaner Production*, DOI: 10.1016/j.jclepro.2015.07.042.

20. Jędrych, E. (2013). *Investing in social innovation in business organizations*. Warsaw: PWN, pp. 85-86.
21. Kędzierska-Szczepaniak, A., Szopik-Depczyńska, K., Łazorko, K. (2016). *Innovation in organizations*. Publishing House Texter, p. 7.
22. Kostera, M. (2011). *Organizations in Practice. Case studies for management students*. Warszawa: Poltext.
23. Kulik, M. *Innovation in Orange Polska, Vision 2050: Social Innovation*. Available: https://www.pwc.pl/pl/doradztwo-csr/wizja-2050/assets/broszura_wizja_2050_pl_innowacje_spoleczne_podsumowanie.pdf.
24. Maruyama, Y., Nishikido, M., Iida, T. (2007). The rise of community wind power in Japan: Enhanced acceptance through social innovation. *Energy Policy, Vol. 35*, pp. 2761-2769.
25. Mikkonen, I., Gynther, L., Matschoss, K., Koukoufikis, G., Murauskaite-Bull, I., Uihlein, A. (2020). *Social innovations for the energy transition*. EUR 30446 EN. Luxembourg: Publications Office of the European Union, ISBN 978-92-76-25283-2 (online), doi:10.2760/555111 (online), JRC122289.
26. Mikołajuk, H., Zatorska, M., Stępiak, E., Wrońska, I. (2021). Statistical information on electricity. *Energy Market Agency Monthly Bulletin, 3(327)*, 14. Available: <https://www.ame.waw.pl/wy-dawnictwa#informacja-statystyczna-o-energii-elektrycznej>.
27. Ministry of Climate and Environment, *Directions of development of energy innovations*. Available: <https://www.gov.pl/web/klimat/kierunki-rozwoju-innowacji-energetycznych>.
28. Moulaert, F., Martinelli, F., Swyngedouw, E., Gonza, S. (2005). Towards alternative model(s) of local innovation. *Urban Studies, Vol. 42, No. 11*, p. 1976.
29. Moulaert, F., Mehmood, A., MacCallum, D., Leubolt, B. (2017). *Social innovation as a trigger for transformations: the role of research*. European Commission, DG for Research and Innovation. doi:10.2777/68949.
30. Mulgan, G. (2006). The process of social innovation, *Innovations: Technology. Governance Globalization, Vol. 1, No. 2*, pp. 145-162.
31. Mulgan, G., Tucker, S., Ali, R., Sanders, B. (2007). *Social innovation: what it is, why it matters, how it can be accelerated*. Available: <http://youngfoundation.org/publications/socialinnovation-what-it-is-why-it-matters-how-it-can-be-accelerated>.
32. Mulgan, G. (2012). The theoretical foundations of social innovation. In: A. Nicholls, A. Murdock (Eds.), *Social Innovation: Blurring Boundaries to Reconfigure Markets* (pp. 33-65).
33. Niekerk, L., Manderson, L., Balabanova, D. (2021). The application of social innovation in healthcare: A scoping review. *Infect. Dis. Poverty, 10*, 26.
34. OECD/Eurostat, *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*. The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg.

35. Okraszewska, E. (2016). Energy democracy - the public as prosumer of electricity. *Economy in Practice and Theory*, t. 45, <http://dx.doi.org/10.18778/1429-3730.43.0>.
36. Olejniczuk-Merta, A. (2013). *Social Innovation in: Consumption and Development*, nr 1, p. 28.
37. Ooms, M., Huygen, A., Rhomberg, W. (2017). Social innovation in energy supply: summary report. *Deliverable*, 7, p. 4.
38. Phills, J.A., Deiglmeier, K., Miller, D.T. (2008). Rediscovering social innovation. *Stanford Social Innovation Review*, Vol. 6, No. 4, pp. 34-43.
39. Pol, E., Ville, S. (2009). Social innovation: buzz word or enduring term? *The Journal of Socio-Economics*, Vol. 38, No. 6, pp. 878-885.
40. Szwed, D., Maciejewska, B. (2014). *Energy Democracy*. Warszawa: Green Institute, p. 4.
41. Vision 2050 Social Innovation. A summary of the working group's work in 2013 (2013). Available: https://www.pwc.pl/pl/doradztwo-csr/wizja-2050/assets/broszura_wizja_2050_pl_innowacje_spoleczne_podsumowanie.pdf.
42. Wiktorska-Święcicka, A., Moroń, D., Klimowicz, M. (2015). *Social innovation management, trends, perspectives, challenges*. Warszawa: Difin, p. 65.
43. Wójcik, P. (2013). The importance of the case study as a research method in management science. *E-mentor*, nr 1(48).
44. Wyrwa, J. (2015). *Social innovation in theory and practice*. Warsaw: PWE, pp. 53-54.
45. Yin, R.K. (2013). *Case study research: Design and methods*. Sage publications, p. 10.

SELECTED ASPECTS OF THE STATE HEALTH POLICY DURING THE FIRST WAVE OF THE SARS-COV-2 PANDEMIC

Bożena PŁONKA-SYROKA¹, Marek STYCH^{2*}, Małgorzata KMAK³, Beata PAWLICA⁴

¹ Wrocław Medical University; bozena@plonka-syroka.pl, ORCID: 0000-0001-8743-4634

² Pedagogical University of Cracow; marek.stych@up.krakow.pl, ORCID: 0000-0003-4359-1085

³ University of Silesia in Katowice; malgorzata.kmak@us.edu.pl, ORCID: 0000-0002-2285-5793

⁴ Pedagogical University of Cracow; beata.pawlica@up.krakow.pl, ORCID: 0000-0002-2941-7470

*Corresponding author

Purpose: The authors analyze the decisions made from March to September 2020 which affected the functioning of Polish health care facilities. According to the authors, that period determined and significantly influenced the decisions taken by state authorities during the subsequent waves of the SARS-CoV-2 pandemic.

Design/methodology/approach: The analysis of the issue presented in the paper will be a descriptive one. The research exploration will be carried out using the desk research method.

Findings: Analyses of secondary and compilation documents showed that the authorities of the Republic of Poland were not prepared to manage the state in unprecedented conditions caused by the first wave of the pandemic, and the decisions taken at that time by public administration bodies were chaotic, not always well thought out and often influenced by public opinion.

Originality/value (mandatory) The article can be considered original due to the fact that it combines an analysis of Polish legal acts issued during the first wave of the COVID-19 epidemic with, above all, an analysis of their social effects. The analyses showed that Polish authorities were not prepared for the pandemic crisis. The article is addressed to state administration employees as well as employees and students of universities with majors in national defense, public safety, medicine, medical rescue and public health. It may become a basis for developing legal acts of a preventive nature, which can be immediately applied in the event of another epidemic.

Keywords: SARS-CoV-2 coronavirus, health policy, health protection.

Introduction

Nowadays, health is not understood only as "no diseases" (Domaradzki, 2013, p. 6). According to the definition provided by the World Health Organization (WHO), it is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". This definition emphasizes the importance of sustainable development, an integral

part of which is man. An analysis of the definition leads one to a conclusion that sustainable development is conducive to health. In this kind of development health is a value at the local community level. At the same time, the health of an individual is a public good protected by the principles of solidarity and co-responsibility (Domaradzki, 2013, p. 6). At the regional level, health protection involves a significant number of organizations and institutions performing health-related activities and human resources, i.e. health professionals. The comprehensive structure of the health protection system is perceived as a special social good. This means that health protection is one of the modern state's basic obligations (Romaniuk, Brukało, 2015, pp. 101-124). Health as a public good is provided for in Article 68 of the Constitution of the Republic of Poland (Journal of Laws of 1997, no. 78, item 483, of 2001, no. 28, item 319, of 2006, no. 200, item 1471, of 2009, no. 114, item 946), pursuant to which "everyone has the right to health protection". The aforementioned constitutional standard obliges public authorities to protect health in two dimensions: individual and social. Similarly, Article 9 and 168 of the Treaty on the Functioning of the European Union seem to impose an obligation on individual Member States and the European Union itself to guarantee a high level of public health protection, inter alia, in order to combat infections and infectious diseases, including during activities related to the management of COVID-19 risk. The authors point out that it is necessary to respect the principle of proportionality in limiting the rights or freedoms of individuals when combating epidemic diseases. The analysis of the available documents and information allows them to conclude that the language used in the sphere of public health protection does not conduce to the compliance with the above principle. The widespread use of the phrase "combating SARS-CoV-2 infections" – according to the authors – suggests undertaking a wide range of activities that are necessary to overcome the epidemic. These activities do not come down only to providing health services, which may suggest the existence of an extraordinary threat that has to be combated like armed aggression against the state. This may be interpreted as a certain consent to broad or severe restrictions of the freedoms and rights of individuals for the purpose of achieving the above goal. The SARS-CoV-2 epidemic is treated as a "war with an invisible enemy" and health care workers as the ones performing professional activities on the "front line". This form of communication was reinforced by the statements of populist politicians.

The direction of Polish national health policy is determined by the Minister of Health, and it is implemented by entities such as the National Health Fund, Voivodes (regional representatives of the government), units of local self-government and health care entities of varied legal status.

The state health policy (Ministry of Health, *Health Policy Programs*, 09.04.2018) should be aimed at making sure that citizens have universal access to preventive health services and health care, and that the quality of health care services be improved, while remaining compliant with the constitutional principle of "equal access to health services". Therefore, it is possible to increase health security and improve the living conditions of the people. Regardless of the

model functioning in a given country, the WHO emphasizes that national equality in health and financing of health protection under allocation mechanisms based on the principles of equal access to health services is a universal goal of each health system (WHO, *Health 21: The Health for All Policy Framework for the WHO European Region – 21 Targets for 21st Century*, WHO, Copenhagen, 1998).

Today, the functioning of the healthcare system is influenced mainly by the rapid development of medical technologies and modern diagnostic methods. The outbreak of the COVID-19 pandemic was an unprecedented challenge for the health care sector (MacIntyre, 2020, pp. 1-3). Globally, the end of 2020 showed that combating the spread of the SARS-CoV-2 virus and its aftermath effectively was beyond the capabilities of healthcare structures in many countries of the world (Ruktanonchai, 2020, pp. 1465-1470). The same held for Poland, where combating the epidemic was being organized while the virus was already spreading among the Polish population.

The COVID-19 pandemic caused by the SARS-CoV-2 coronavirus began on 17 November 2019 in central China, in the city of Wuhan (Yi-Fan Lin, 2020, pp. 1-7). The first case of this disease in Poland was recorded on 4 March 2020. A few days later, on 11 March 2020, the WHO recognized COVID-19 as a pandemic (WHO...). The emergence and mass spread of the SARS-CoV-2 coronavirus changed not only the functioning of the healthcare system and the economy, but also redefined the lives of individual people, including their social activity, which had an impact on all aspects of life. It also gave Polish authorities grounds to issue legal acts regulating the organization of the healthcare system's work and introduce social life restrictions.

Research method

The analysis will focus on the decisions of Polish authorities on the functioning of healthcare facilities during the COVID-19 epidemic issued from March to September 2020. This period was critical and defined the direction of the policy pursued by Polish authorities with regard to preventing the epidemic and organizing healthcare. The authors attempt to answer the following question (solve a research problem): How was the state health policy shaped during the first wave of the SARS-CoV-2 pandemic? In order to answer this question, it is necessary to analyze the legal solutions pertaining to health protection adopted during the first wave of the pandemic. The legislative changes introduced at that time seem to have been significant, as they determined the functioning of the entire healthcare system during the pandemic's subsequent waves until April 2022. Without going into details, the authors will focus on the examples of actions taken by the authorities with regard to the functioning of healthcare facilities.

Results

The emergence and mass spread of the SARS-CoV-2 coronavirus in Poland was an unprecedented challenge for the healthcare sector, just like anywhere else in the world. At the regional level, the turning point was the training on the organization of so-called "field reception rooms" (triage tents) at selected hospitals in individual voivodeships, commenced on 3 March 2020 by the Ministry of Health. The purpose of the training was to practically prepare the healthcare structures for the introduction of COVID-19 dedicated hospitals. On 7 March 2020, the Regulation on diseases causing the obligation of hospitalization was issued (Regulation of the Minister of Health of 7 March 2020). Then, on 12 March 2020, the Minister of Health issued the Regulation on the method and procedure for financing healthcare services provided in connection with the prevention of COVID-19 from the state budget (Journal of Laws of 2020, item 422). On 15 March 2020, the National Health Fund issued a recommendation to suspend scheduled health services in healthcare facilities. According to the recommendation, the suspension of scheduled health services should not include the scheduled diagnostics and treatment of cancer. At the same time, when limiting or suspending the provision of services, it was necessary to take into account the patient's treatment plan and the probability of their post-surgery hospitalization in anesthesiology and intensive care departments. The so-called "healthcare freeze" had far-reaching negative consequences for patients with severe and chronic diseases. On 18 March 2020, the Council of Ministers presented an anti-crisis package. Two days later, the state of epidemic was announced in Poland (Regulation of the Minister of Health of 20 March 2020), which made it possible to delegate people to work in combating the epidemic pursuant to Article 47 of the Act on preventing and combating infections and infectious diseases in humans. The employees that could be delegated to such work included employees of medical entities or other persons performing a medical profession. In practice, the decisions of Voivodes in this respect were to a large extent not respected by doctors and nurses (Personel medyczny...).

During the analyzed first wave of the pandemic, various recommendations, decisions or appeals were made:

- National Health Fund's recommendation issued on 21 March regarding the suspension of some scheduled surgical procedures from 30 March 2020 (including endoprosthetics of large joints, large corrective spine surgeries, vascular procedures on the abdominal and thoracic aorta, coronary artery bypass grafting, nephrectomy, hysterectomy);
- Ministry of Health's recommendation to the Agency for Health Technology Assessment and Tariff System to prepare: "Polish diagnostic, therapeutic and organizational recommendations in respect to the people infected with or exposed to SARS-CoV-2 infection" – version 1.0, 25 April 2020 ([https://www.aotm.gov.pl/...](https://www.aotm.gov.pl/));

- establishment of a board for coordinating the COVID-19 laboratory network (Ordinance of the Minister of Health of 3 April 2020);
- Ministry of Health's recommendations of 8 April to all hospitals to assign isolation sites for patients with suspected SARS-CoV-2 infection and to assign wards for hospitalization of patients;
- introduction of the principle "one doctor – one job" (Regulation of the Minister of Health of 28 April 2020), which encountered great resistance from representatives of medical professions;
- Ministry of Health's appeal to the patients to continue treatment discontinued as a result of the "healthcare freeze" (12 May 2020);
- an amendment to the regulation "one doctor – one job" made it possible for managers of medical entities not to allow persons performing medical professions to work in other medical entities (Regulation of the Minister of Health of 20 July 2020) and introduced the so-called "COVID allowances" which compensated for the lost income from those persons second and third jobs;
- adoption of a strategy to combat the coronavirus for the autumn period - a departure from the concept of COVID-19 dedicated hospitals towards the concept of allocating the so-called COVID beds in infectious and general hospitals.

The so-called "healthcare freeze" was of key importance for the health care system at regional level. As mentioned earlier, the healthcare facilities started suspending the provision of the scheduled health services, including surgical procedures. At the same time, primary healthcare as well as outpatient specialist care were provided remotely. Taking into account outdated ICT systems in some healthcare entities, medical advice was in fact given by phone. As part of the reorganization of the system in terms of managing the epidemic situation, the Ministry of Health decided in mid-March to transform 19 facilities (Wprowadzamy stan...) into the so-called COVID-19 dedicated hospitals taking care of only the patients with suspected and confirmed SARS-CoV-2 infection. In the following weeks, the number of such hospitals increased to 21 (List of hospitals...). Managing the transformed facilities centrally was problematic due to a variety of healthcare providers and their varied legal status. It should be emphasized that these were the largest hospitals in individual voivodeships. The lack of a long-term policy for combating the pandemic is evidenced by the fact that the COVID-19 dedicated hospitals, which proved ineffective in combating the pandemic, started to gradually close down on 1 June 2020 (approx. 60% of beds had not been used). This process was a consequence of the delayed decentralization of health care activities, because the number of beds for COVID-19 patients in those hospitals depended, justifiably, on the epidemiological situation in a given region. Therefore, from September 2020, they were also to admit patients other than infected with COVID-19, as well as those in a serious condition or requiring specialist help due to their comorbidities.

The period between March and September 2020 was a time of information chaos. No coherent and clear message about the COVID-19 pandemic could be heard from the state authorities. What is more, there was a lack of legal certainty. The fact that certain areas and activities were regulated by means of secondary regulation should be criticized, as it constituted a gross violation of the constitutional principles regarding the hierarchy of acts of universally applicable law. A considerable amount of that legislation was adopted at an accelerated pace and without proper public consultation. In some cases, the adopted regulations were used to amend provisions not related to pandemic prevention. Considering their purpose and the proportionality of individual restrictions, e.g. the ones pertaining to the freedom of movement or assembly, the way those regulations were adopted raises certain doubts. In addition, chaos was caused due to the fact that the restrictions were announced at press conferences before respective regulations were even published.

In practice, doctors, pharmacists and patients were not able to properly get acquainted with the new regulations. At the same time, health care facilities experienced significant difficulties in fully implementing them. The first as well as the second wave of the pandemic were accompanied by hasty and ill-considered legislation, which testifies to the lack of procedures and preparation on part of public administration bodies in Poland to control the rapid development of a pandemic.

Another negative effect of the actions taken by the decision-makers towards both potential patients and doctors was limiting/depriving the citizens of access to healthcare. The patients were forced to seek medical attention in facilities far away from their place of residence, because nearby hospitals had limited the number of patients admitted. Due to the inability to conduct medical activities not related to the treatment of COVID-19, many doctors resigned from work, which in turn contributed to the increase in staff shortages in hospitals. The lack of patients rendered it impossible for resident doctors to carry out their specialization training. Another negative consequence of the said actions was also the fact that expensive specialized equipment in the COVID-19 dedicated hospitals remained idle (Alert zdrowotny...).

Decentralization of activities related to preventing and combating pandemics should be understood as transferring tasks from national to regional level. Such an approach allows for conducting a regional policy and guarantees each region autonomy of action in accordance with the principle of subsidiarity. Undoubtedly, this is a better solution, as the regional policy and its instruments vary depending on the epidemic risk in a given region. In order to assess such a risk, differentiated epidemiological factors are used.

Discussion – assessment of the functioning of healthcare facilities

The assessment of the functioning of healthcare facilities is not favorable. This is evidenced, among others, by the results of the study "Patient in a pandemic" (Chorzy przewlekle...). The study was carried out by telephone on a representative sample of 1,000 people from 5 to 10 May 2020. As the results show, as many as 71% of the respondents considered the functioning of the healthcare system during the pandemic a threat to the health and life of chronically ill patients. Taking into account the chaos in the functioning of these institutions and "freezing" them due to the pandemic, the authors have to agree with this position. Interestingly, non-public healthcare facilities managed to operate without major obstacles. 69.6% of the respondents considered that the way the health care system was functioning during the pandemic made it difficult for patients to recover from surgery or illness. A relatively low percentage of the respondents (28.2%) considered that patient rights were respected as before the pandemic started, and 27.7 % of them that the healthcare system was well-prepared for functioning in a pandemic situation.

The second important issue raised in the study was the cancellation or suspension of appointments with doctors. Those were most noticeable by the respondents who characterized themselves as:

- patients – 62.7%,
- chronic patients – 43.8%,
- patients in drug programs – 50%,
- guardians of dependent persons (minors and elderly persons) 69.1%.

Conclusions

Summing up the above considerations, a number of conclusions can be drawn. These conclusions refer to actions taken at central and regional level during the subsequent waves of the pandemic. This assessment was possible after analyzing the available materials (legal acts, documents, reports). What deserves to be criticized is:

1. the lack of a real strategy for preventing and combating COVID-19. The period of epidemic calming (in the summer) was not used by the central public administration bodies to prepare a specific policy to counteract the pandemic;

2. taking action based on proposals, recommendations or appeals. The adopted strategic documents did not refer to real operational actions taken to counteract the further development of the epidemic. According to the authors, this was a consequence of the lack (or shortcomings) of procedures or their ad hoc preparation without an analytical approach to the problem (<https://orka.sejm.gov.pl/...>);
3. the institutions and entities involved in combating the epidemic were organizationally and financially ill-prepared, and they lacked human resources (<https://orka.sejm.gov.pl/...>);
4. the scale of the epidemic's development surprised the central authorities and bodies (Ministry of Health, Chief Sanitary Inspectorate).

From a national perspective, the unprecedented coronavirus pandemic revealed the need to transform the way of providing citizens with access to healthcare facilities (Płonka-Syroka, Hudaszek, Kurzyna, 2022). It also revealed the necessity to coordinate public health financing, which is essential to maintain the continuity and proper functioning of health facilities. A wide use of e-health solutions was observed as well, including e-prescriptions, e-appointments, e-referrals and others, which should be praised.

In conclusion, it should be stated that developing a crisis-resistant healthcare system seems to be a priority today if we want to ensure the efficient functioning of the state and the effective protection of the population.

References

1. Domaradzki, J. (2013). O definicjach zdrowia i choroby [On health and disease definitions]. *Folia „Medica Lodziensia”, 40/1.*
2. MacIntyre, C.R. (2020). Global spread of COVID-19 and pandemic potential. *Global Biosecurity, 1(3).*
3. Płonka-Syroka, B., Hudaszek, M., Kurzyna, W. (2022). *Obraz epidemii COVID w polskich tygodnikach opinii, czasopismach lekarskich i świadomości pacjentów. Analiza krytyczno-porównawcza [The perception of the COVID epidemic in Polish opinion weekly magazines, medical journals and awareness of patients. A critical and comparative analysis].* Wrocław: Wydawnictwo Uniwersytetu Medycznego im. Piastów Śląskich we Wrocławiu.
4. Romaniuk, P., Brukało, K. (2015). Ochrona zdrowia jako obowiązek państwa. Ewolucja polskiego ustroju konstytucyjnego w aspekcie przepisów dotyczących zdrowia [Health protection as a duty of the state. Evolution of the Polish constitutional system in the aspect of health regulations]. *Roczniki Nauk Społecznych, 7(43).*
5. Ruktanonchai, N.W. et al. (2020). Assessing the impact of coordinated COVID-19 exit strategies across Europe. *Science, 369(6510).*

6. Yi-Fan, L. (2020). Spread and Impact of COVID-19 in China: A Systematic Review and Synthesis of Predictions From Transmission-Dynamic Models. *Frontiers in Medicine*, 7.
7. World Health Organization (1998). *Health 21: The Health for All Policy Framework for the WHO European Region – 21 Targets for 21st Century*. Copenhagen: WHO.
8. WHO, *Transmission of SARS-CoV-2: implications for infection prevention precautions*, 9.07.2020, https://apps.who.int/iris/bitstream/handle/10665/333114/WHO-2019-nCoV-Sci_Brief-Transmission_modes-2020.3-eng.pdf, 15.01.2023.
9. *Personel medyczny poszukiwany do walki z COVID-19 [Medical personnel needed for the fight against COVID-19]*, <https://pulsmedycyny.pl/personel-medyczny-poszukiwany-do-walki-z-covid-19-1005954>.
10. *Wprowadzamy stan epidemii w Polsce [We are introducing the state of epidemic in Poland]*, 23.03.2020, <https://www.gov.pl/web/koronawirus/wprowadzamy-stan-epidemii-w-polsce>, 20.03.2022.
11. *List of hospitals transformed into infectious hospitals to combat COVID-19*, <https://pulsmedycyny.pl/lista-szpitali-przekształczonych-w-zakazne-do-walki-z-covid-19-985029>, 20.03.2022.
12. Alert zdrowotny 1 [Health alert], 21.04.2022.
13. *Chorzy przewlekle a zamrożony system ochrony zdrowia [The chronically ill and the frozen health care system]*, <https://www.politykazdrowotna.com/60534,chorzy-przewlekle-a-zamrozony-system-ochrony-zdrowia>, 20.03.2022.
14. <https://orka.sejm.gov.pl/zapisy9.nsf/0/59DAEE3871A2FC2AC12586D8004B894F/%24File/0122709.pdf>, 20.03.2022.
15. <https://www.aotm.gov.pl/covid-19/zalecenia-w-covid-19/>, 20.03.2022.
16. *Treaty on the Functioning of the European Union of 25.03.1957* (Journal of Laws of 2004, No. 90, item 864/2).
17. Ministry of Health (9.04.2018). *Health policy programs*, <https://www.gov.pl/web/zdrowie/programy-polityki-zdrowotnej>, 20.03.2022.
18. Regulation of the Minister of Health of 7 March 2020 on the list of diseases causing the obligation of quarantine or epidemiological supervision and the period of mandatory quarantine or epidemiological supervision. Journal of Laws of 2020, item 376; Repeal date: 7 April 2020.
19. Regulation of the Minister of Health of 20 March 2020 on the announcement of the state of epidemic in the territory of the Republic of Poland. Journal of Laws of 2020, item 491.
20. Ordinance of the Minister of Health of 3 April 2020 on the establishment of a Team for coordinating the COVID laboratory network, Journal of Min. of Health, item 31 and 110; repealed by the Ordinance of the Minister of Health of 10 September 2021 repealing the Ordinance on the establishment of the Team for coordinating the COVID laboratory network. Journal of Min. of Health, item 72.

21. Regulation of the Minister of Health of 28 April 2020 amending the regulation on standards regarding restrictions in providing health care services to patients other than those suspected of being infected or infected with SARS-CoV-2 virus by medical professionals who have direct contact with patients suspected of being infected or infected with this virus. Journal of Laws of 2020, item 775.
22. Regulation of the Minister of Health of 20 July 2020 amending the regulation on standards regarding restrictions in providing health care services to patients other than those suspected of being infected or infected with SARS-CoV-2 virus by medical professionals who have direct contact with patients suspected of being infected or infected with this virus. Journal of Laws of 2020, item 1275.
23. Journal of Laws of 2020, item 422; entered into force on 13 March 2020.

SITUATIONAL LEADERSHIP IN PROJECT MANAGEMENT: EMPIRICAL RESEARCH OF PROJECT MANAGERS

Marzena PODGÓRSKA^{1*}, Łukasz DETKO²

¹ Silesian University of Technology, Faculty of Organization and Management, Zabrze;
marzena.podgorska@polsl.pl, ORCID: 0000-0001-7549-7320

² Silesian University of Technology; lukadet786@student.polsl.pl

* Correspondence author

Purpose: The goal of the study was to examine project managers ability to apply different styles of leadership depending on the project situation.

Design/methodology/approach: LEAD-Self questionnaires were used as the main research tool, which is based on the Model of Situational Leadership by P. Hersey and K. Blanchard. The tests were carried out in 12 production plants located in Poland, Italy, Spain, Turkey and China. The plants produce parts for household appliances, automotive and HVAC industries as well as intelligent power grids. 45 project managers participated in the study.

Findings: Research results indicate that project managers have a wide range of styles, yet their adaptability is low and moderate level. None of the surveyed project managers has a high level of adaptation. This means that the project managers participating in the study use only the basic leadership style and only occasionally use supporting styles.

Practical implications: Implications for organizations and project managers are given in the publication. The most important of them is training project managers in the field of situational leadership model and making managers aware of the strengths and weaknesses of each style, so that they are able to adapt them to the situation and to be ready to act by individual team members.

Originality/value: The publication refers to the issue of situational leadership in the context of project management, which broadens the knowledge of human resource management in project management, and highlights the importance of adapting the leadership style of a project manager to a specific situation. The publication can be valuable for organizations implementing industrial projects and for project managers themselves.

Keywords: leadership in project management, situational leadership, LEAD-self, project management, project manager.

Category of the paper: Research paper.

1. Introduction

Project management has gained recognition from many organizations and is increasingly seen as a basic skill in times of constant and rapid change. Due to the characteristics of projects, including their unique and remarkable nature, managers who direct such projects face various challenges. To face these challenges, they need excellent project management skills and leadership, recognized as one of the most important factors in successful project management. Leadership in this case can be seen as the art of influencing team members to achieve the desired project outcomes and the effective cooperation of an project team (Podgórska, 2022). In other words, it can be argued that leadership has a large impact on the entire project process, including the actions of others, as leaders guide the behaviour of others by setting a vision and direction for their actions.

Project managers have multiple roles to bring projects to completion within the triple constraints of: scope, time and budget, and to meet project quality requirements and stakeholder expectations. In order to be successful in project implementation, project managers must have a good understanding of how to use the tools and techniques for qualitative project management (PMBOK, 2017). However, project management is more than just applying technical skills to perform project work, such as planning, scheduling, budgeting and calculations, and working with numbers, templates and charts. Most importantly, project managers need to guide project team members, interact effectively, and influence others (Kerzner, 2006). Moreover, the project manager must show a special approach to building and maintaining relations within the team due to the temporary nature of the project and interpersonal relations – project completion involves termination of the project team and then moving on to a new project and a new team (Podgórska, Pichlak, 2019). Therefore, there is a wide range of skills that a project manager needs to develop and learn to use them in a timely manner. One of these key interpersonal skills is leadership, which undoubtedly must be mastered by project managers in order to achieve goals and be effective. Additionally, project managers' understanding of their own leadership style and the ability to predict team member's readiness to work are key in guiding people and projects (Kerzner, 2006).

It should also be emphasized that leadership is part of a much broader process that goes beyond the leader. It focuses on interacting with other people, including in particular project team members and their special characteristics (Forsberg, 2000). This method of researching leadership, developed by (Hersey, Blanchard, 1977) was applied in the Model of Situational Leadership. This model was used in this study to conduct empirical research. Situational leadership, with its emphasis on adaptability, offers profound benefits for organizations, managers and employees. Whether a more directive or supportive approach should be adopted depends on many different factors, including project goals, challenges faced by the team, and existing skill levels and experience of team members. Taking this into account, in this paper, the goal of the thesis was to examine the ability of project managers to apply different

styles of leadership depending on the situation/context of the project. In order to achieve the aim of the research, three following research questions were asked, i.e.:

1. Which leadership styles do project managers take as primary and which styles as supportive ones?
2. What is the ability of project managers to adopt different leadership styles?
3. To what extent does the behaviour of project managers meet the requirements of their colleagues regarding the problem or situation?

2. Theoretical background

Leadership is defined in many different ways. Leadership has been recognized in terms of leader traits (Bowden, 1927; Carlyle, 1841) and impact that these traits have on leadership effectiveness (Bingham, 1927; Kirkpatrick, Locke, 1991; Senior et al., 2012). The development in leadership research have had also an effect in terms of consideration of other aspects of leadership, such as: leaders behaviors (Fleishman et al., 1955; Likert, 1961; Blake, Mouton, 1985; Argyris, 1976; McGregor, 1964), situational moderator variables (Fiedler, 1964; Evans, 1970; Hersey, Blanchard, 1969, 1977; Yukl, 1971; Vroom, Yetton, 1973; Vroom, Jago, 1988), relationships between leader and followers (Greene, 1975; Hollander, 1979), emotional intelligence (Goleman et al., 2002), subordinates commitment (Field, 1989; Eden, 1984; Bass, 1985; Bass, Avolio, 1995) and finally with the competence of leaders (Kotter, 1990; Kouzes, Posner, 1998; Alimo-Metcalfe, Alban-Metcalfe, 2001; Dulewicz, Higgs, 2003; Podgórska, Pichlak, 2019). This article focuses on situational leadership.

2.1. The evolutionary model of P. Hersey and K.H. Blanchard

As leadership research has been conducted, researchers have come to the conclusion that the characteristics and behaviors of effective leaders, and even the mechanisms of influence they use, only partially explain why they were effective, as much depends on the situation in which they find themselves. This was the reason for undertaking research work as part of the situational approach to leadership (Paliszkievicz, 2019).

Situational leadership represents a significant departure from the mainstream behavioral concepts of leadership theories. Researchers such as F.E. Fiedler (1964), R.J. House (1977), V. Vroom and P. Yetton (1973) and P. Hersey and K.H. Blanchard (1977) suggested that effective leadership should be a function of the situation. Their approach reflects new theoretical models that emphasize the impact of a changing organizational situation on leadership behavior. These models state that a leader must adapt their leadership patterns and management style to the requirements of the situation. One of the most popular theories of situational leadership is the evolutionary model of P. Hersey and K.H. Blanchard (1977).

In 1969, P. Hersey and K.H. Blanchard published the Life Cycle Theory of Leadership (Hersey, Blanchard, 1969). They revised it, and in 1977 they published the Situational Leadership® Model (Hersey, Blanchard, 1977). Unlike other conditional theories, situational leadership is not called a theory by its authors because it does not try to explain why something is happening. However, other authors do call it a theory (Schermerhorn, 1997).

The primary conditional variable in situational leadership is the level of subordinates maturity. Leadership style depends on the behavior of the person trying to influence others. It includes directive (task) and supportive (relational) behaviors. **Directive behaviors** help group members achieve goals by providing guidance, setting goals and assessment methods, setting deadlines, defining roles, and showing how goals are to be achieved. The nature of directive behavior determines, often by means of one-way communication, what is to be done, how it is to be done and who is responsible for it. **Supportive behaviors** allow group members to feel good about themselves, their colleagues and the situation that has arisen. Supportive attitudes include two-way communication and reactions that show social and emotional support for other participants (Lussier, 2001).

Within the presented theory, leadership styles can be divided into four separate categories (Figure 1). The first style (S1) called directive style, the second style (S2) - coaching style, the third style (S3) is the supporting style, the fourth style (S4) is the delegating style.

The directive style (S1) is a style of a high level of compulsion and a low level of support. In this approach, the leader focuses communication on achieving goals and spends less time applying supporting activities. By applying this style, the leader communicates to his subordinates orders as to goals and ways of achieving them, and then carefully controls his subordinates. **The second - coaching style (S2)** is characterized by a high degree of directivity and a high degree of support. In this approach, the leader focuses communication on both achieving goals and satisfying the social and emotional needs of subordinates. The coaching style requires the leader to get involved in the matters of subordinates by encouraging them to act and soliciting their opinions. This style is an extension of the directive style (S1) as it still requires the leader to make the final decision as to what to do and how to do it to achieve the goal. Another style is **the supportive approach (S3)**, which requires the leader to adopt a style with a high level of support and a low level of directive. In this approach, the leader does not focus only on goals, but uses supportive behaviors that allow them to develop the skills of employees related to the task being carried out. Supportive style includes the ability to listen, praise, seek help, and provide feedback. A supportive leader often shows appreciation and offers support. **The delegating style (S4)** is not very supportive and directive style and consists in delegating tasks. In this approach, the leader communicates less information about the task and offers less support, which increases the confidence and motivation of employees in relation to the task. The delegating leader is less involved in planning, controlling details and clarifying goals. By agreeing within the group on what to do, they allow employees to take responsibility for carrying out the task as they see fit. A leader using the delegating style gives control to subordinates and refrains from unnecessarily intervening (Lussier, 2001).

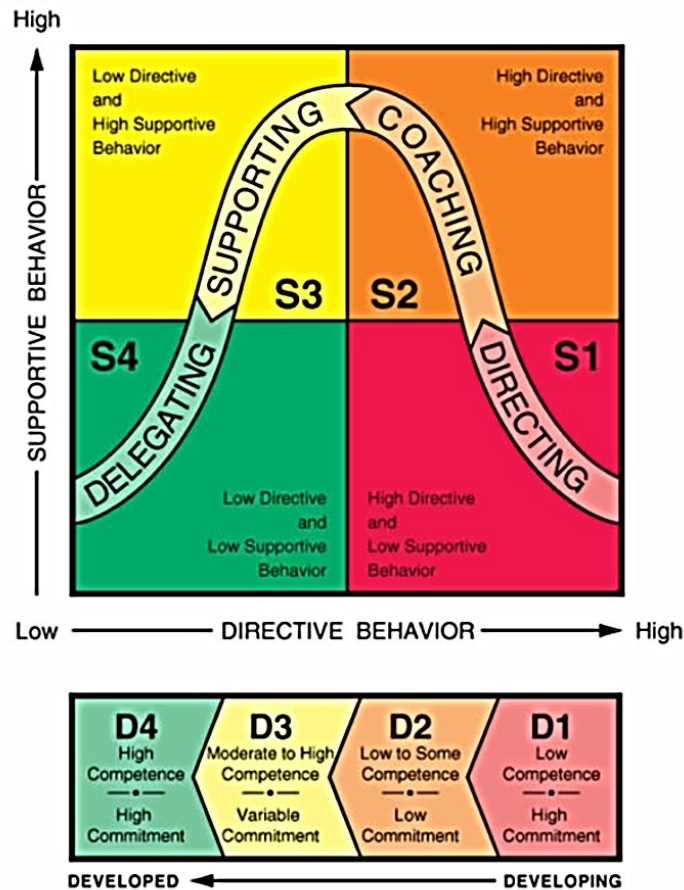


Figure 1. Model of situational leadership.

Source: Hersey, P.K., Blanchard, K. (2013). *Management of Organizational Behavior Utilizing Human Resources*. 10th edition. New Jersey: Prentice-Hall Inc.

The second important part of the situational leadership model concerns the level of development of subordinates. It means the degree to which subordinates have the appropriate competences and commitment necessary to perform the task. Regarding this, employees can be divided into four categories: D1, D2, D3 and D4, from low development to high development. D1 employees are characterized by low competences and high commitment. They are new to a given task and do not know exactly how to get it done, but they are excited about the challenge that comes with it. D2 employees are defined as people with certain competences, but low commitment. They started learning in a particular field, but lost some of their original motivation for work. D3 are employees who are moderately or highly competent, but may lack commitment. They have the necessary skills to do the job, but are not sure if they are capable of carrying out the task on their own. D4 employees are the most developed, having both a high level of competence and a high degree of commitment to the performance of a given task (Northouse, 2010).

According to P. Hersey and K. Blanchard's (Hersey, Blanchard, 1977) situational model, the choice of leadership style that should be applied to individuals or groups depends on the level of readiness of the people that the leader is trying to influence. When managers identify

the level of readiness of the person or group they want to influence, the key to effective leadership is to apply the right leadership style.

2.2. The role of leadership in project management

Leadership is an essential factor in successful project management. Changes taking place in the business world and in organizations require a re-evaluation of some issues, including the role of leadership. Leadership constitutes a fundamental role in interpersonal relationships and leadership is often associated with the success or failure of the project. Necessary knowledge, skills, qualifications and personal characteristics that is, competences, ensure the successful implementation of projects thanks to making the right decisions at the right time. The primary function of leadership is to make changes and set directions for action in the face of change, which is not similar to planning or directing (Nixon et al., 2012).

Project management literature emphasizes the importance of leadership as a necessary precondition for project implementation and as a means of motivating people to change which has an impact on the overall quality of the project. Project team members led by strong leadership, held by project managers, contribute to the success of the project. They show great dedication, commitment and an attitude towards achieving the project's goals. Leadership motivates team members to ensure that project outcomes are improved by achieving higher outcomes. One of the key principles of leadership is transforming project managers into leaders by making them more effective (Shenhar, 2004).

Leadership is an effective tool used by the project manager and contributes significantly to improving project outcomes. Inadequate leadership skills are often associated with project failure. Project managers, who are leaders, formulate a clear vision of the project. They communicate this vision to the project team in order to create a project strategy that is linked with the business strategy (Baccarini, 1999). Leaders need to build awareness and trust among the team in order to feel that they play a fundamental role in the success or failure of the project. They give others a sense of security and predictability, mobilize people and focus their energy around what is important. A strong leader and strong leadership mean setting a clear vision, setting a clear course of action and setting goals that are achieved together by the team (Curran et al., 2009).

It can be concluded that leadership is becoming more and more essential to the effectiveness of business outcomes and project success. Strong leadership and effective management are essential in organizations to achieve the highest possible effectiveness of implemented projects, because managers with appropriate qualifications are not able to guarantee the organization of effective leadership (Lunenburg, 2011). In summary, leaders deal with change by creating a vision, setting direction, building motivation and inspiration. Managers deal with introducing some order and consistency by organizing, planning and budgeting. The combination of these features can contribute to more effective project management.

3. Methods

Quantitative research was carried out using the diagnostic survey method with the questionnaire technique. The study was conducted online using MS Forms software. The questionnaire was prepared in two languages i.e. Polish and English. The access path to the questionnaire was sent via e-mail with a request to complete the survey and information about anonymity and the purpose of the survey. The questionnaire used for the study had a bipartite structure.

The first part of the questionnaire is the Leader Effectiveness and Adaptability (LEAD – self assessment) questionnaire by Hersey-Blanchard. It includes 12 situational questions where the respondent is asked to assume the role of a leader and putting themselves in the situations described in order to identify with them as much as possible. The respondents mark 1 out of 4 answers which, in their opinion, will be consistent with their actions on the situation (LEAD, 1993). The questionnaire was developed to enable leaders to self-assess their leadership styles and assess their adaptability. This tool is used to assess the leader's perception of how he responds to certain scenarios as a situational leader. P. Hersey and K. Blanchard based the questionnaire on three characteristics: leadership styles, range of styles and adaptability to a given style.

Leadership style refers to the consistent behavior patterns that leaders evince. The reading of the base style, supporting style (s) and style range is done in table 1. **The base** (primary) **style** is indicated by the cell in the "Sum" row with the highest score. **The supporting** (minor) **style** indicates a cell in the "Sum" row where the sum of the responses is two or more.

The range of styles is the leaders basic leadership style along with any other supporting styles that define their ability to use a variety of styles. **The range of styles** determines how flexibly one can change the way of approaching their actions in an attempt to influence others. Three or more answers in the "Sum" row (Table 1) indicate a high degree of flexibility in the application of certain behaviors. Two answers in the line "Sum" represent moderate flexibility. One answer is not statistically significant (low elasticity) as it is difficult to predict flexibility in this style (LEAD, 1993).

Table 1.

The key to identifying the primary and secondary leadership styles

		The range of styles			
		S1 (Directive)	S2 (Coaching)	S3 (Supportive)	S4 (Delegating)
Situation	1	A	C	B	D
	2	D	A	C	B
	3	C	A	D	B
	4	B	D	A	C
	5	C	B	D	A
	6	B	D	A	C
	7	A	C	B	D
	8	C	B	D	A
	9	C	B	D	A
	10	B	D	A	C
	11	A	C	B	D
	12	C	A	D	B
The sum					
	S1 - directive	S2 - coaching	S3 - supportive	S4 - delegating	

Source: LEAD: Self Leadership Style/perception of Self, Center for Leadership Studies, 1993, pp. 1-4.

Adaptability of style is the degree to which a leader's behavior matches the demands of his colleagues in relation to a problem or situation (Hersey, Blanchard, 1977). **Style adaptability** is determined by scoring according to the key in Table 2. Points are awarded for each alternative action selected in response to the twelve situations outlined in the LEAD-self questionnaire. The number of awarded points depends on how well the chosen alternative action fits the situation. The number "3" indicates "best match" and the number "0" indicates that an alternative operation with a very low probability of success was selected. The use of a point system enables the expression of the adaptability of the leadership style in numerical form. This result ranges from 0 to 36 points. A numeric expression enables performing comparative analysis based on a range pattern of numeric values (LEAD, 1993).

Table 2.

The key to scoring the ability to adapt the leadership style

		Adaptability			
		The probability of success			
		A	B	C	D
Situation	1	3	1	2	0
	2	3	0	2	1
	3	2	1	0	3
	4	2	0	3	1
	5	0	2	3	1
	6	1	2	0	3
	7	0	3	1	2
	8	3	1	0	2
	9	0	2	3	1
	10	2	0	1	3
	11	0	3	1	2
	12	1	3	0	2
The sum					
	The sum A; B; C; D				

Source: LEAD: Self Leadership Style/perception of Self, Center for Leadership Studies, 1993, pp. 1-4.

Scores from 30 to 36 points indicate a leader with a high degree of adaptability. Such a leader accurately diagnoses the possibilities and readiness of his co-worker to act in a given situation and adjusts to it accordingly. A score in the range of 24-29 points reflects a moderate degree of adaptability. Scores in this range typically indicate a distinct primary leadership style with less flexibility in supportive styles. The number of points below 23 indicates the need for self-development. This result proves the inability to diagnose the readiness of group members to perform a task. Such a leader cannot apply the appropriate leadership behavior (LEAD, 1993).

The second part of the questionnaire is the metric in which the respondent is asked about age, gender, education, experience as a project manager, area of project application and possessed certification. The classification of project types and their application was determined on the basis of the division according to D. Lock, i.e. engineering projects (e.g. construction, petrochemical, mining), production projects (e.g. research and development of new products; production of equipment/parts for automotive or domestic applications), IT projects and projects related to management of change and research projects (Zaskórski et al., 2015).

3.1. Sample

The tests were carried out in 12 production plants located in Poland, Italy, Spain, Turkey and China. The plants produce parts for household appliances industry (parts for dishwashers, washing machines, refrigerators), automotive (switches, control panels, car chargers), HVAC (heating, air conditioning, ventilation) and intelligent power networks (Smart Grid). The study included 48 project managers. On average, there were 3-5 people per plant. The required minimum number of people in the study was determined using the sample selection calculator¹. Assuming the confidence level of 95%, the fraction size of 0.5 and the maximum error of 5%, the minimum number of people in the study is 43 project managers.

45 project managers participated in the study, 15 of whom are women (which constitutes 33,33% of the respondents), and 30 people are men, which constitutes 66,67% of the studied population. The study sample was divided according to age. Most of the respondents were in the group aged 30 to 39 (40,00%). There were 7 women in this group (15,56% of the respondents) and 11 men (24,44% of the surveyed population). The second largest group was the age group from 40 to 49 (37,78%), with 5 women (11,11% of the study population) and 12 men (26,67% of the respondents). The next age group are respondents under 30 (11,11%). There were 2 women in this group (4,44% of the respondents) and 3 men (6,67% of the studied population). In the age group from 50 to 59 there were only 4 men (8,89% of the respondents). The last and least numerous group are respondents aged over 60 (2,22%). This group consisted of only one person and it was a woman (2,22% of the respondents). The above data is presented in Table 3.

¹ <https://www.naukowiec.org/dobor.html>, 6.01.2022.

Table 3.*Characteristics of the studied sample according to the respondents age*

Age range	Women (W)	% Women	Men (M)	% Men	Sum	Percent (W+M)
< 30	2	4,44%	3	6,67%	5	11,11%
30-39	7	15,56%	11	24,44%	18	40,00%
40-49	5	11,11%	12	26,67%	17	37,78%
50-59	0	0,00%	4	8,89%	4	8,89%
> 60	1	2,22%	0	0,00%	1	2,22%
Total:	15	33,33%	30	66,67%	45	100%

Source: Own study based on quantitative research.

The criterion for dividing the research sample was also education. More than a half, because 24 people (53,33%) had a Master's degree, including 7 women (15,56% of the respondents) and 17 men (37,78% of the respondents). Incomplete higher education is a group of 16 people (35,56%), of which 7 are women (15,56% of the respondents) and 9 people are men (20,00% of respondents). The least numerous group are the respondents with secondary education, i.e. 5 people (11,11%), including 1 woman (2,22% of respondents) and 4 men (8,89% of respondents). None of the respondents declared a doctoral degree.

The sample was then divided according to experience as a project manager. Experience of less than 1 year was declared by 1 person (2,22% of respondents). 10 people (22,22% of respondents) had experience from 1 to 3 years.

Experience from 3 to 5 years was declared by 9 respondents (20,00%), while 14 respondents (31,11%) showed experience from 5 to 10 years.

The sample was also divided according to the type of project, taking into account the criterion of project application. The obtained results indicate that 36 respondents declared managing production projects (80,00% of respondents), the remaining 9 people indicated IT projects (20,00% of respondents). Engineering and scientific projects have not been declared.

The project management certification was also the criterion for dividing the research sample. 21 respondents (46,67% of the respondents) indicated the answer confirming their certification in the field of project management. The remaining 24 respondents (53,33% of the surveyed population) do not have certification in the field of project management. The most common certificate in the field of project management was Prince2 Foundation, owned by 14 respondents (31,11% of respondents). Another certificate is PMI PMP, owned by 10 respondents (22,22% of the population). AgilePM Foundation was indicated by 4 respondents (8,89% of respondents), while the IPMA D certification was indicated by 3 respondents (6,67% of respondents). 2 people have the Price2 Practitioner certification (4,44% of the respondents). The least frequent certification in the surveyed population was AgilePM Practitioner - 1 person (2,22%) and IPMA C - 1 person (2,22%). In the surveyed population, project managers often showed more than one certificate in project management. 5 respondents showed two certificates up (11,11% of respondents), 3 certificates were shown by 2 respondents (6,67%), and 4 certificates were shown by 1 respondent (2,22% of respondents).

4. Results

Results concerning the participants' perceptions of leadership styles in terms of the primary and secondary styles are presented in Figure 2. The dominant primary style, which the respondents use most often, is the coaching style (S2 - high level of directivity, high level of support). This group included 71,11% of the respondents. The second most frequent choice is the supporting style (S3 - low level of directivity, high level of support). In this case, it is 17,78% of the respondents. The third primary style is the delegating style (S4 - low level of directivity, low level of support) with the result of 6,67% of the respondents. The last one and at the same time the least numerous primary leadership style studied among the respondents is the delegating style (S1 - high level of directivity, low level of support), which is used by 4,44% of the surveyed population. The secondary style most frequently used by the respondents is directive behavior (S1 - high level of directivity, low level of support) and supportive style (S3 - low level of directivity, high level of support), which is indicated by 38,67% of the respondents. The secondary delegating style (S4 - low level of directivity, low level of support) is used by 13,33% of respondents, while 9,33% of respondents define their secondary style as delegating.

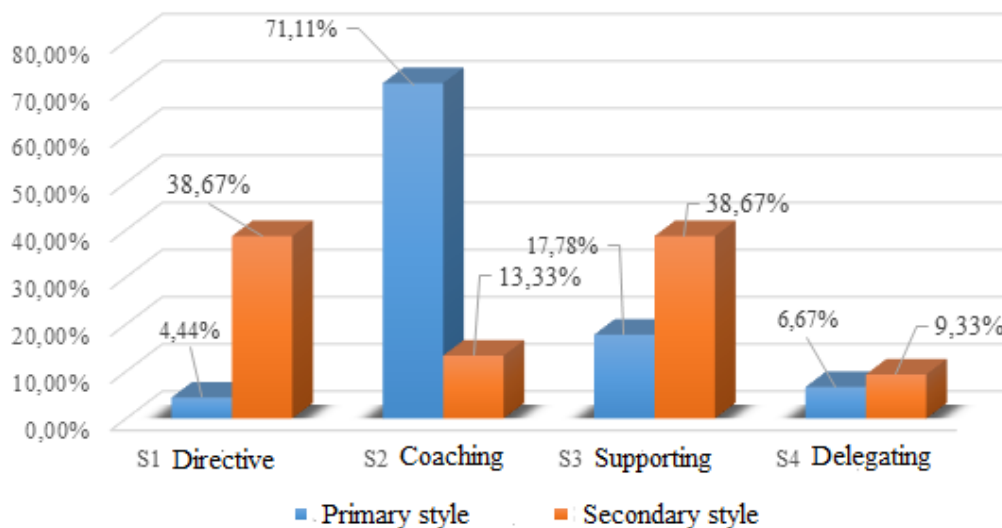


Figure 2. Characteristics of the studied sample due to the primary and secondary leadership style.

Source: Own study based on the results of quantitative research.

From the data presented in Fig. 2, it can be concluded that the leading primary style is the coaching style (S2). The supporting styles with the highest response rate are the directive style (S1) and the supporting style (S3). These are the most frequently shown styles for which the same result was achieved, i. e. 38,67%.

On the basis of the obtained results, it is also possible to distinguish two pairs of styles that were most often used by the respondents. The first pair of styles that can be distinguished are the coaching (S2) and the directive (S1) styles. The S2 and S1 style profile is effective for low to medium readiness. Leaders using these styles are often unable to fully develop the potential of group members. This is until they have mastered the ability to properly use the supporting (S3) and delegating (S4) styles.

The second pair of styles shown in the study are coaching (S2) and supportive (S3) styles. People with dominating S2 and S3 styles tend to be good at working with people with an average level of readiness. On the other hand, they have difficulty coping with disciplinary issues and workgroups with a lower level of readiness, as well as delegating tasks to competent people to maximize their development. These are perfect styles for working with people with an average level of readiness. If leaders with this profile want to maximize their potential, they must learn to use the S1 and S4 styles if necessary. In total, 86,7% of respondents most often used these pairs of leadership styles, i.e. S2 and S1 as well as S2 and S3.

The scope of the styles is presented in Fig. 3. The scope of the three leadership styles is used by 53,3% of the respondents. Two leadership styles are used by 33,3% of respondents. The range of four styles uses 11,1% and 2,2% only one leadership style. It can therefore be concluded that most of the respondents have a wide range of leadership styles.

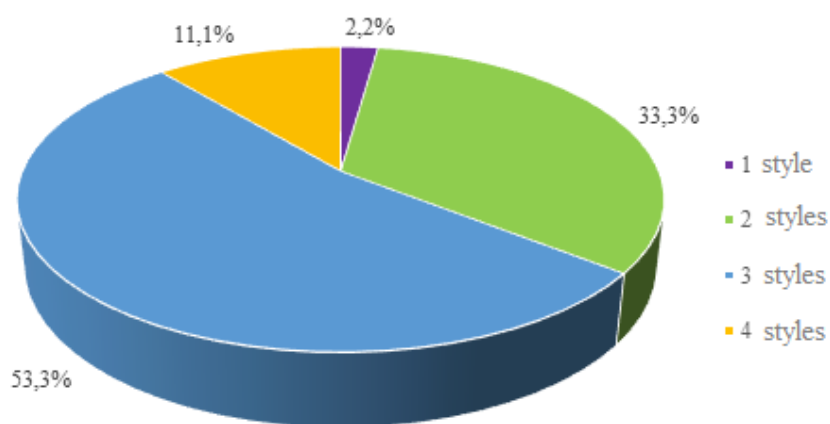


Figure 3. Characteristics of the studied sample in terms of the scope of application of leadership.

Source: Own study based on the results of quantitative research.

The next step in the analysis is to determine the flexibility of using leadership styles. Fig. 4 shows the results of the performed analysis. As can be seen, the coaching style (S2) shows the highest level of flexibility. High flexibility for this style is demonstrated by 89% of the respondents, moderate flexibility - 9% of the respondents, while low flexibility (statistically insignificant result) is shown in the analysis by 2% of the respondents. The second leadership style in terms of high flexibility is the supportive style (S3) - ie 58% of the respondents from the surveyed population. 29% of the studied population shows moderate flexibility and 13% of

the study population - low. Another analyzed leadership style is the directive style (S1). High flexibility for this style is indicated by 40% of respondents, moderate - 31%, and low - 29%. The last style is the delegating style (S4). High flexibility for this style is indicated by 9% of the respondents, moderate - by 13% of the respondents, and low flexibility - by 78% of the respondents in the surveyed population.

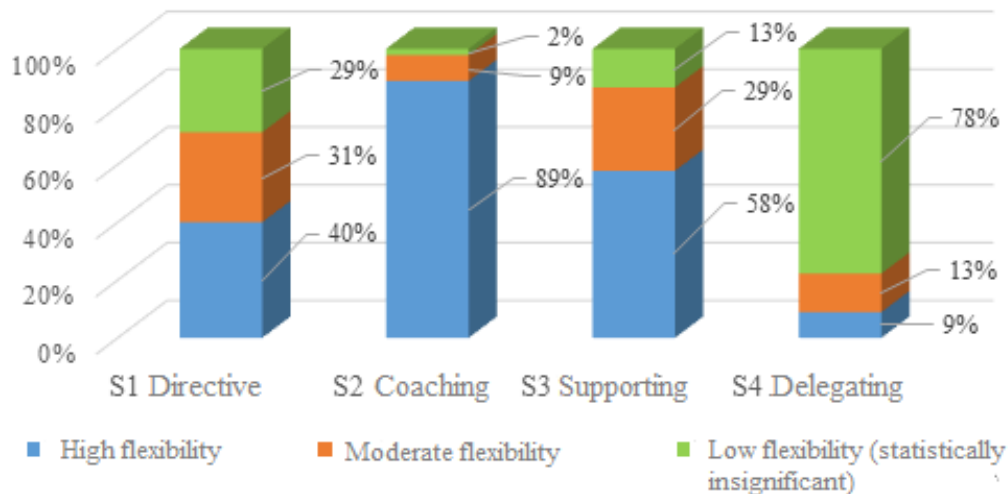


Figure 4. Characteristics of the studied sample due to the flexibility of using leadership styles.

Source: Own study based on the results of quantitative research.

The ability to adapt the style, i.e. the degree to which the leaders behavior meets the requirements of their colleagues in relation to a problem or a given situation, is presented in Fig. 5.

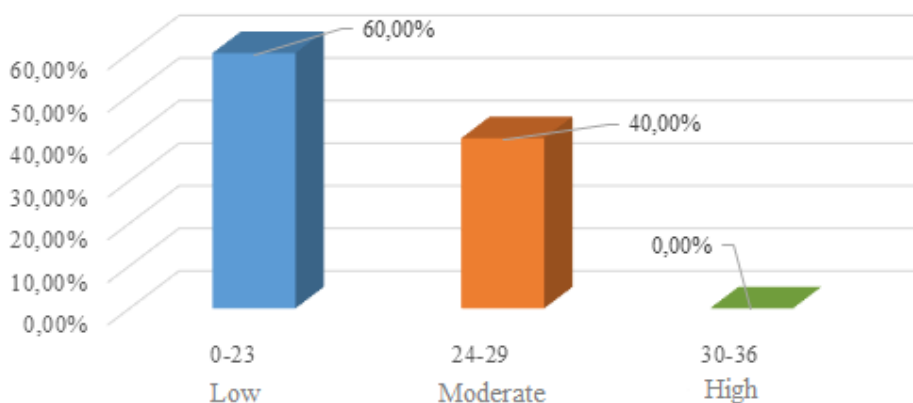


Figure 5. Characteristics of the studied sample in terms of the ability to adapt leadership styles.

Source: Own study based on the results of quantitative research.

As can be seen from the chart above, 60,00% of the respondents showed a low level of adaptation of leadership styles, 40,00% of the respondents showed a moderate degree of adaptation, while none of the respondents showed a high level of adaptation of leadership styles.

5. Discussion

The article posed three research questions. The first concerned the leadership styles that project managers adopt as primary and supportive styles. The second was related to the ability of project managers to apply different leadership styles, and the third related to the extent to which project managers' behavior corresponded to the requirements of their colleagues in a given situation.

Answering the first question, it can be indicated that in the studied group of project managers, the basic style of leadership, i.e. the behavior pattern that is most often used when trying to influence the actions of others, is the coaching style (S2), which was demonstrated by 71.11% of the respondents. According to K. Blanchard, this leadership style is characterized by the presence of both task-related and relational behaviors at an above-average level (Hersey, Blanchard, 2013). The coaching style is especially effective when colleagues are motivated to act but need a lot of guidance. It can be concluded that the coaching style is recommended primarily for team members who want to learn. As secondary leadership styles, the respondents used the directive style (S1) and the supportive style (S3). Both styles achieved the same result, i. e. 38,67% of the respondents.

On the basis of the obtained results, it is also possible to distinguish two pairs of styles that were most often used by the respondents. The first pair of styles that we can isolate are the coaching (S2) and the directive (S1) styles. People who mainly use these two styles tend to increase and decrease their support for subordinates. This trend also applies to relationship-building behaviors. Leaders feel uncomfortable if it is not them who "make the decisions". Based on the research of K. Blanchard, it was found that this style profile is characteristic for engineers who have been promoted to a managerial position, but are reluctant to quit engineering work (Hersey, Blanchard, 2013). It can also be pointed out that this is often a very effective style for people working in a manufacturing company where managers are under a lot of time pressure, and also in crisis situations where time is a very limited resource. The second pair of styles shown in the study were coaching (S2) and supportive (S3) styles. People representing S2 and S3 styles tend to be good at working with those of an average level of readiness. On the other hand, they find it difficult to deal with disciplinary issues and workgroups with a lower level of readiness, as well as delegating tasks to competent people to maximize their development. According to research, this style is most often identified in the United States and other countries with a high level of education and industrial experience. A leader with S2 and S3 styles is usually more effective than other leaders (Hersey, Blanchard, 2013).

Regarding the second question, the research showed that leaders differ in their ability to differentiate their leadership style in different situations. Some leaders are limited to one basic style - 2.22% of those surveyed. These leaders are only effective when their style is compatible

with their surrounding. 11.1% of respondents are able to modify their behavior to fit each of the four basic styles. Three styles are used by more than half of the respondents, i.e. 53.3%, and two styles are used by 33.33% of the respondents. It can therefore be concluded that a small group of respondents uses all four leadership styles. Most of the respondents show the ability to use three leadership styles. This indicates the need to improve the surveyed project managers in terms of the possibility of using several styles by them, as flexible leaders, i.e. leaders with a wide range of styles, have the potential to be effective in many situations. It is desirable that leaders have and know how to use as many styles as possible. People who have a narrow range of styles can be successful for a long time if left in situations where their style is likely to be successful. Conversely, people with a wide range of styles may be ineffective if their behavior does not meet the demands of the situation.

However, the scope of styles is not as important for effectiveness as the ability to adapt it, which was included in research question 3. In this context, research has shown that 60% of project managers have a low degree of adaptation to leadership styles. This means that leaders are not able to diagnose subordinates' readiness to perform a task and to apply appropriate leadership behaviors. They only use a basic leadership style. 40.00% of the respondents showed a moderate degree of adaptability. These leaders typically exhibit a distinct mainstream leadership style with less flexibility in supportive styles. In the surveyed group of project managers nobody showed a high degree of adaptation. This may indicate that leaders are misdiagnosing opportunities and readiness of their co-worker to act. They cannot adapt properly to the situation, so their effectiveness may be low. The leader's diagnostic ability is the key to adaptability. These results are supported by research conducted by K. Blanchard in the Center of Leadership Studies, which showed that only few leaders are able to learn to apply all four basic styles of leadership (Hersey, Blanchard, 2013).

6. Conclusion

This article contributes to the literature on project management in the field of human resource management and from the perspective of organizations implementing industrial projects, thus extending the theory of project management and developing an argument for greater emphasis on the use of situational leadership by project managers. In practice, the article responds to the needs of companies to reflect on the desired competences of project managers implementing industrial projects. The obtained results are therefore the basis for identifying the following recommendations both for project managers and for the organization that implements the projects.

As for the organization, the following recommendations are proposed: (1) organizations implementing projects in the industrial field should focus on training project managers in the concept of situational leadership, which will allow them to manage a project team more effectively tailored to the situation and to the readiness of individual team members, (2) organizations should consider introducing competency situational tests for candidates for the position of a project manager, and (3) organizations should secure financial resources enabling them to implement the concept of situational leadership in project management, including in particular training and competency tests.

As far as project managers are concerned, the following recommendations are proposed: (1) making project managers aware of the strengths and weaknesses of each leadership style, which will allow them to increase the scope of the styles, increase the ability to adapt the leadership style to changing situations and assess the readiness of the co-worker, (2) it is important that there is direct interaction of project managers with members of their teams, which will allow them to get to know their colleagues well enough to flexibly manage the constantly changing requirements of the organization, (3) making project managers aware that the ability to adapt the leadership style to a specific situation is one of the key success factors of each project.

References

1. Alimo-Metcalfe, B., Alban-Metcalfe, R.J. (2001). The development of a new Transformational Leadership Questionnaire. *Journal of Occupational and Organizational Psychology*, Vol. 74, pp. 1-27.
2. Argyris, C. (1976). Leadership, Learning and Changing the Status Quo. *Organizational Dynamics*, Vol. 4, pp. 29-43.
3. Baccarini, D. (1999). The logical framework method for defining project success. *International Journal of Project Management*, Vol. 30, No. 4, pp. 30-31.
4. Bass, B.M. (1985). *Leadership and Performance beyond Expectations*. New York: Free Press.
5. Bass, B.M., Avolio, B.J. (1995). Individual consideration viewed at multiple levels of analysis: A multi-level framework for examining the diffusion of transformational leadership. *The Leadership Quarterly*, Vol. 6, pp. 199-218.
6. Bingham, W.V., Davis, V.T. (1927). Leadership. In: H.C. Metcalf (Ed.), *The Psychological Foundations of Management* (pp. 56-74). New York: Shaw.
7. Blake, R.R., Mouton, J.S. (1985). *The Managerial Grid*. Houston: Gulf Publishing Company.

8. Bowden, A.O. (1927). A study on the Personality of Student Leadership in the United States. *Journal of Abnormal and Social Psychology*, Vol. 21, pp. 149-160.
9. Carlyle, T. (1841). *Heroes and Hero Worship*. Boston: Adams.
10. Curran, C.S., Niedergassel, B., Picker, S., Leker, J. (2009). Project leadership skills in cooperative projects. *Management Research News*, Vol. 32, No. 5, pp. 460-462.
11. Dulewicz, V., Higgs, M. (2003). Design of a new instrument to assess Leadership Dimensions and Styles. *Henley Management College Working Paper Series HWP 0311*. UK: Henley Management College.
12. Eden, D. (1984). Self-fulfilling Prophecy as a Management Tool: Harnessing Pygmalion. *Academy of Management Review*, Vol. 9, pp. 64-73.
13. Evans, M.C. (1970). The effects of Supervisory Behavior on the Path-goal Relationship. *Organizational Behavior and Human Performance*, Vol. 5, pp. 277-298.
14. Fiedler, F.E. (1964). A contingency model of leadership effectiveness. In: L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (pp. 149-190). New York: Academic Press.
15. Field, R.H.G. (1989). The Self-fulfilling Prophecy Leader: Achieving the Metharme Effect. *Journal of Management Studies*, Vol. 26, pp. 151-175.
16. Fleishman, E.A., Harris, E.F., Burt, H.E. (1955). *Leadership and Supervision in Industry*. Columbus, Ohio.
17. Forsberg, K. (2000). *Visualizing project management 2nd edition*. New York: John Wiley & Sons, Inc.
18. Goleman, D., Boyatzis, R., McKee, A. (2002). *The New Leaders*. Boston: Harvard Business School Press.
19. Greene, C.N. (1975). The Reciprocal Nature of Influence between Leader and Subordinate. *Journal of Applied Psychology*, Vol. 60, pp. 187-193.
20. Hersey, P., Blanchard, K.H. (1969). Life cycle theory of leadership. *Training Development Journal*, Vol. 23, pp. 26-34.
21. Hersey, P., Blanchard, K.H. (1977). *Management of Organizational Behavior: Utilizing Human Resources*. NJ: Prentice-Hill, Englewood Cliffs.
22. Hersey, P., Blanchard, K.H. (2013). *Management of organizational behavior: utilizing human resources. 10th edition*. New Jersey: Prentice Hall, pp. 304-314.
23. Hollander, E.P. (1979). *Leadership Dynamics: A Practical Guide of Effective Relationship*. New York: Free Press.
24. House, R.J. (1977). A 1976 theory of charismatic leadership. In: J.G. Hunt, L.L. Larson (eds.), *Leadership: The cutting edge*. Carbondale: Southern Illinois University Press.
25. Kerzner, H. (2006). *Project management a systems approach to planning, scheduling, and controlling, 9th edition*. New Jersey: Wiley & Sons.
26. Kirkpatrick, A.S., Locke, A.E. (1991). Leadership: do traits matter? *Academy of Management Executive*, Vol. 5, pp. 48-60.

27. Kotter, J.P. (1990). What leaders really do. *Harvard Business Review*, Vol. 68, pp. 103-111.
28. Kouzes, J.M., Posner, B.Z. (1998). *Encouraging the heart*. San Francisco: Jossey-Bass.
29. LEAD: Self Leadership Style/perception of Self (1993). Center for Leadership Studies.
30. Likert, R. (1961). *New Patterns of Management*. New York: McGraw-Hill.
31. Lunenburg, F.C. (2011). Leadership versus Management: A Key Distinction — At Least in Theory. *International Journal Of Management, Business And Administration*, Vol. 14, No. 1, pp. 1-4.
32. Lussier, R.N. (2001). *Leadership theory application skill building*. Cincinnati: South-Western College Pub.
33. McGregor, D. (1964). *Leadership and Motivation*. Cambridge, Massachusetts: MIT Press.
34. Nixon, P., Harrington, M., Parker, D. (2012). Leadership performance is significant to project success or failure: A critical analysis. *International Journal of Productivity and Performance Management*, Vol. 61, No. 2, pp. 205-206.
35. Northouse, P.G. (2010). *Leadership theory and practice, 5th ed.* Thousand Oaks: SAGE Publication Inc.
36. Paliszkievicz, J. (2019). *Przywództwo, Zaufanie i Zarządzanie Wiedzą w Innowacyjnych Przedsiębiorstwach*. Warszawa: CeDeWu.
37. PMBOK® Guide, 6th Edition (2017). Pennsylvania.
38. Podgórska, M. (2022). Challenges and Perspectives in Innovative Projects Focused on Sustainable Industry 4.0—A Case Study on Polish Project Teams. *Sustainability*, Vol. 14, No. 9, 5334.
39. Podgórska, M., Pichlak, M. (2019). Analysis of project managers leadership competencies. Project success relation: what are the competencies of polish project leaders? *International Journal of Managing Projects in Business*, Vol. 12, No. 4, pp. 869-887.
40. Senior, C., Martin, R., Thomas, G., Topakas, A., West, M., Yeats, M.R. (2012). Development stability and leadership effectiveness. *The Leadership Quarterly*, Vol. 23, pp. 281-291.
41. Shenhar, A.J. (2004). Strategic Project Leadership Toward a strategic approach to project management. *R and D Management*, Vol. 34, No. 5, pp. 569-578.
42. Schermerhorn, J.R. (1997). Situational Leadership: Conversations with Paul Hersey. *Mid-American Journal of Business*, Vol. 12, No. 2, p. 6.
43. Vroom, V.H., Jago, A.G. (1988). *The New Leadership: Managing Participation In Organizations*. New Jersey: Prentice-Hall.
44. Vroom, V.H., Yetton, P.W. (1973). *Leadership and Decision-Making*. PA: University of Pittsburgh Press.
45. Yukl, G.A. (1971). Toward a Behavioral Theory of Leadership. *Organizational Behavior and Human Performance*, Vol. 6, pp. 414-440.
46. Zaskórski, P., Woźniak, J., Szwarz, K., Tomaszewski, Ł. (2015). *Zarządzanie projektami w ujęciu systemowym, wyd. II*. Warszawa: WAT.

ENVIRONMENTAL AND SOCIAL ASPECTS OF CORPORATE SUSTAINABILITY AS PERCEIVED BY CONSUMERS – A CASE STUDY OF CLOTHING BRANDS

Monika RADZYMIŃSKA^{1*}, Bożena GARBOWSKA²

¹ University of Warmia and Mazury, Faculty Economics, Institute of Management and Quality Sciences, Olsztyn; mradz@uwm.edu.pl, ORCID: 0000-0003-0531-268X

² University of Warmia and Mazury, Faculty Economics, Institute of Management and Quality Sciences, Olsztyn; bozena.garbowska@uwm.edu.pl, ORCID: 0000-0003-0566-3543

* Correspondence author

Purpose: Competing for a limited number of socially conscious consumers and the appearance of new generations on the market forces a continuous addition of knowledge concerning pro-environmental and pro-social consumer attitudes and behaviour. Therefore, the present study attempts to: - identify the type of actions taken within the framework of sustainable development by selected clothing brands, - assess the pro-environmental and pro-social attitudes of young consumers purchasing clothing, - determine whether environmental and social aspects are a criterion for clothing choice among young consumers.

Design/methodology/approach: Two approaches were used in the research. In the first stage of the research, messages posted on the websites of selected clothing brands were analysed. In the second, a quantitative study was conducted among young consumers (n = 218) by indirect online survey measurement, using a survey questionnaire embedded in a Google form.

Findings: Young consumers present positive pro-environmental and pro-social attitudes. According to the respondents, the social commitment of companies influences the positive image and popularity of their products. However, almost half of all consumers presented an ambivalent or negative attitude towards paying more for the purchase of goods whose producers are involved in philanthropic and pro-environmental activities. This suggests that, in the view of this segment of respondents, it is the traders who should take financial responsibility for their actions by not raising the prices of the products they sell. Concern for others by purchasing socially committed brands and the environmental friendliness of the product were shown to rank lower in the hierarchy of clothing choice factors.

Research limitations: The research was conducted on a narrow subject basis, so the results obtained cannot be generalised to the young consumer segment. The scope of the presented research is also limited. The results of the research should be regarded as a pilot study.

Practical implications: The findings are of relevance to managers in charge of sustainability campaigns for clothing brands. They point to the need for further education aimed at shaping altruistic and pro-environmental attitudes.

Originality/value: This study highlights that sustainability encompasses a range of activities with different ways of communicating values to consumers.

Keywords: sustainability, consumer, pro-environmental attitudes, pro-social attitudes, behavior.

Category of the paper: marketing research.

1. Introduction

The growing problem arising from environmental deterioration and social and economic progression has obliged companies to implement sustainable development. Its key issue is to increase environmental benefits while maintaining economic growth (Azizi et al., 2016; Nathaniel et al., 2021; Ruan et al., 2022). The manufacturing sector is most responsible for carbon emissions and climate change, among other things. Nowadays, contractors are paying more and more attention to environmental protection, which has made companies more aware of the benefits of applying green solutions to the organisation's internal management process (Dou et al., 2021; Ren et al., 2021; Farah et al., 2021; Ren et al., 2022). In addition, the deepening global financial crises in recent years, mainly as a result of pandemics, have meant that some business models and industries may struggle to survive. This has caused companies to reinvest in sustainability (Dhanda, Shroitryia, 2021).

A definition of sustainability was developed by the World Commission on Environmental Development, according to which it is development aimed at meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environmental Development, 1987, p. 41). This has given rise to many different concepts such as sustainability management, sustainable innovation, sustainable entrepreneurship or corporate sustainability at the organisational level (Dyllick, Hockerts, 2002; Schaltegger, Wagner, 2011). According to Bocken et al. (2014), eight standards can be used to develop a business model for sustainability. These include maximising material and energy efficiency, utilising waste, substituting renewable energy sources and natural processes, emphasising the functionality of products and services, taking a leadership role, encouraging sufficiency, repurposing business for society and the environment, and developing scaled solutions. Oskam et al. (2018) pointed out that the role of the manager has an important tide in the process of changing a business model to a sustainable one, and according to Kurucz et al. (2017), relational leadership processes help organisations to implement their sustainability ideas.

Companies often invest in sustainability for charitable reasons or to protect their income. In particular, corporate social responsibility (CSR) facilitates a company's competitive positioning (as a result of generating reputational capital that can be used as a bargaining chip to negotiate more favourable commercial agreements), increase customer satisfaction and thereby retain customers. In addition, CSR can facilitate access to new capital and financial

opportunities or cost-cutting options by mitigating risk and having a positive impact on employee productivity and morale. As a company's operations affect its counterparties, it needs to meet their needs in order to fulfil its obligations. For this to happen, CSR initiatives must be integrated into corporate decisions and resource allocation (Genedy, Sakr, 2017; Gamal et al. 2022). Due to constant technological change, companies need to make strategic decisions to maintain their competitive position and optimise investments in CSR as well as sustainability initiatives. This depends primarily on the availability of resources in the industry as well as the phase of the company's life cycle. Consequently, a company's actions must take into account the social and environmental background. This is required for long-term profitability, determined by the CSR activities and the life cycle phase of the company. Therefore, the life cycle of a company is characterised by a set of internal and external factors that must be taken into account at each stage (Elsayed 2015; Hasan et al., 2018; Wahba, Elsayed, 2015).

The area of CSR is of academic interest to many national and international academic centres. The literature emphasises that CSR improves corporate image, fosters positive brand attitudes and enhances customer loyalty therefore it is used by many brands across product categories. Competing for a limited number of socially conscious consumers and the emergence of new generations on the market necessitate the continuous addition of knowledge regarding consumers' perception of CSR activities. These findings are relevant for managers in charge of sustainability campaigns.

In the context of the issues presented, this paper attempts to:

- identify the type of sustainable development activities undertaken by selected clothing brands,
- assess the pro-environmental and pro-social attitudes of young consumers purchasing clothes,
- determine whether environmental and social aspects are a criterion for clothing choice among young consumers.

2. Subject and research methodology

The research was conducted in two stages. In the first stage of the research, messages posted on the websites of selected clothing brands (Zara, H&M, Reserved, Sinsay, Mohito, Cropp, House) were analysed from the point of view of their sustainability activities. In the second stage, a pilot study was conducted among young consumers purchasing the selected clothing brands (n = 218). A non-probabilistic sampling technique was used - convenience sampling. The research was conducted using an online indirect survey measurement method, using a survey questionnaire hosted on Google Form. The questionnaire consisted of two thematic blocks. The first part referred to the assessment of consumers' pro-environmental and pro-social

attitudes. The second part of the questionnaire referred to the selection criteria for clothing. The list of choice determinants used in the study was created on the basis of an analysis of the results of a previously conducted qualitative study, which used open-ended questions adapted from Green and Pelozo's (2011) study. In the research conducted, the respondent expressed their level of approval or disapproval, in relation to the statements posted using a 7-point Likert scale, with strong disagreement with the statement corresponding to a rating of 1 and strong agreement with it corresponding to a rating of 7.

The results were subjected to statistical analysis using Statistica 13.3 software. The following were used to interpret the results:

- central trend measures: arithmetic mean (\bar{x}), median (M), mode (Me),
- dispersion measure: standard deviation (SD),
- shape measure: skewness (S), kurtosis (K),
- percentage distribution of individual scores (% selected: N – negative, A – neutral/ambivalent, P – positive).

3. Results and discussion

3.1. Sustainability measures by selected clothing brands - case studies

In order to identify actions taken by clothing brands for sustainable development, the following brands were selected: Zara, H&M, LPP (Reserved, Sinsay, Mohito, Cropp, House).

It was found that the range of activities carried out by the selected brands as part of the implementation of their CSR strategy, is very broad. Brands build their positive image based on activities concerning consideration of social interests and environmental aspects.

The marketing communication of the Zara brand shows that it implements socially engaged marketing tools. It works to reduce the environmental impact of its products from the beginning of their life cycle. This is done through the successive monitoring of raw materials and the introduction of new sustainable production processes that guarantee safety for customers. The Join Life Standard created is based on the High Index, which helps to assess the social and environmental impact of the textile industry. Production is carried out through the use of technologies such as care for fibre, care for water and care for planet. The use of technologies from renewable energy sources enables the brand to introduce sustainable processes. Zara promotes the use of organic farming systems that protect the environment. The organic cotton used in the production of the clothes is obtained using sustainable cultivation techniques, which reduces water, gas emissions. The brand uses the Better Cotton label, which communicates the sustainability of cotton grown by farmers who have been certified by the

Better Cotton Initiative. Zara has implemented the Organic Content Standard (OCS) and the Global Content Standard (GOTS). This certification is issued by an organisation that teaches farmers to work with dignity, manage water and care for nature. Zara clothing is made from raw materials that come from sustainably managed forests (lyocell, viscose, modal). The production of lyocell is done in a closed loop, allowing water to be reused, while the production of viscose follows the EU BAT (Best Available Techniques) environmental standards set by the European Union, supporting the Roadmap Towards Responsible Viscose and Modal Fibre Manufacturing initiative implemented by Changing Markets. Zara collaborates in the textile sector with the organisation Conopy to jointly promote the production of artificial silk or viscose with respect for primary forests. Zara also uses recycled materials for its garments. It is a priority for Zara to use sustainable materials, to recycle them afterwards and to adopt practices that ensure animals live with dignity. Together with PETA, Zara has committed to not using angora wool, mohair. As members of the Fur Free Retailer programme implemented by the Fur Free Alliance, the brand does not use animal fur in its production. As part of its use of sustainable materials, the company uses recycled paper and cardboard for its packaging. The brand is committed to the safety and health of its customers. A list of Inditex-approved chemical products has been created to ensure the health safety of users. The idea of sustainable production is central to the company, which is why it is constantly training its teams and suppliers in raw materials and technology to minimise their environmental impact. In addition, the sustainable innovation hub initiative has been launched. This is a collaborative platform for identifying technological innovations in areas such as the re-use of raw materials, their traceability, their renewable origin and the development of new technologies to reduce water consumption, energy and the use of chemical products. In addition, the company is working with suppliers, employees, trade unions and international bodies to develop a supply chain in which human rights are respected and promoted, contributing to the UN Sustainable Development Goals.

An analysis of the information on H&M's website shows that the brand is committed to the idea of conscious, whereby products are made with respect for society and the planet. Conscious clothing is made up of at least half of environmentally friendly materials, such as organic cotton or recycled polyester. As part of the idea, customers can bring in unused clothes and exchange them for conscious points, which are exchanged for discounts on purchases made in the H&M shop. The cotton used by H&M is natural, renewable and biodegradable. Organic cotton requires 62% less energy and 91% less water than conventional cotton and is GMO-free. The use of recycled cotton reduces textile waste and the amount of virgin raw materials used. It also uses cotton sourced through the Better Cotton Initiative programme, which reduces the use of artificial fertilisers and cares for workers. H&M wants to help customers in the process of making informed purchasing choices by demonstrating the environmental impact of products and materials. The Higg Index Sustainability Profile programme has been launched. The brand is improving its work to develop more sustainable production, delivery and packaging methods.

The company provides training to employees on how to minimise water consumption. H&M uses Screened Chemistry, which allows the use of sustainable chemicals, thereby reducing harmful substances right from the design stage. The brand only uses biodegradable packaging. Sustainable environmental efforts also extend to transport. H&M has adopted the Maersk initiative, which is responsible for inventing a 'carbon-neutral ocean product', a biofuel blend to replace fossil fuel and reduce emissions from shipping.

The brand is keen to ensure that all workers involved in the production of clothing have safety, equal opportunities, decent working conditions. A supplier wishing to work with the brand must sign a Sustainability Commitment, according to which fair wages, decent working conditions, respect for animals are to be respected. Suppliers must adhere to strict rules prohibiting forced labour and child labour.

An analysis of the messages posted on the website of the Polish clothing manufacturer LPP, which manages brands such as Reserved, Mohito, House, Cropp and Sinsay, showed that the company meets the UN Sustainable Development Goals 2015-2030. The company implements new solutions from the collection design stage, through the selection of raw materials, cooperation with suppliers, logistics, to pro-environmental solutions in showrooms and e-commerce channels. In addition, it pursues pro-environmental goals regarding the management of daily office operations. LPP has developed a proprietary Eco Aware Production programme, focusing on supporting suppliers in implementing best practices to reduce the consumption of natural resources. LPP is the first Polish company to join the Zero Discharge of Hazardous Chemicals (ZDHC) Agreement, which strives for chemical safety in clothing production. By 2025, LPP is to significantly reduce energy consumption in its stationary shops, and green energy is to be used to operate its online shops. The company is also taking action on social issues as part of its sustainable development. The company raises the qualifications of its employees and supports employee volunteering, takes care to respect human rights, employee rights and supplier safety. LPP implements the idea of sustainable development among consumers by promoting responsible consumption. The collection of second-hand clothing, which is donated to the needy, allows the company to fulfil its social mission and reduce its environmental impact.

The clothing industry is one of the sectors that has a significant negative impact on the environment and is the most challenging industry in terms of sustainability. Although sustainability requires companies to have a positive impact on the environment and society and not only focus on economic performance, the environmental aspect is usually the most analysed in the literature (Bernardi et al., 2022). According to available research, there is a strong link between sustainability and innovation. Sustainability requires new ways of thinking, new products, processes and business models aimed at achieving economic, social and environmental benefits while ensuring that meeting today's needs does not limit the range of economic, social and environmental opportunities available for future generations. When it comes to sustainable innovation, the textile industry is a good research context, as it is one of

the most complex and least researched sectors (Scuotto et al., 2020; Macchion et al., 2017). Although sustainability is mainly analysed by looking at the environmental performance generated by companies, it is a complex and multidimensional concept that includes social and economic aspects, as summarised in the Triple Bottom Line (TBL). This means that a sustainable enterprise makes choices to reduce the environmental impact of its production activities, to rationalise its production processes, to reduce waste, and to design and produce items that, due to the raw materials and production processes used, do not have an unduly negative impact on the environment. However, a sustainable company is one that also respects the health and rights of workers and consumers and creates transparent links with the communities concerned (Tartaglione et al., 2012). The need for more sustainable production in the garment industry emerged in the 1960s, when consumers began to be aware of the environmental impact of garment production (Jung, Jin, 2014), but became more important after the Rana Plaza factory accident. Its collapse in Bangladesh in 2013 led to the deaths of more than 1,000 people and heightened interest in sustainability and ethics in the garment textile industry, mainly focusing on increasing supply chain control and transparency throughout the production process (Jung, Jin, 2014). For the textile industry, characterised by outsourcing and relocation, the concept of sustainability should start with improving working conditions (Da Giau et al., 2016). The literature still lacks comprehensive research results on the implementation of sustainability concepts and CSR in the apparel industry (Bernardi et al., 2022; Pavione et al., 2016). Also, when it comes to developing sustainable innovations, the textile industry is among the most challenging and least addressed industries (Macchion et al., 2017). The clothing industry is characterised by high demand uncertainty and constant fluctuations in consumer expectations and trends. Consequently, process innovation is key to gaining a significant foothold in the industry by creating an agile supply chain capable of responding to changes in consumer needs (Jin et al., 2019).

3.2. Pro-environmental and pro-social attitudes and behavior – consumer research

Table 1 presents results relating to pro-environmental and pro-social attitudes of young consumers purchasing clothing brands, i.e. (Zara, H&M, Reserved, Sinsay, Mohito, Cropp, House). Analysis of the measures of the shapes of the distributions of the obtained results showed that in all cases the values of skewness and kurtosis were within the range from -1 to 1. This suggests that the distributions of the variables did not deviate significantly from the normal distribution. The distributions of the data were approximately symmetrical or moderately skewed. Descriptive statistics such as mean and standard deviations (in addition to the median) are therefore reasonably relevant for interpreting the data obtained. The study found that the vast majority of young consumers (approximately 75%) are sensitive to environmental and ethical issues (mean scores were at levels of respectively: 6.51, M = 6, Mo = 6 and 6.18, M = 6, Mo = 6). An overwhelming majority of respondents believed (c. 84%) that companies should engage pro-environmentally and socially (M = 6, Mo = 6). According to the majority of

respondents (c. 84%), the social involvement of companies influences the positive image and popularity of their products. Furthermore, in the opinion of respondents, companies should clearly communicate to consumers that they participate in social and environmental initiatives (mean score was 6.19, M = 6, Mo = 6). When analysing the pro-environmental behaviour of young consumers, it was noted that 79% of respondents try to choose environmentally friendly clothing. Approximately 76% of respondents, by buying products whose manufacturers support social initiatives, feel that they are socially responsible, care about the environment and contribute to helping others. In turn, about 57% of consumers take social information into account when buying clothes and about 60% buy fair trade products, the production of which ensures decent working and pay conditions. The research showed that just over half of the total respondents (53%) are willing to pay a higher price for clothing brands involved in philanthropic (mean score 5.92, M = 5, Mo = 5) and pro-environmental activities (mean score 5.76, M = 5, Mo = 6).

Table 1.

Pro environmental and prosocial attitudes of young consumers

Variables	X	SD	M	Mo	S	K	Percentage of responses		
							N	A	P
I am sensitive to environmental issues	6,51	1,62	6	6	0,52	-0,75	14,79	9,21	76,00
I think of myself as someone who is concerned about ethical issues	6,18	1,81	6	6	0,65	-0,89	12,46	12,44	75,10
The actions of environmentally committed businesses are important to me	6,25	1,79	5	5	0,65	-0,54	19,83	13,82	66,35
I value the products of brands that engage in social campaigns	6,12	1,59	6	6	-0,01	-0,96	11,07	12,90	76,03
I believe that businesses should engage in pro-environmental and philanthropic activities	6,51	1,44	6	6	0,55	-0,60	8,31	7,83	83,86
In my opinion, the involvement of brands in philanthropic and pro-environmental campaigns should be a more frequent phenomenon	6,69	1,90	6	6	0,99	0,69	7,84	11,06	81,10
I believe that social involvement of companies influences the positive image and popularity of their products	6,67	1,55	6	6	0,55	-0,60	8,77	6,91	84,32
I think that companies/brands should clearly communicate to consumers that they participate in social and environmental initiatives	6,19	1,88	6	6	0,10	-0,90	11,07	8,75	80,18
I try to choose clothes that are environmentally friendly	6,04	1,83	6	6	0,24	-0,90	12,46	8,75	78,79
When buying clothes, I take into account product information on social issues	5,41	1,79	5	5	0,15	-0,98	31,35	11,52	57,13

Cont. table 1.

By buying products whose producers support social initiatives, I feel socially responsible, care about the environment, and contribute to helping others	5,61	1,48	5	5	0,88	-0,36	14,22	9,67	76,02
I buy fair trade products, where fair working and pay conditions are guaranteed	5,03	1,68	5	5	0,73	-0,46	14,76	24,88	60,36
I am prepared to pay a premium price for goods whose producers are involved in philanthropic activities	5,92	1,92	5	5	0,88	-0,36	25,37	22,11	52,53
I am prepared to pay a premium price for goods whose producers are involved in environmental activities	5,76	1,98	5	5	0,21	-0,94	23,94	20,73	55,28

x – arithmetic mean, M – median, Mo – mode, SD – standard deviation, S – skewness, K – kurtosis, N – negative responses, A – neutral/ambivalent responses, P – positive responses.

Source: own research results.

Data published in the literature shows that CRM activities result in consumers having a more positive attitude towards a company, being more likely to purchase its products and, therefore, making the company more profitable (Robinson et al., 2012; Qamar 2013). A published report by Nielsen Global Research (2014) found that more than half (55%) of consumers surveyed worldwide were willing to pay extra for a company's products and services if it was socially and environmentally committed. As a result, 4900 companies located in 49 countries worldwide (KPMG, 2017) participate in corporate social responsibility, publishing reports that reveal their social responsibility activities towards society at large.

Research on the socially engaged consumer has shown the importance of psychographic characteristics in profiling CRM advocates. Consumer attitudes towards engagement marketing activities were found to be significantly related to feelings of personal and social responsibility (Youn, Kim, 2008). Furthermore, the literature suggests that a significant moderator of CRM effectiveness is consumers' altruistic attitudes (Vlachos, 2012). In the context of CRM, altruism is considered a key factor in encouraging consumers to support social causes and become socially responsible members of society (Adomaviciute et al., 2016). In studies, altruism has been proven to influence consumers' attitudes towards a socially engaged company and to strengthen emotional attachment to CRM campaigns. It has been found that when consumers have a positive attitude towards a brand that implements CRM, they show a high intention to purchase it, and the relationship between brand attitude and purchase intention becomes stronger the more consumers are involved in social initiatives (Patel et al., 2017). It has also been found (Gupta, Pirsch, 2006) that when consumers perceive a brand's altruistic motivation to unify with a social initiative, their willingness to support it becomes much stronger, and this in turn allows consumers to adopt positive attitudes towards the sponsoring brand. Research among Polish consumers shows that women are more in favour of social issues than men.

Consumers, especially young consumers, show strong anxiety towards social issues. Consumers prefer to support activities related to helping children (Witek, 2015).

Table 2 evaluates the factors that are important when young consumers choose clothing. Analysing obtained results, it was found that for the young consumer (about 94% of the respondents), the functional value related to quality is the most important factor when purchasing clothing (mean score 6.67, M = 7, Mo = 7). Price (mean score 6.54, M = 6, Mo = 6) and promotion (mean score 6.17, M = 6, Mo = 6) also rank high in the hierarchy of factors. Branding and fashion/trend are important to around 72% of respondents. Slightly more than half of the respondents (about 58% of indications) pay attention to whether the products they purchase are environmentally friendly (mean score 5.25, M = 5, Mo = 5). When analysing social value as a criterion for product selection, it was found that the producer's involvement in charitable activities is only important for about 38% of consumers when purchasing food products.

Table 2.

Consumer assessment of values relevant to clothing choice

Variables	X	SD	M	Mo	S	K	Percentage of responses		
							N	A	P
Quality	6,67	1,02	7	7	0,18	0,54	2,30	3,22	94,48
Price	6,54	1,07	6	6	0,22	0,58	6,90	2,76	90,34
Promotion	6,17	1,53	6	6	0,37	-0,63	9,20	6,45	84,35
Brand	5,94	1,34	5	5	-0,44	-0,94	18,42	9,21	72,37
Fashion/trends	5,53	1,44	5	5	-0,48	-0,87	18,88	8,75	72,37
Country of origin	5,24	1,59	5	5	0,16	-0,92	32,22	13,36	54,42
Product composition	5,77	1,15	5	5	-0,13	-0,86	21,20	10,42	68,38
Environmentally friendly product	5,25	1,34	5	5	-0,71	-0,52	23,80	18,43	57,77
The manufacturer's commitment to charity	4,01	1,66	3	3	-0,97	-0,28	49,15	12,35	38,50

x – arithmetic mean, M – median, Mo – mode, SD – standard deviation, S – skewness, K – kurtosis, N – negative responses, A – neutral/ambivalent responses, P – positive responses.

Source: own research results.

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Although sustainability is mainly analysed by looking at the environmental performance generated by companies, it is a complex and multidimensional concept that includes social and economic aspects, as summarised in the Triple Bottom Line (TBL). This means that a sustainable enterprise makes choices to reduce the environmental impact of its production activities, to rationalise its production processes, to reduce waste, and to design and produce items that, due to the raw materials and production processes used, do not have an unduly negative impact on the environment. However, a sustainable company is one that also respects the health and rights of workers and consumers and creates transparent links with the communities concerned (Tartaglione et al., 2012). The need for more sustainable production in the garment industry emerged in the 1960s, when consumers began to be aware of the environmental impact of garment production (Jung, Jin, 2014), but became more important after the Rana Plaza factory accident. Its collapse in Bangladesh in 2013 led to the deaths of more than 1,000 people and heightened interest in sustainability and ethics in the garment textile industry, mainly focusing on increasing supply chain control and transparency throughout the production process (Jung, Jin, 2014). For the textile industry, characterised by outsourcing and relocation, the concept of sustainability should start with improving working conditions (Da Giau et al., 2016). The literature still lacks comprehensive research results on the implementation of sustainability concepts and CSR in the apparel industry (Bernardi et al., 2022; Pavione et al., 2016). Also, when it comes to developing sustainable innovations, the textile industry is among the most challenging and least addressed industries (Macchion et al., 2017). The clothing industry is characterised by high demand uncertainty and constant fluctuations in consumer expectations and trends. Consequently, process innovation is key to gaining a significant foothold in the industry by creating an agile supply chain capable of responding to changes in consumer needs (Jin et al., 2019).

Conclusions

With global brands spreading their innovative solutions in the business world, sustainable practices are becoming a reality and more consumers should pay attention to the social and environmental aspects of their activities. The study found that young consumers have positive pro-environmental and pro-social attitudes. In the opinion of the overwhelming majority of respondents, the social involvement of companies influences the positive image and popularity of their products. Nevertheless, almost half of the total number of consumers presented an ambivalent or negative attitude towards incurring higher costs for purchasing goods whose producers are involved in philanthropic and pro-environmental activities. This suggests that, in the view of this segment of respondents, it is the producers who should take financial responsibility for their actions by not raising the prices of the offered products.

The results of the survey indicate that concern for others by purchasing socially committed brands and the environmental friendliness of the product have lower rankings in the hierarchy of other clothing choice factors, especially functional values. This indicates that these values are secondary benefits in the decision-making process of young consumers.

The study presented here has some limitations. The research was conducted on a narrow subject basis, so the results obtained cannot be generalised to the segment of young consumers. The scope of the presented research is also limited. Further research is needed to establish the profile of the socially responsible consumer, taking into account psychographic characteristics and features resulting from the social structure. Future research would also need to establish the relationship between consumers' attitudes towards sustainability and their actual behaviour.

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References

1. Adomaviciute, K., Bzikadze, G., Cherian, J., Urbonavicius, S. (2016). Cause-Related marketing as a commercially and socially oriented activity: what factors influence and moderate the purchasing? *Engineering Economics*, 27, pp. 578-585, doi: <https://doi.org/10.5755/j01.ee.27.5.15166>.
2. Azizi, M., Mohebbi, N., De Felice, F. (2016). Evaluation of sustainable development of wooden furniture industry using multi criteria decision making method. *Agriculture and Agricultural Science Procedia*, No. 8, pp. 387-394, doi: 10.1016/j.aaspro.2016.02.033.
3. Bernardi, A., Cantù, C.L., Cedrola, E. (2022). Key success factors to be sustainable and innovative in the textile and fashion industry: Evidence from two Italian luxury brands. *Journal of Global Fashion Marketing*, Vol. 13, No. 2, pp. 116-133, doi: 10.1080/20932685.2021.2011766.
4. Bocken, N.M.P., Short, S.W., Rana, P., Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, No. 65, pp. 42-56, doi: 10.1016/j.jclepro.2013.11.039.

5. Da Giau, A., Macchion, L., Caniato, F., Caridi, M., Danese, P., Rinaldi, R., Vinelli, A. (2016). Sustainability practices and web-based communication: An analysis of the Italian fashion industry. *Journal of Fashion Marketing and Management, Vol. 20, No. 1*, pp. 72-88, doi: <https://doi.org/10.1108/JFMM-07-2015-0061>.
6. Dhanda, U., Shroitryia, V.K. (2021). Corporate sustainability: the new organizational reality. *Qualitative Research in Organizations and Management, Vol. 16, No. 3/4*, pp. 464-487, doi: <https://doi.org/10.1108/QROM-01-2020-1886>.
7. Dou, Y., Li, Y., Dong, K., Ren, X. (2021). Dynamic linkages between economic policy uncertainty and the carbon futures market: does COVID-19 pandemic matter? *Resources Policy, Vol. 75, No. 102455*, pp. 1-14, doi: <https://doi.org/10.1016/j.resourpol.2021.102455>.
8. Dyllick, T., Hockerts, K. (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment, Vol. 11*, pp. 130-141, doi: 10.1002/bse.323.
9. Elsayed, K. (2015). Corporate social responsibility: Does inventory management matter? *International Journal of Supply Chain and Operations Resilience, Vol. 1, No. 2*, pp. 139-156, doi: <https://doi.org/10.1504/IJSCOR.2015.069925>.
10. Farah, T., Li, J., Li, Z., Shamsuddin A. (2021). The non-linear effect of CSR on firms' systematic risk: international evidence. *Journal International Financial Markets, Institutions and Money, Vol. 71, No. 101288*, pp. 1-15, doi: <https://doi.org/10.1016/j.intfin.2021.101288>.
11. Gamal, L., Wahba, H., Correia, M.R. (2002). Corporate sustainability performance throughout the firm life cycle: case of Egypt. *Corporate Governance and Organizational Behavior Review, Vol. 6, No. 1*, pp. 79-97, doi: <https://doi.org/10.22495/cgobrv6i1p6>.
12. Genedy, A., Sakr, A. (2017). The relationship between corporate social responsibility and corporate financial performance in developing countries. Case of Egypt. *International Journal of Business and Economic Development (IJBED), No. 5(2)*. Retrieved from: <https://www.ijbed.org/details&cid=144>.
13. Green, T., Pelozo, J. (2011). How does corporate social responsibility create value for consumers? *Journal of Consumer Marketing, 28*, p. 55, doi: 10.1108/07363761111101949.
14. Gupta, S., Pirsch, J.A. (2006). Taxonomy of Cause-Related Marketing Research: Current Findings and Future Research Directions. *Journal of Nonprofit and Public Sector Mark, 15*, pp. 25-43, doi: https://doi.org/10.1300/J054v15n01_02.
15. Hasan, I., Kobeissi, N., Liu, L., Wang, H. (2018). Corporate social responsibility and firm financial performance: The mediating role of productivity. *Journal of Business Ethics, Vol. 149, No. 3*, pp. 671-688, doi: <https://doi.org/10.1007/s10551-016-3066-1>.
16. Jin, B.E., Cedrola, E., Kim, N.L. (2019). Process innovation: Hidden secret to success and efficiency. In B. Jin, E. Cedrola (Eds.), *Process innovation in the global fashion industry* (pp. 1-23), doi: https://doi.org/10.1057/978-1-137-52352-5_1.

17. Jung, S., Jin, B. (2014). A theoretical investigation of slow fashion: Sustainable future of the apparel industry. *International Journal of Consumer Studies*, Vol. 38, No. 5, pp. 510-519, doi: <https://doi.org/10.1111/ijcs.12127>.
18. KPMG (2017). *The KPMG Survey of Corporate Responsibility Reporting 2017*. <https://home.kpmg/xx/en/home/insights/2017/10/the-kpmg-survey-of-corporate-responsibility-reporting-2017.html>, 11.10.2021.
19. Kurucz, E.C., Colbert, B.A., Lüdeke-Freund, F., Upward, A., Willard, B. (2017). Relational leadership for strategic sustainability: Practices and capabilities to advance the design and assessment of sustainable business models. *Journal of Cleaner Production*, No. 140, pp. 189-204, doi: <https://doi.org/10.1016/j.jclepro.2016.03.087>.
20. Macchion, L., Moretto, A., Caniato, F., Caridi, M., Danese, P., Spina, G., Vinelli, A. (2017). Improving innovation performance through environmental practices in the fashion industry: The moderating effect of internationalisation and the influence of collaboration. *Production Planning and Control*, Vol. 28, No. 3, pp. 190-201, doi: <https://doi.org/10.1080/09537287.2016.1233361>.
21. Nathaniel, S.P., Murshed, M., Bassim, M. (2021). The nexus between economic growth, energy use, international trade and ecological footprints: the role of environmental regulations in N11 countries. *Energy, Ecology and Environment*, No. 6, pp. 496-512, doi: <https://doi.org/10.1007/s40974-020-00205-y>.
22. Nielsen Global Research (2014). *Doing Well by Doing Good*. <https://www.nielsen.com/us/en/insights/report/2014/doing-well-by-doing-good/>, 11.05.2021.
23. Oskam, I., Bossink, B., de Man, A.P. (2018). The interaction between network ties and business modeling: Case studies of sustainability-oriented innovations. *Journal of Cleaner Production*, No. 177, pp. 555-566, doi: <https://doi.org/10.1016/j.jclepro.2017.12.202>.
24. Patel, J.D., Gadhavi, D.D., Shukla, S.Y. (2017). Consumers' Responses to Cause Related Marketing: Moderating Influence of Cause Involvement and Skepticism on Attitude and Purchase Intention. *International Review in Public Nonprofit Marketing*, 14, pp. 1-18, doi: [10.1007/s12208-016-0151-1](https://doi.org/10.1007/s12208-016-0151-1).
25. Pavione, E., Pezzetti, R., Matteo, D.A. (2016). Emerging competitive strategies in the global luxury industry in the perspective of sustainable development: The case of Kering group. *Management Dynamics in the Knowledge Economy*, Vol. 4, No. 2, pp. 241-261. <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjanMWJyPn0AhVQzKQKHeNnCIIQFnoECAwQAQ&url=http%3A%2F%2Fwww.managementdynamics.ro%2Findex.php%2Fjournal%2Farticle%2Fdownload%2F162%2F125&usg=AOvVaw2vA2WudfK5kB41kAawiuee>.
26. Qamar, N. (2013). Impact of cause related marketing on consumer purchase intention: mediating role of corporate image, consumers' attitude and brand attractiveness'. *Middle-*

- East Journal of Scientific Research*, 16, pp. 633-643 doi: 10.5829/idosi.mejsr.2013.16.05.11846.
27. Ren, X., Cheng, C., Wang, Z., Yan, C. (2021). Spillover and dynamic effects of energy transition and economic growth on carbon dioxide emissions for the European Union: a dynamic spatial panel model. *Sustainable Development*, Vol. 1, No. 29, pp. 228-242, doi: 10.1002/sd2144.
 28. Ren, X., Li, Y., Shahbaz, M., Dond, K., Lu, Z. (2022). Climate risk and corporate Environmental Performance: Empirical evidence from China. *Sustainable Production and Consumption*, No. 30, pp. 467-477, doi: <https://doi.org/10.1016/j.spc.2021.12.023>.
 29. Robinson, S.R., Irmak, C., Jayachandran, S. (2012). Choice of cause in cause-related marketing. *Journal of Marketing*, 4, pp. 126-139.
 30. Ruan, X., Ding, N., Yang, J. (2022). Dual-level eco-efficiency analysis in sustainable management: An empirical study on textile manufacturers and supply chains in China. *Journal of Environmental Management*, No. 304, pp. 1-11, doi: 10.1016/j.jenvman.2021.114227.
 31. Schaltegger, S., Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business Strategy and the Environment*, Vol. 20, pp. 222-237, doi: <https://doi.org/10.1002/bse.682>.
 32. Scuotto, V., Garcia-Perez, A., Cillo, V., Giacosa, E. (2020). Do stakeholder capabilities promotesustainable business innovation in small and medium-sized enterprises? Evidence from Italy. *Journal of Business Research*, No. 119, pp. 131-141, doi: <https://doi.org/10.1016/j.jbusres.2019.06.025>.
 33. Tartaglione, C., Gallante, F., Guazzo, G. (Eds.) (2012). *Sostenibilit : Moda. Cosa significa, Comesi applica, Dove sta andando l'idea di sostenibilit  nel sistema moda*. ARES 2.0.
 34. Vlachos, P.A. (2012). Corporate Social Responsibility and Consumer-Firm Emotional Attachment: Moderating Effects of Consumer Traits. *European Journal of Marketing*, 46, pp. 1559-1581, doi: 10.1108/03090561211259989.
 35. Wahba, H., Elsayed, K. (2015). The mediating effect of financial performance on the relationship between social responsibility and ownership structure. *Future Business Journal*, Vol. 1, No. 1-2, pp. 1-12, doi: <https://doi.org/10.1016/j.fbj.2015.02.001>.
 36. Witek, L. (2015). Implementacja Cause Related Marketing – korzyści i warunki tworzenia skutecznych programów. *Logistyka*, 2, pp. 1633-1639.
 37. World Commission on Environmental Development (1987). *Our Common Future*. Oxford: Oxford University Press.
 38. Youn, S., Kim, H. (2008). Antecedents of Consumer Attitudes toward Cause-Related Marketing. *Journal of Advertising Research*, 48, pp. 123-137, doi: 10.2501/S0021849908080136.

KEY ACTIVITIES OF DIGITAL TRANSFORMATION - COMPARATIVE ANALYSIS OF SELECTED MODELS

Jakub SEMRAU^{1*}, Mateusz ZACZYK²

¹ Silesian University of Technology, Faculty of Organization and Management; jakub.semrau@polsl.pl,
ORCID: 0000-0002-4894-7792

² Silesian University of Technology, Faculty of Organization and Management; mateusz.zaczyk@polsl.pl,
ORCID: 0000-0002-3206-4784

* Correspondence author

Purpose: Systematization of knowledge in the field of defining and occurrence of key activities that make up the overall concept of digital transformation with an indication of the key stages of its implementation. In addition, the aim of the article is also to conduct a comparative analysis of selected models of digital transformation in terms of a number of criteria, such as: the degree of concentration of the model on the selected sector of the economy, the degree of concentration on digital competences, the degree of focus on management concepts, the degree of concentration on digital transformation tools, the degree of focus on the digital maturity of the organization.

Design/methodology/approach: The objectives of the article were achieved through an in-depth analysis of the literature on the subject in the field of models of digital transformation emphasizing the stages of its course. The article presents a comparative analysis of models selected in preliminary studies developed by consulting companies and models created as a result of research works by other scientists.

Findings: The authors of the article compared the existing models of digital transformation and suggested the need to develop a new model using the partial advantages of the compared models. The authors also indicated a gap in the need to implement a component emphasizing the importance of managing resistance to changes in the organization.

Originality/value: The originality of the article consists in drawing a conclusion in the form of a suggestion of the need to develop work in the field of modeling the digital transformation process in the context of the theory of organizational change, with particular emphasis on key competences, focus on methods and resistance to changes in an organization wishing to go through the digital transformation process.

Keywords: digital transformation, stages of digital transformation, digital transformation models, digital transformation tools.

Category of the paper: literature review.

1. Introduction

Digital transformation in the current literature is referred to as disruptive or incremental change process. It starts with the adoption and use of digital technologies, then evolving into an implicit holistic conversion of an organization, or deliberate in pursuing value creation. Digital transformation is a new concept frequently used by practitioners and academics, but which changes form very often depending on the context in which it is used. The term "digital transformation" is very widely used, very often wrongly, because there is no specific definition in the literature. Many authors have tried to define it and discuss its concept. In the course of preliminary literature research carried out by the authors of this publication, a need has been noticed to systematize the knowledge in the field of defining and occurring key activities that make up the overall concept of digital transformation with an indication of the key stages of its implementation, was noticed. The main aim of the article is an attempt to systematize the course of digital transformation in the form of a set of stages and related methods and tools.

The main goal of this publication is to make an attempt to systematize the available literature on the key activities of digital transformation embedded in the Industry 4.0 concept. The authors, conducting a literature review, compared a number of digital transformation models in terms of its key stages and tools used at individual stages of digital transformation.

Numerous scientific publications in the subject area indicate a phased course of the digital transformation process (Catlin et al., 2017; Bechtold et al., 2021; Schallmo et al., 2016). Some of them present models of digital transformation from the perspective of conducted scientific research, while some describe models created in the course of the work of consulting companies. This dualism suggests the need to consider the similarities and differences within the presented models. Some models postulate the need to implement various tools aimed at the development of digital competences (Brunelli et al., 2017; Pessl et al., 2017). The ambiguity of approaches to the issues of the tools used, the issue of focusing the presented models on particular market areas, and thus - the universality of digital transformation models, led to the research questions of this article:

RQ1: "Is it possible to define a universal model for the course of digital transformation taking into account its key stages and sets of tools used at each stage based on the currently available digital transformation models?"

RQ2: "Are there a distinctive set of components of digital transformation models presented by consulting companies and models developed within the scientific community?"

Answers to the above research questions will be sought through a comparative analysis of existing models, taking into account two proprietary sets of comparison criteria. The first one will be focused on the universality of the model, the second - on issues related to the theory of changes in the organization.

2. Materials and methods

A systematic literature review - in particular bibliometrics - was carried out for research from the last 10 years on the construction of digital transformation models. The first step was to analyse publications included in the Scopus database. However, for a comprehensive study, the analysis was deepened to include the Web from Science database.

The following queries were run on 30 October 2022:

- WoS: TOPIC: ("digital transformation models"); Timespan: 2012-2022. Indexes: SCIEXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCREXPANDED, IC.
- Scopus: TITLE-ABS-KEY ("digital AND transformation AND model") AND (LIMIT-TO (PUBYEAR, 2022) OR (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIM-IT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012)).

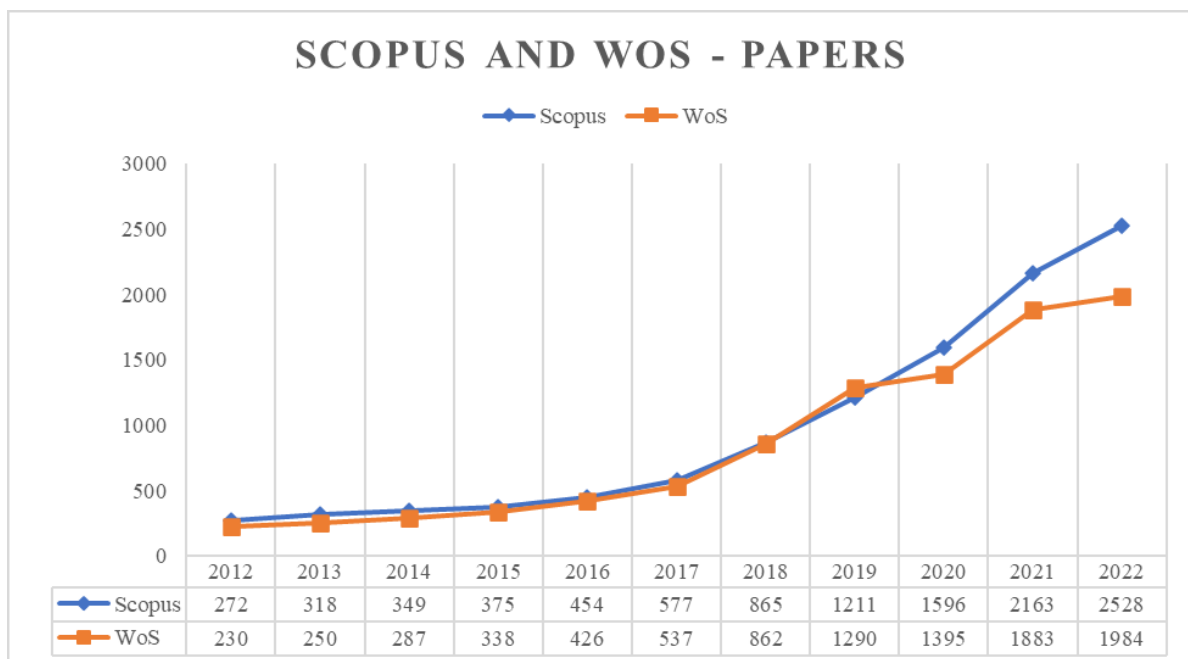


Figure 1. Publication of articles in each year for Scopus and WoS databases.

Source: own study

Figure 1 shows the upward trend in the number of publications on the topic under review. According to the authors, there is a lack of comprehensive comparative analyses of digital transformation models.

3. Defining digital transformation – literature review

Digital transformation is a new concept that has gained great popularity among practitioners and researchers over the last few years. In constant evolution, we are witnessing a real revolution introduced by enterprises and organizations. To fully understand the concept of digital transformation, we should first define and differentiate between the terms Digitization, digitalization, and digital transformation. There is some confusion in the application of these concepts in the scientific community, as most researchers in the world use these terms interchangeably, when in fact there is a significant difference between them. It is very important to distinguish between these three terms. Indeed, digitization means converting from analogue to digital information language. It is a presentation of information in any computer system. For example, we can scan a photo with a scanner to save it to a digital file (Mahrez et al., 2019).

While Digitalization means the use of digital data and technology to optimize processes and automate data handling. It defines the use of a computer system for semi-automatic or full process automation. From a certain point of view, computerization is a term akin to digitization and is sometimes considered a synonym (Schwertner, 2017).

Digital transformation is a new concept frequently used by practitioners and academics, but which changes form very often depending on the context in which it is used. The term "digital transformation" is very widely used, very often wrongly, because there is no specific definition in the literature. Many authors have tried to define it and discuss its concept (Majchrzak, 2016).

The Table 1 shows various definitions of digital transformation used in the literature.

Table 1.
Definitions of digital transformation used in literature

ID	Source	Definition
1.	Henriette et al. (2016)	The digital transformation is a disruptive or incremental change process. It starts with the adoption and use of digital technologies, then evolving into an implicit holistic conversion of an organization, or deliberate in pursuing value creation.
2.	Hess et al. (2016)	Digital transformation is concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or the automation of processes. These changes can be observed in the rising demand for Internet-based media, which has led to changes in entire business models (for example, in the music industry).
3.	Horlach et al. (2017)	Digital transformation as encompassing the digitization of sales and communication channels and the digitization of a firm's offerings (products and services), which replace or augment physical offerings. Furthermore, digital transformation entails tactical and strategic business moves that are triggered by data-driven insights and the launch of digital business models that allow new ways of capturing value.
4.	Liere-Netheler et al. (2018)	The use of new digital technologies (social media, mobile, analytics, or embedded devices) to enable significant business improvements (such as enhancing customer experience, streamlining operations, or creating new business models).
5.	Karagiannaki et al. (2017)	The use of technology to radically improve performance or reach of enterprises.

Cont. table 1.

6.	Matt et al. (2015)	Digital transformation strategy is a blueprint that supports companies in governing the transformations that arise owing to the integration of digital technologies, as well as in their operations after a transformation.
7.	Schmarzo et al. (2017)	Digital transformation is the adoption of digital technology by an organization. Common goals for its implementation are to improve efficiency, value or innovation.

Source: own elaboration based on Mahrez et al., 2019.

The term first appeared in 2000 (Patel, McCarthy, 2000) and focused on digitization. He is currently dealing with the phenomenon of new consumer applications that directly affect current business models and organizations.

The first definition of this term appears in the work of Fors and Stolterman (Fors, Stolterman, 2004), in which they described digital transformation as changes that digital technology entails or affects all aspects of human life.

Other researchers (Westerman et al., 2011) define digital transformation as the application of technology to increase the reach or efficiency of enterprises and the creation of new business opportunities through the use of digital data and technologies.

IBM also proposed its own definition, which says that digital transformation is a customer-centric, digital approach to all aspects of business, from business models, through customer experiences, to processes and operations. It uses artificial intelligence, automation, hybrid cloud, and other digital technologies to leverage data and drive intelligent workflows, make faster and smarter decisions, and respond in real time to market disruptions. Ultimately, it changes customer expectations and creates new business opportunities.

The change currently affects not only business processes or macro processes, but all support processes, business processes and the organization's project itself. These processes are entirely devoted to creating value.

Companies and organizations are forced to rethink their activities and the way they interact with stakeholders to adapt to new market needs or to take advantage of technological tools for productivity.

The different definitions of digital transformation can be broken down into three distinct elements (Reis et al., 2018):

- -Technological digital transformation is based on the use of new digital technologies such as social media, mobile, or analytical.
- -Organizational digital transformation requires changing organizational processes or creating new business models.
- -Social digital transformation is a phenomenon affecting all aspects of human life.

In addition, transformational changes are necessary to implement the digital transformation that is related to strategy, organizational culture and leadership. The impact of digital transformation in any organization can be broken down into three different levels: changing business models, transforming customer experiences, and transforming business processes (Mahrez et al., 2019).

4. Key activities of digital transformation in the context of its phased course

In the literature being the subject to this review, 14 models have been identified focusing on the key digital transformation activities that make up its phased course. Four of them are the result of the work of consulting companies, and twelve were created as part of scientific studies. Table 2 indicates the stages of the digital transformation process accentuated in particular models of digital transformation.

Table 2.
Phased course of digital transformation process according to models

Model ID	Model (Author)	Stages of digital transformation process
1.	McKinsey (Catlin et al., 2017)	1. Defining the value 1.1 Secure senior management commitment 1.2. Set clear, ambitious targets 1.3. Secure investment 2. Launch and acceleration 2.1 Start with lighthouse projects 2.2 Appoint a high-caliber launch team 2.3 Organize to promote new, agile ways of working 2.4 Nurture a digital culture 3. Scaling up 3.1 Sequence initiatives for quick returns 3.2 Build capabilities 3.3. Adopt a new operating model
2.	Six-step journey towards I4.0 - Capgemini (Bechtold et al., 2021)	1) Conduct a digital maturity assessment 2) Identify opportunities and threats in I4.0 environment 3) Define I4.0 vision and strategy 4) Prioritize the transformation domains 5) Derive the roadmap towards I4.0 6) Implement and sustain the change
3.	Schallmo et al., 2016	1. Digital Reality 2. Digital Ambition 3. Digital Potential 4. Digital Fit 5. Digital Implementation
4.	Baslyman, 2022	The transformation comprises two main phases: 1. Exploitation (is concerned with exploring digital technologies and selecting the ones that would help achieve the strategic goals of a corporation) and 2. Integration. (is concerned with the actual implementation and adoption of those digital solutions into the running of the business of the corporation)
5.	Szopa, Cyplik, 2020	1. The assessment of the current level of digitization of the enterprise as well as 2. The proposal of its digital transformation

Cont. table 2

6.	Parviainen et al., 2017	<p>1. The first step is to analyze the potential impact of digitalization for the company and decide on the position that the company wants or needs to take in the change.</p> <p>2. The second step is to review the current state of the company with respect to the desired position and the impact of digitalization, as well as to identify the gap between the current situation and the wanted future.</p> <p>3. The third step defines the approach that needs to be taken to close the gap from the organization's current state to the desired position and defines the concrete actions needed to reach the desired position.</p> <p>4. The fourth step is about implementing and validating the actions and returning to previous steps if needed. The model is used iteratively to gradually build the solution and fine-tune digitalization goals and plans, if needed</p>
7.	I 4.0 roadmap (Issa et al., 2017)	<p>1) task-force set-up</p> <p>2) digitalization assessment</p> <p>3) focus definition</p> <p>4) use-case idea generation</p> <p>5) use-case impact estimation</p> <p>6) use-case selection</p>
8.	Agile change management model (Le Grand et al., 2019)	<p>3 phases:</p> <p>1) define</p> <p>a) the context</p> <p>b) the actors involved</p> <p>2) experiment</p> <p>a) the workshop cycle</p> <p>b) the control cycle</p> <p>3) anchor</p> <p>a) transformation dashboard</p> <p>b) business-change assessment grids</p>
9.	Conceptual model to guide firms to systematically develop action plans for digitalization (Ng et al., 2019)	<p>5 stages</p> <p>1) the assessment of the current digital capabilities</p> <p>2) the design of the digital business model</p> <p>3) the assessment of the current digital capabilities</p> <p>4) the identification of future digital capabilities</p> <p>5) the development of the action plan</p>
10.	Customer-focused actions to undertake a digital transformation journey (Shah et al., 2019)	<p>1) broaden the definition of digital transformation</p> <p>2) discover how in love customers really are</p> <p>3) build momentum from the top</p> <p>4) teach the power of digital</p> <p>5) encourage digital accountability</p> <p>6) commit to never being satisfied</p> <p>7) invest beyond the here-and-now</p>
11.	Integral 2.0 - the key challenges faced during a Digital transformation initiative (Kearney, 2020)	<p>1) being digital</p> <p>a) success definition</p> <p>b) digital domain structure</p> <p>c) digital upskilling</p> <p>2) doing digital</p> <p>a) innovation engine</p> <p>b) execution engine</p> <p>c) scaling engine</p>
12.	Blueprint for Digital Success (Reinhard et al., 2016)	<p>Six steps:</p> <p>1) map out I4.0 strategy</p> <p>2) create initial pilot projects</p> <p>3) define the capabilities needed</p> <p>4) become a virtuoso in data analytics</p> <p>5) transform into a digital enterprise</p> <p>6) actively plan an ecosystem approach</p>

Cont. table 2.

13.	Guidelines to help manufacturers develop their digital transformation initiatives - BCG (Brunelli et al., 2017)	Steps: 1) understand the value of making the change 2) assess the current state of systems and operations 3) define a roadmap and vision 4) improve existing processes 5) expand capabilities along the value chain
14.	A model to make companies analyse their individual maturity levels (Pessl et al., 2017)	1) a kick-off workshop 2) ascertaining the company's status and existing I4.0 competences 3) a target state for each function definition 4) derivation of concrete measures to determine the differences between the current stage and target maturity level 5) balanced scorecard creation

Source: own elaboration.

Comparative analysis of selected models

In order to conduct a comparative analysis of digital transformation models, four of those listed in Table 2 were selected. Two of them come from studies prepared by leading management consulting companies, while the other two - from scientific studies presented in scientific journals.

The following comparative analysis of digital transformation models was conducted taking into account two sets of criteria. The first set of criteria (Table 3) focuses on the versatility of models and consists of the following:

- the degree of concentration of the model on the selected sector of the economy,
- the degree of concentration on digital competences,
- the degree of focus on management concepts,
- the degree of concentration on digital transformation tools,
- the degree of focus on the digital maturity of the organization.

As part of the second set of criteria, the following elements resulting from the theory of change management from the organization were taken into account:

- emphasizing the role of leadership in digital transformation,
- determining the significance of digital transformation,
- creating and communicating a digital transformation strategy,
- focus on resistance to changes,
- analysis of opportunities and threats arising from the environment of the organization,
- focus on creating a roadmap of digital transformation,
- -indication of the competences and skills of participants in digital transformation.

The comparison of selected models with the use of criteria given above is presented in Tables 3 and 4.

Table 3.*Comparison of digital transformation models - first set of criteria*

Criteria/model	BCG (Brunelli et al., 2017)	Capgemini (Bechtold et al., 2021)	Schallmo et al., 2016	Pessl et al., 2017
Focus on the sector	No	No	No	No
Focus on digital competences	Yes	Yes	Yes	Yes
Focus on management concepts	Yes (Change management, Lean management)	Yes (Lifecycle management, Shared resources management, Knowledge management)	Yes (Innovation management, Change management)	Yes (Change management, Knowledge management, Process management)
Focus on tools	Yes	Yes	Yes	Yes
Focus on digital maturity	Yes	Yes	No	Yes

Source: own elaboration.

Table 4.*Comparison of digital transformation models – second set of criteria*

Criteria/model	BCG (Brunelli et al., 2017)	Capgemini (Bechtold et al., 2021)	Schallmo et al., 2016	Pessl et al., 2017
Emphasizing the role of leadership	Yes	Yes	No	No
Determining the significance of transformation	No	No	No	Yes
Strategy creation and communication	Yes	Yes	Yes	Yes
Focus on resistance to change	No	No	No	No
Analysis of opportunities and threats from the environment	Yes	Yes	Yes	Yes
Assessment of digital maturity	Yes	Yes	Yes	Yes
Development of the digital transformation roadmap	Yes	Yes	Yes	Yes
Indication of digital competences and skills of participants in the organization	No	No	Yes	No

Source: own elaboration.

Comparing selected models, it can be concluded that some of them strongly focus on a few selected aspects of digital transformation, while others present a broader perspective, taking into account a wide range of change management issues. By using strong elements of individual models being the subject of comparative analysis, one may attempt to develop a concept for building a new model using elements of existing models and suggesting the need to expand elements insufficiently developed within the compared models.

The concept of building a new model using elements of the existing models

The proposed, extensive model of digital transformation could fragmentarily use the advantages of the models presented in Tables 3 and 4. Table 5 presents a list of the components of digital transformation models taken into account in the context of the theory of change management in an organization, along with an indication of models strongly emphasizing these components.

Table 5.

Digital transformation model components accentuated in existing models

Model component	Models accentuating key components
Emphasizing the role of leadership	BCG (Brunelli et al., 2017), Capgemini (Bechtold et al., 2021)
Determining the significance of transformation	Pessl et al., 2017
Strategy creation and communication	BCG (Brunelli et al., 2017), Capgemini (Bechtold et al., 2021), Schallmo et al., 2016, Pessl et al., 2017
Focus on resistance to change	None - the need to develop recommendations
Analysis of opportunities and threats from the environment	BCG (Brunelli et al., 2017), Capgemini (Bechtold et al., 2021), Schallmo et al., 2016, Pessl et al., 2017
Assessment of digital maturity	BCG (Brunelli et al., 2017), Capgemini (Bechtold et al., 2021), Schallmo et al., 2016, Pessl et al., 2017
Development of the digital transformation roadmap	BCG (Brunelli et al., 2017), Capgemini (Bechtold et al., 2021), Schallmo et al., 2016, Pessl et al., 2017
Indication of digital competences and skills of participants in the organization	Schallmo et al., 2016

Source: own elaboration.

An attempt to build a hybrid model, taking into account the strengths of the models compared in this article, would require:

- a) The use of the consulting companies model (BCG, Capgemini) for the component of emphasizing the role of leadership in the digital transformation process.
- b) The use of the scientific model presented by Pessl for the component of determining the importance of digital transformation for the organization.

- c) The use of elements of all models in creating and communicating strategies for carrying out digital transformation.
- d) The development of comprehensive model assumptions and recommendations on issues related to combating resistance to change.
- e) The use of elements of all models in the scope of conducting the analysis of opportunities and threats arising from the organization's environment.
- f) The use of elements of all models in assessing the digital maturity of an organization willing to enter the digital transformation process.
- g) The use of elements of all models in creating a roadmap of the digital transformation process.
- h) The use of the scientific model presented by Schallmo in the scope of indicating the competences and digital skills of the participants of the organization.

5. Conclusion

Concluding the content of this article, digital transformation is an area in which the academic literature is most interested, but still requires a more in depth definition of the concept, a better understanding of the requirements, but also a strategic orientation in a long term perspective. To provide a better characterization for both research and practice, and therefore, to structure the field of digital transformation, the authors systematized the definitions of the digital transformation process appearing in the literature on the subject. Then, they presented 14 models of digital transformation emphasizing the phased character of its course, in order to select 4 of them in the next stage of work for a comparative analysis. For the purpose of conducting a comparative analysis of the existing models, 2 sets of comparison criteria were composed. The first one was to indicate the degree of universality of the compared models, while the second one took into account the elements resulting from the theory of changes in the organization. The proposed, extensive model of digital transformation could fragmentarily use the advantages of the models presented in Tables 3 (Comparison of digital transformation models - first set of criteria) and 4 (Comparison of digital transformation models – second set of criteria). Table 5 authors presents a list of the components of digital transformation models taken into account in the context of the theory of change management in an organization, along with an indication of models strongly emphasizing these components.

References

1. Baslyman, M. (2022). Digital Transformation From the Industry Perspective: Definitions, Goals, Conceptual Model, and Processes. *IEEE Access*, 10, 42961-42970.
2. Bechtold, J., Kern, A., Lauenstein, C., Bernhofer, L. *Industry 4.0—The Capgemini Consulting View*. Capgemini Consulting. Available online: https://www.capgemini.com/consulting/wp-content/uploads/sites/30/2017/07/capgemini-consultingindustrie-4.0_0_0.pdf, 30 October 2022.
3. Brunelli, J., Lukic, V., Milon, T. (2017). *Five Lessons from the Frontlines of Industry 4.0*. Bost. Consult. Gr. Available online: <https://www.bcg.com/publications/2017/industry-4.0-lean-manufacturing-five-lessons-frontlines>, 30 October 2022.
4. Catlin, T., Lorenz, J.-T., Sternfels, B., Willmott, P. *A Roadmap for a Digital Transformation*. McKinsey Co. Available online: <https://www.mckinsey.com/industries/financial-services/our-insights/a-roadmap-for-a-digital-transformation>, 30 October 2022.
5. Henriette, E., Feki, M., Boughzala, I. (2016). *Digital Transformation Challenges*. Mediterranean Conference on Information Systems.
6. Hess, T. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive*, 15(2), 123-139, ISSN 15401960.
7. Horlach, B., Drews, P., Schirmer, I., Böhmman, T. (2017). *Increasing the Agility of IT Delivery: Five Types of Bimodal IT Organization*. Proceedings of the Hawaiian International Conference on System Sciences. Hawaii: USA.
8. Issa, A., Hatiboglu, B., Bildstein, A., Bauernhansl, T. (2018). *Industrie 4.0 roadmap: Framework for digital transformation based on the concepts of capability maturity and alignment*. Proceedings of the 51st CIRP Conference on Manufacturing Systems, CIRP CMS 2018, Vol. 72. Stockholm, Sweden, 16-18 May 2018, pp. 973-978.
9. Karagiannaki, A., Vergados, G., Fouskas, K. (2017). The Impact Of Digital Transformation In The Financial Services Industry: Insights From An Open Innovation Initiative In Fintech In Greece. MCIS 2017, *Proceedings*, 2.
10. Le Grand, T., Deneckere, R. (2019). COOC: *An Agile Change Management Method*. Proceedings of the 21st IEEE Conference on Business Informatics, Vol. 2. CBI 2019, Moscow, Russia, 15-17 July 2019, pp. 28-37.
11. Liere-Netheler, K., Packmohr, S., Vogelsang K. (2018). *Drivers of Digital Transformation in Manufacturing*. Hawaii International Conference on System Sciences.
12. Mahraz, M.I., Benabbou, L., Berrado, A. (2019). *A Systematic literature review of Digital Transformation*. Proceedings of the International Conference on Industrial Engineering and Operations Management, Toronto, Canada, October 23-25, 2019.
13. Majchrzak, A. (2016). Designing for digital transformation: Lessons for information systems research from the study of ICT and societal challenges. *MIS Quarterly*:

- Management Information Systems*, 40(2), 267-277, ISSN 02767783, doi:10.25300/MISQ/2016/40.
14. Matt, C., Hess, T., Benlian, A. (2015). Digital Transformation Strategies. *Bus. Inf. Syst. Eng.*, 57, 339-343.
 15. Ng, H.Y., Tan, P.S., Lim, Y.G. (2019). *Methodology for Digitalization—A Conceptual Model*. Proceedings of the 2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Bangkok, Thailand, 16-19 December 2019, pp. 1269-1273.
 16. Parviainen, P., Tihinen, M., Kääriäinen, J., Teppola, S. (2017). Tackling the digitalization challenge: How to benefit from digitalization in practice. *International Journal of Information Systems and Project Management*, 5(1), 63-77.
 17. Patel, K., McCarthy, M.P. (2000). *Digital Transformation: The Essentials of E-Business Leadership 1st*. McGraw-Hill Professional.
 18. Pessl, E., Sorko, S.R., Mayer, B. (2017). *Roadmap industry 4.0—Implementation guideline for enterprises*. Proceedings of the 26th International Association for Management of Technology Conference, Vol. 5, IAMOT, Vienna, Austria, 14-18 May 2017, pp. 193-202.
 19. Reinhard, G., Jesper, V., Stefan, S. (2016). *Industry 4.0: Building the Digital Enterprise*. PwC. Available online: <https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf>, 30 October 2022.
 20. Reis, J. (2018). Digital transformation: A literature review and guidelines for future research. *Advances in Intelligent Systems and Computing*, 745, 411-421, ISSN 21945357, doi:10.1007/978-3-319-77703-0_41.
 21. Schallmo, D., Williams, C.A., Boardman, L. (2017). Digital transformation of business models-best practice, enablers, and roadmap. *Int. J. Innov. Manag.*, 21, 119-138.
 22. Schmarzo, B. (2017). What is Digital Transformation? *CIO*, May 31, 2017.
 23. Schwertner, K. (2017). Digital Transformation of Business. *Trakia Journal of Science*, 15, no. Suppl. 1, 388-93. <https://doi.org/10.15547/tjs.2017.s.01.065>.
 24. Shah, B., Roytman, A., De Matteis, P. (2020). *Accenture Interactive-Point of View Series Digital Transformation Re-Imagine from the outside-In*. Available online: https://www.accenture.com/t20160128t000639__w_/us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/technology_7/accenture-interactive-digital-transformation.pdf, 30 October 2022.
 25. Stolterman, E., Fors, A.C. (2004) Information Technology and the Good Life. In: B. Kaplan, D.P. Truex, D. Wastell, A.T. Wood-Harper, J.I. DeGross (eds.), *Information Systems Research. IFIP International Federation for Information Processing, vol. 143*. Boston, MA: Springer.
 26. *Strategic Digital Transformation—Kearney*. Available online: <https://www.kearney.com/digital/strategic-digital-transformation>, 30 October 2022.

-
27. Szopa, Ł., Cyplik, P. (2020). The concept of building a digital transformation model for enterprises from the SME sector. *LogForum*, 16.4.
 28. Westerman, G., Calmejane, C., Bonnet, D. (2011). Digital Transformation: A Roadmap for Billion-Dollar Organizations. *Capgemini Consulting and MIT Center for Digital Business*, Nov. 17.

DETERMINANTS OF INNOVATIVE POTENTIAL OF SMEs IN THE PERIOD OF THE COVID-19 PANDEMIC

Oksana SEROKA-STOLKA^{1*}, Bartosz KOKOT²

¹ Częstochowa University of Technology; o.seroka-stolka@pcz.pl, ORCID: 0000-0003-2044-4875

² bartosz.kokot@wp.pl, ORCID: 0000-0002-4155-8110

Purpose: The objective of the paper is to assess the degree of influence of determinants from the environment and the internal environment of SMEs on the growth of their innovation potential (IP) and to verify the moderating effect of the cooperation with external actors and financial condition on the relationship between the influence of external and internal determinants on the innovation potential of the investigated enterprises during the COVID-19 pandemic.

Design/methodology/approach: To achieve the paper's objective regression analysis has been applied.

Findings: The paper presents the results of empirical research conducted among Polish SMEs during the pandemic period in 2021. The results reveal that financial condition constitutes a significant moderator of the relationship between determinants coming from the company's environment and their level of SME innovation potential. Furthermore, it has been demonstrated that cooperation with entities responsible for helping to implement innovation significantly moderates the relationship between the influence of determinants coming from the internal environment of SMEs and their innovation potential. It has been also found, on the basis of a multivariate regression model, that among external determinants the strongest predictors of IP growth were socio-cultural and demographic factors, and among internal determinants: the quality management sphere and the financial sphere of the surveyed SMEs.

Research limitations/implications: The main limitation of the conducted research is the impact of the pandemic conditions and also the location of the investigated SMEs in the region of the Lower Silesian Voivodship.

Practical implications: The paper provides practical knowledge regarding the determinants of acting in the conditions related to a pandemic crisis.

Originality/value: The paper provides new knowledge, analyses the external conditions and the internal environment of SMEs during the COVID-19 pandemic in the region, which is known as one of the most innovative in Poland. The research is addressed to research scholars, business pretensioners and policy makers of innovative policy.

Keywords: innovation potential, measurement, enterprise, SME sector.

Category of the paper: research paper.

1. Introduction

Innovativeness represents one of the most important challenges for enterprises operating in a competitive economy, and the SME sector is the main driving force of the Polish economy (Lachiewicz, Matejun, 2012). Not only do SMEs constitute a significant part of Poland's GDP (PARP, 2022) but they also employ the largest number of employees and largely determine the innovativeness, modernity and position of many world economies (Aga et al., 2015). Therefore, a key challenge for researchers is to measure the innovation potential for the SME sector. In addition, the discussion on innovation measurement methods is ongoing among management practitioners with regard to the tools for measuring and evaluating innovation capability and the effectiveness of innovation processes taking place in firms (Pahalad, Krishnan, 2010). Moreover, during the pandemic period, there were changes in SME business models as a result of responses to current needs and changes in conditions of conducting business activity, as well as limited financial resources. Unfortunately, the COVID-19 pandemic negatively affected the economic situation and conditions of conducting business especially among Polish small medium-sized enterprises (PARP, 2020). In response to the crisis caused by the COVID-19 pandemic, a number of enterprises were forced to seek innovative solutions in order to adapt to the new environment (Clauss et al., 2022). It is worth noting that analyses regarding the impact of multiple factors on an organisation's innovation capacity are complicated due to the dynamics of their change (Pertuz et al., 2018). Therefore, the assessment of innovation potential and the factors determining its growth is an important issue for researchers and entrepreneurs.

In light of the above-mentioned, the objective of the paper is to assess the strength of the impact of determinants from the outside and the inside investigated SMEs that influence IP the during the COVID-19 pandemic and to verify the influence of the moderating effect of financial condition and the cooperation of the investigated enterprises with entities responsible for helping them implement innovations.

To this end, the following research questions were formulated:

1. What is the level of innovation potential of Lower Silesian SMEs?
2. What determinants from the company's external environment have the greatest influence on the growth of innovative potential of the investigated SMEs?
3. Which determinants from the company's internal environment have the greatest impact on the growth of the innovation potential of the investigated SMEs?
4. Is there a significant moderating effect of the cooperation of the investigated companies with entities responsible for helping to implement innovation on the relationship between internal determinants and the innovative potential of the investigated SMEs?
5. Is financial condition a significant moderator of the impact of determinants from the company's external environment on the innovation potential of the investigated SMEs?

2. Innovative potential of SMEs

The literature on the subject includes various definitions of the innovation potential (IP), ranging from a very narrow view to ones where it is understood broadly. In the narrow view, innovation potential is the ability to effectively introduce innovations in the form of new products and technologies, organisational methods and marketing innovations. Potential defined in this way is shaped by its four key elements: financial potential, human potential, material potential and knowledge (Poznańska, 1998). Financial potential means predominantly the company's own financial resources and those obtained from financial and non-financial institutions operating in the company's external environment. Human potential is defined as the company's employees and their structure, as well as the skills and qualifications they possess. Material potential, on the other hand, includes the structure of the production apparatus with its flexibility, i.e. the ability to quickly adapt production to the needs of a changing market. The age and level of mechanisation and automation of the machinery stock should also be considered. The final element of IP is knowledge, within which technical knowledge and information flowing from the market are particularly important.

In a slightly different way, innovation potential is considered by Żoźniński (2005), who argues that it is determined by internal innovation potential and access to external sources of innovation. He includes the following as the internal innovative potential:

- personnel (their knowledge and experience, qualifications and skills and how they manage the available resources, information management),
- R&D (dedicated R&D units, ongoing R&D, contracted work, etc.),
- technology (computers and ICT technology, machinery and equipment, and degree of modernity of machinery and equipment).

In his opinion, external sources of innovation include mainly universities and R&D units, but also competing companies, suppliers and customers.

A different definition of IP of enterprises is provided by Białoń, according to whom it is a set of interrelated elements of the enterprise's resources, which, thanks to work, will be transformed into a new state of affairs. In such an approach, innovation potential is treated as the sum of the potential of science, technology and the economy, which are closely linked one to another. The potential of science magnifies the potential of the economy and technology and creates potential for itself. The potential of technology increases the potential of the economy and science and vice versa. Each of the components creates potential for itself and can act as a barrier to growth for all three components of potential (Białoń, 2010).

The potential of science can be defined as the quantitative and qualitative state of scientific personnel and the experimental base for research (Malecki, 1965) or the complex of research activities and the assets of knowledge held (Spruch, 1973). Economic potential, on the other hand, is the set of elements that enable the development of the economy, science and

technology, together with the incentive systems that encourage activity (Bialoń, 2010). On the other hand, in the interaction model of Rothwell and Zegveld it is suggested that a company's innovation potential should be based on R&D, production and marketing activities. These are the basic conditions for the effectiveness of innovation activities, and thus for the development and improvement of competitiveness and efficiency of a company's activities (Rothwell, Zegveld, 1985). IP is presented differently by Haffer. It is part of an integrated model of the innovation process in a company. IP consists of a number of interrelated and interdependent elements. It is thus defined by: tangible and intangible resources of the enterprise, which constitute the basis for defining the strategy of the enterprise's innovation activities and the tools for effective implementation of this strategy; sectoral environment (customers, suppliers, competitors, cooperators); institutional environment (including the sphere of science, government, business support institutions) (Haffer, 2004). Wang and Ahmed in turn, based on the literature, describe IP in five of its dimensions. These are product innovation, market innovation, process innovation, behavioural innovation and strategic innovation. In line with the literature research, they define an organisation's IP as the overall innovative capacity of an organisation to introduce new products to market or open new markets through a combination of strategic orientation and innovative behaviour and process (Wang, Ahmed, 2004)

During the Covid-19 pandemic, the financial situation of SMEs, as well as the economies of entire countries, became very difficult. The pandemic also affected the potential for innovation, as enterprises were forced to change their business model to adapt to the new situation (Omar et al., 2020). Covid-19 had a negative impact on the economic well-being of states and businesses (Sneider, Singhal, 2020). The pandemic not only affected global health, but also threatened the structure of the global economic order. As a result, a number of economies fell into recession (OECD, 2020).

The impact of the coronavirus pandemic on the economic activities of SMEs exposed them to negative effects in the short or long term. The main obstacles were cash flow problems, business closures and employee layoffs (Wahyudi, 2014). Changes in business strategies and business conduct, as well as pressures to seek new growth opportunities, were considered key challenges to the survival of SMEs (Svatošová, 2017). However, these changes vary depending on the types of business activity, the size of enterprises and the resources available (Cassia, Minola, 2012).

The survival of SMEs is of key importance for economic development due to their multifaceted role, so an outage in their operation harms the entire economy (Pu et al., 2021). During the pandemic, every sector of the economy was affected by crisis, the profound effects are also observed in the SME sector. In most economies, SMEs play an essential role in driving economic growth, creating jobs and opening new markets (Puriwat, Tripopsakul, 2021). In addition, the current pandemic has caused discomfort for SMEs by increasing financial

liabilities such as loan payments to financial institutions, inventory shortages and operational expenses (Le et al., 2020).

The global health crisis that started in 2020 affected all enterprises, but some of them showed resilience or discovered a new operational niche. Most SMEs in the service sector started to operate in new and previously unknown conditions (Gregurec et al., 2021). The negative impact of the pandemic had its economic, political, social and psychological consequences (Bretas, Alon, 2020), which provides a basis for further research and filling the research gap.

The COVID-19 pandemic affected the profitability and long-term viability of SMEs globally (Emejulu et al., 2020) as well as in Poland (Kliuchnikava et al., 2022). However, the new crisis situation created new opportunities for adaptive capacity and firm performance (Hadi, Supardi, 2020), reduced financial limitations (Nyanga, Zirima, 2020) and increased productivity (McGeever et al., 2020). Research shows that strategic resource support, such as technological integration, effective financial intermediation and government incentives, have been essential in enhancing the chances of survival for SMEs during the pandemic (Fitriasari, 2020), prompting the analysis of this phenomenon. While referring to the impact of technological integration on SMEs, a growing number of researchers opt for a positive relationship between technological adaptation and IP (Das et al., 2020). This means that operational efficiency enables SMEs to benefit from competitive markets. Innovative integration of financial services reduces the effects of financial redistribution and execution and enables higher levels of financial efficiency (McGuinness et al., 2018). Research indicates that technological adaptability, creative financing and government involvement are essential for SME growth (Pu et al., 2021).

In pursuit of the stated research objectives and questions and the identified research gaps, the following research hypotheses have been formulated.

Research hypotheses:

H1: External determinants have positively influenced the increase in innovation potential of the investigated SMEs.

H2: Internal determinants have positively influenced the increase in innovation potential of the investigated SMEs.

H1a: There is a significant moderating effect of the influence of the financial condition of the investigated enterprises during the pandemic period on the relationship between the influence of environmental determinants on the innovation potential of the investigated SMEs.

H2a: There is a significant moderating effect of the impact of the cooperation of the investigated SMEs with entities responsible for helping to implement innovation on the relationship between the impact of internal determinants on the innovation potential of the investigated SMEs.

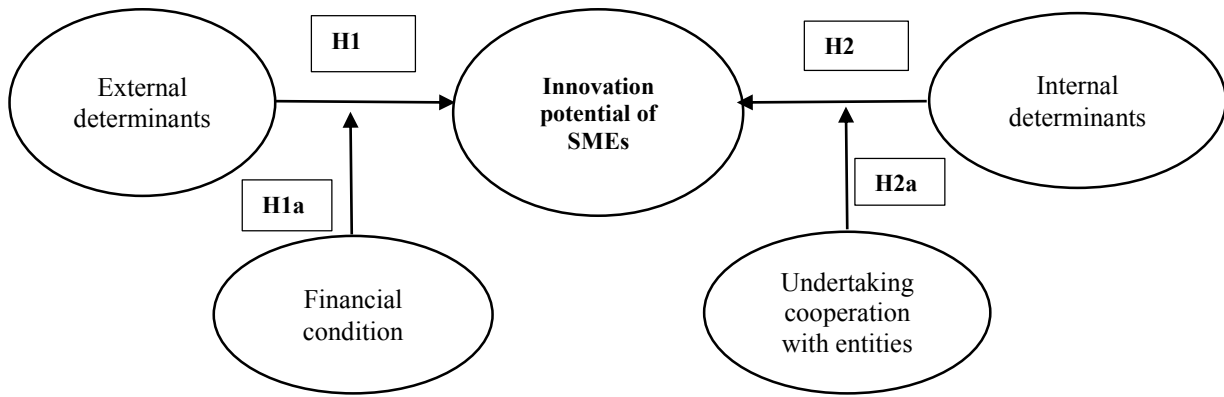


Figure 1. The research framework.

Source: Own elaboration.

3. Methods

The questionnaire survey constituting the basis for the achievement of the set objectives and verification of the hypotheses was conducted in 2021 during the COVID-19 pandemic, which had already been going on for over a year, on a sample of 150 enterprises from the Lower Silesian Voivodeship. The study used stratified random sampling, allowing stratification of the population in terms of belonging to micro, small or medium-sized enterprises. The sampling frame covered 600 enterprises. The questionnaire return percentage was 25%. The final sample structure consisted of 50 micro-, 50 small- and 50 medium-sized enterprises. The research tool was an original survey questionnaire. The questionnaires were addressed to entrepreneurs/owners of SMEs.

One-dimensional and multivariate regression analysis was carried out in GPower (version 3.1). A significance level of $\alpha = 0.05$ was adopted. The regression analysis for IP was the main focus of the calculations - a series of one-dimensional models were made, and multivariate models were also constructed using the stepwise method. Variables having a p-value < 0.250 in the unidimensional models (Hosmer et al., 2013) (and in later analyses, interactions between individual independent variables (moderation analysis) were introduced as predictors for the multivariate models. The R^2 coefficient value has been provided to assess the models. In the regression models, the collinearity of the predictors was analysed using the VIF coefficient. The operationalisation of the research model was carried out using the different categories of variables: the dependent variable (IP as an aggregate variable) and the independent variables (external and internal determinants) and the control variables (financial condition, undertaking cooperation with entities). The dependent variable and most of the independent variables were tested on a 5-point Likert scale. The size classification of the surveyed enterprises was adopted according to the number of employees: micro (up to 9 employees),

small (10 to 49 employees) and medium (50 to 249 employees). In the study, a series of unidimensional regression analyses were conducted in which the dependent variable was IP. The predictors were all the variables for which the correlation analysis was performed and the control variables: financial condition of the company (at the break-even point and below the break-even point, above the break-even point and well above the break-even point), undertaking cooperation with entities responsible for helping to implement innovation (binary variable - '1' or '0'). As the skewness in the distributions of all quantitative variables did not exceed the range -3.00; 3.00 it was considered that this would not affect the power of the models. Most analyses were statistically significant (at the $p < 0.001$ level, unless otherwise stated). The research diagram has been shown in Figure 1, which provides a visualisation of the interaction pattern of the relationships tested.

4. Results

The quantitative evaluation (aggregated IP variable) averaged 4.11 for the IP variable and indicates a good level of IP of the investigated SMEs. Moreover, the analysis of the one-dimensional regressions presented in Table 1 demonstrates that the impact of internal determinants (analysed individually) by one unit made it possible to predict an increase in IP by 0.42 units (R&D sphere) to a maximum of 0.83 units (intangible resources sphere). An increase in the level of the *internal determinants* variable (total) made it possible to predict an increase in IP of 1.09 units (95% CI = 0.94; 1.23). The range of increase in IP level with an increase in individual external determinants by one-unit ranges from 0.43 units (political-legal determinants) to 0.64 (socio-cultural and demographic determinants).

The impact of the *external determinants* variable (total) by one unit made it possible to predict an increase in IP level by 0.73 units (95% CI = 0.61; 0.85). Other significant determinants influencing IP growth in the unidimensional models include: an assessment of the need for state support in implementing innovation (B = 0.75; 95% CI = 0.62; 0.88) and sociocultural and demographic determinants (B = 0.64; 95% CI = 0.51; 0.77).

The influence of internal determinants analysed together made it possible to predict the highest increase in IP among the studied predictors (B = 1.09; 95% CI = 0.94; 1.23), and among the determinants analysed individually, the highest increase in IP was observed for the intangible resources sphere (B = 0.83; 95% CI = 0.63; 1.02). This sphere included past experiences and contacts, the company's reputation and image, as well as technical knowledge and information flowing from the market. In addition, a high increase in IP was observed for the financial sphere (B = 0.72; 95% CI = 0.57; 0.86). For all the analysed predictors, a positive effect on the IP growth of the investigated SMEs was observed. Thus, the hypothesis H1 has been confirmed.

The analysis concerning the correlation of the effect of financial condition (above the break-even point compared to condition at the break-even point and below the break-even point) allowed predicting an increase in IP of 0.98 (95% CI = 0.55; 1.41), and financial condition well above the break-even point compared to condition at the break-even point and below allowed predicting an increase in IP of 1.29 units (95% CI = 0.76; 1.81). The presented analysis shows that financial condition statistically significantly affects IP growth. The hypothesis H1a has been confirmed.

Table 1.

One-dimensional regression models for the impact of analysed variables on the growth of innovation potential

Predictor	Innovation potential		
	B	95% CI dla B	p
Internal determinants			
Production sphere	0.70	0.52; 0.87	< 0.001
Employment sphere	0.56	0.39; 0.72	< 0.001
Logistics sphere	0.48	0.35; 0.61	< 0.001
R&D sphere	0.42	0.29; 0.55	< 0.001
Organization and management sphere	0.72	0.57; 0.87	< 0.001
Quality management sphere	0.71	0.62; 0.81	< 0.001
Marketing sphere	0.63	0.48; 0.78	< 0.001
Intangible resources sphere	0.83	0.63; 1.02	< 0.001
Financial sphere	0.72	0.57; 0.86	< 0.001
Information and communication sphere	0.71	0.61; 0.81	< 0.001
External determinants			
Economic determinants	0.49	0.38; 0.60	< 0.001
Political-legal determinants	0.43	0.26; 0.59	< 0.001
Socio-cultural and demographic determinants	0.64	0.51; 0.77	< 0.001
International determinants	0.57	0.46; 0.69	< 0.001
Technical determinants	0.56	0.47; 0.66	< 0.001
Geographical determinants	0.58	0.48; 0.68	< 0.001
Sectoral determinants	0.53	0.43; 0.64	< 0.001
Total			
Internal determinants	1.09	0.94; 1.23	< 0.001
External determinants	0.73	0.61; 0.85	< 0.001
Financial condition (compared: at and below the break-even point)			
Above the break-even point	0.98	0.55; 1.41	< 0.001
Well above the break-even point	1.29	0.76; 1.81	< 0.001
Undertaking cooperation with entities (no vs. yes)	0.21	-0.10; 0.52	0.178

B – non-standard regression coefficient; 95% CI – confidence intervals 95%; p – p value for the regression model.

Source: own elaboration.

Only the variables significantly affecting the predictive power of the model remained in the multivariate model 1 (Table 2). The variables that had a p-value < 0.250 in the unidimensional models were entered as predictors in the model (except for internal and external determinants analysed together): all internal and external determinants, financial condition and undertaking cooperation with entities. Model 1 was statistically significant (p < 0.001) and explained 81% of the variance in IP (very strong effect). The following variables remained in model 1 shown in Table 2 (although not all statistically significant): production sphere (p = 0.002), organisation

and management ($p = 0.023$), quality management ($p < 0.001$), finance ($p = 0.002$), political and legal conditions ($p = 0.056$), socio-cultural and demographic ($p = 0.031$), international ($p = 0.155$), technical ($p = 0.074$), geographical ($p = 0.002$).

The multivariate regression model revealed that the strongest predictors among the external determinants influencing the increase in IP of the investigated SMEs were socio-cultural and demographic determinants (95% CI = 0.02; 0.29). On the other hand, among the internal determinants, the strongest predictors were the quality management sphere, whose increase by one unit predicted an increase in IP by 0.26 units (95% CI = 0.12; 0.40) and the financial sphere - an increase in the level of this variable by one unit allowed predicting an increase in IP by 0.21 units (95% CI = 0.08; 0.34). While analysing the introduced variables in model 1, a negative value of the beta coefficient was observed for some of the significant predictors: geographical determinants ($B = -0.16$; 95% CI = -0.29; -0.02) and the organisation and management sphere ($B = -0.16$; 95% CI = -0.29; -0.02). This means that an increase in the level of the examined variables under was associated with a decrease in IP by the value of the beta coefficient (Table 2).

Table 2.

Multivariate model 1 for innovation potential (determinants individually)

Predictor	Innovation potential		
	B	95% CI dla B	p
Production sphere	0.19	0.07; 0.30	0.002
Organization and management sphere	-0.16	-0.29; -0.02	0.023
Quality management sphere	0.26	0.12; 0.40	< 0.001
Financial sphere	0.21	0.08; 0.34	0.002
Political-legal determinants	-0.11	-0.24; < 0.01	0.056
Socio-cultural and demographic determinants	0.15	0.02; 0.29	0.031
International determinants	0.08	-0.03; 0.18	0.155
Technical determinants	0.12	-0.01; 0.24	0.074
Geographical determinants	-0.21	-0.34; -0.08	0.002

B – non-standard regression coefficient; 95% CI – confidence intervals 95%; p – p value for the predictor.

Source: own elaboration.

Although the VIF (collinearity of variables) value in the multivariate model 1 exceeded 5.00 for no predictor, some of the values were close to this limit. However, it was recognised that the relationships between the individual predictors may have distorted the results of the multivariate regression. It was decided to build multivariate models (2 and 3) that included internal and external determinants as two averaged variables.

In order to test the significance of the moderating effect (H1a and H2a), models 2 and 3 were built in which the variables internal and external determinants, financial condition and cooperation with entities responsible for helping to implement innovations were entered as well as the interactions between the investigated variables (external determinants*financial condition; internal determinants*cooperation with entities). As the different variables were analysed in detail in the earlier models, Table 4 only shows the models where the interaction effect remained significant.

The results revealed that financial condition was a significant moderator of the relation between external determinants and IP ($B = -0.37$; 95% CI = -0.58, -0.16; $p < 0.001$). A post-hoc simple slop analysis also confirmed that the relation between the two variables (external determinants, innovation potential) was significantly lower among firms with financial condition well above the break-even point than among firms with financial condition above the break-even point ($p = 0.012$) or on the borderline and below ($p = 0.045$).

In addition, it was found that undertaking cooperation with entities responsible for helping to implement innovation was a significant moderator of the relationship between internal determinants and IP ($B = -0.36$; 95% CI -0.67; -0.05; $p = 0.026$). Post-hoc analysis detected a significant difference between the strength of the relationship between these variables among the companies that undertook cooperation and those that did not. The relationship between internal determinants and IP was stronger among the companies that did not undertake cooperation with entities responsible for helping them to implement innovation ($p = 0.026$).

Table 4.

Multivariate regression models with moderation for innovation potential (internal and external determinants together, control variables and interactions)

Predictor	Innovation potential		
	B	95% CI dla B	p
Model 2: control variable – financial condition			
Internal determinants	0.86	0.59; 1.14	< 0.001
External determinants	0.89	0.41; 1.37	< 0.001
Financial condition	1.90	0.99; 2.80	< 0.001
External determinants*financial condition	-0.37	-0.58; -0.16	< 0.001
Model 3: control variable – cooperation with entities			
Internal determinants	1.19	1.02; 1.36	0.005
Undertaking cooperation with entities	1.63	0.25; 3.01	< 0.001
Internal determinants*undertaking cooperation with entities	-0.36	-0.67; -0.05	0.026

B – non-standard regression coefficient; 95% CI – confidence intervals 95%; p – p value for the predictor.

Source: own elaboration.

5. Discussion

The conducted research allowed confirming hypotheses H1 and H2 on the positive influence of the analysed determinants from the SME's environment and internal environment. The regression analysis has revealed that the strongest predictors among the influence of internal determinants on IP are the quality management sphere and the financial sphere, while among the external determinants socio-cultural and demographic determinants, which considered factors such as labour mobility, educational level of the population and work ethics.

While analysing socio-cultural and demographic determinants, Dambal, Chandrashekar (2010) indicate that demography is an important indicator of the IP of companies. The authors confirmed the impact of education and highly specialised staff on IP (Dambal, Chandrashekar, 2010). Coinciding with the above results is a study by Zhang et al. (2013), which confirms that higher levels of education correlated positively with the entrepreneurial orientation of SMEs, especially in terms of innovation, competitiveness and proactiveness. Completely different results were obtained in the Czech Republic, with the research finding that education has no significant impact on SME innovation (Kozubíková et al., 2015). The discrepancies in the research results prove that the impact of socio-cultural and demographic conditions on SME's IP depends on the state and socio-demographic situation, which proves the complexity of the problem of building IP.

A study was conducted in Argentina and France among SMEs to analyse the impact of internal determinants on IP. The analysis of IP was based on six criteria (creativity, new product development, human resource management, strategy, project management and knowledge management). In Argentina, creativity was identified as the most significant predictor, while knowledge management was identified as the least significant one. In Argentina, all six criteria analysed show a similar impact on IP growth (Galvez et al., 2013). Among French companies, management strategy had the most important impact on IP. The strategy consisted of an integrated strategy favouring innovation, network operation and the importance of the customer. The importance of innovation financing for IP growth was confirmed, also by the above-mentioned study, which is also confirmed by our results. Nevertheless, it was creativity that accounted for the greatest growth in IP (including the use of tools to enhance creativity, the integration of customers and suppliers into the concept development process and the organisation, compilation and management of external information). Similar research findings were obtained in England, Wales and Scotland, and IP was described in five dimensions: product, market, process, behavioural and strategic. It revealed that strategy had the greatest impact on IP growth (Wang, Ahmed, 2004). However, our research demonstrates that it is the hard elements of management like quality management and innovation financing that stimulate IP growth. The differences in IP growth in Argentina, France and Poland may stem from their geographical location (Norek, Costa, 2015). In France, a deliberate strategy focused on innovation, the Internet, the customer and innovation financing dominates. In Argentina, IP is influenced by the creativity process through customers, suppliers and tools to support creativity and external information management. However, it is worth noting that the financial potential of the company, access to external financing and the degree of computerisation, financial and accounting activities are important strategic elements for SMEs (Popa, Ciobanu, 2014). SMEs that have a favourable financial situation and credit opportunities can allocate significant resources to innovation and thus IP growth (Padilla-Ospina et al., 2021). Madrid-Guijarro et al. (2009) confirm that poor financial condition and excessive costs effectively reduce the IP of SMEs.

Wonglimpiyarat (2014) analysing IP in Thailand based on five IP criteria (organisational, process, service, product and marketing) states that organisational categories have the highest impact on IP growth. This bears a similarity to our study which is the sphere of quality management, which constitutes a key element of efficient management.

Our model shows that there is a positive moderating effect of financial condition on the relationship between IP and the impact of external determinants. The hypothesis H1a has been confirmed. Firms that are well above the break-even point tend to have substantial resources and need less assistance from the entities responsible for helping them to implement innovations to strengthen their IP (Gherghina et al., 2020). Those SMEs that possess sufficient resources tend to invest in innovative solutions, while the potential increase in profits encourages them to seek such solutions. They also tend to have staff who are able to deal with the implementation of innovations and anticipate the revenue they can bring to the company. Some of them also have their own R&D units, so they can improve their potential by looking for solutions that increase innovation. In contrast, companies with poorer financial condition and fewer resources are much more in need of external assistance, including from the state. In this case, concessions, technical assistance and financial support help to strengthen innovation potential. Such companies often do not have the staff to plan and consider innovative solutions (North, Smallbone, Vickers, 2001). In such companies, it is necessary to provide substantive assistance in selecting solutions that are appropriate for the organisation, as well as in activities related to formalities, such as filling in forms for assistance in co-financing innovation from the European Union funds. It also involves financial assistance, which is indispensable for the implementation of innovative solutions that should generate more revenue and income for companies and which will be returned to the state in the form of higher taxes after a successful innovation.

The analyses conducted confirm the hypothesis H2a that the cooperation undertaken with entities responsible for helping to implement innovation has a positive impact on the level of IP of SMEs. Enterprises that use the assistance of research centres, consulting firms or business partners are able to significantly increase their IP (Cankar, Petkovsek, 2013). They enter into cooperation with such entities, counting on expert support. These partners have specific knowledge that helps to effectively increase IP by finding the right solutions, as well as the means to implement them. Enterprises that do not use the help of innovation support centres instead use their functional and resource spheres to increase their IP. These organisations base their development on their own financial resources and staff who are able to put such solutions into practice by implementing innovations for the benefit of the enterprise.

6. Summary

The presented considerations concerning the determinants of the growth of SME innovation potential give grounds for formulating the following conclusions. The results from the conducted empirical study confirm the hypotheses that internal and external determinants have a positive impact on the growth of innovation potential. Despite the fact that the level of innovative potential of the investigated SMEs is good, effective innovative activities of enterprises in this region are required, as they are insufficient in relation to the activities in enterprises of EU countries. SMEs can be highly innovative, but actions are required from within the enterprise, whose managers must be convinced that innovation brings high returns, and from outside, in the form of incentives, facilitation and assistance in innovation activities.

The hypothesis has been confirmed stating that there is a significant moderating effect of the influence of cooperation with entities responsible for helping to implement innovation on the relationship between internal determinants and the IP of the respondents. SMEs that do not cooperate with research centres, business partners or consulting companies are forced to engage their own internal resources to increase IP. The financial expenses, the workforce and their know-how are sufficient to undertake effective innovation activities that will generate profits as well as strengthen the competitiveness of the enterprise.

Organisations whose financial condition is good base the growth of their innovation potential on their own functional and resource spheres. They have well-qualified staff who are able to pursue innovative ideas and implement them with sufficient financial resources. Companies and their managers do not need external support, instead they know that innovation can increase the company's competitiveness, knowledge, profits and also reduce overall operating costs.

In conclusion, it can be said that the issue of the impact of the determinants of IP growth is very broad and should be still analysed. The effects of external and internal determinants on IP growth examined in this paper do not exhaust the entire list of determinants. The complexity of the economy makes it impossible to identify all its components due to the different types of economic activities and the dynamically changing market situation. Therefore, new influences of the determinants of the environment and the internal environment of enterprises will have to be taken into account over time. Further research is needed to identify new factors influencing the construction of IP in order to make small and medium-sized enterprises modern innovators.

An important direction for future research is the study of environmental determinants and internal determinants, i.e. the functional and resource spheres of enterprises and the moderation with other control variables such as enterprise size, legal form.

This study also has its important limitations. An important issue is the time of the pandemic in which the study was conducted. The period of the pandemic and the uncertainty of the environment may change the impact of IP determinants, due to the adaptation of SMEs to the

current problems of the crisis and the war across Poland's eastern border. Therefore, new research will be needed, conducted the times after the crises. The dynamics of changes in the impact of determinants depends on the changing markets in which SMEs operate. Another limitation is the location of the research in one voivodship, thus, it is necessary to carry out research throughout Poland, nevertheless the Lower Silesian Voivodship, as a region of Poland, is one of the most rapidly developing in terms of innovation in the whole country (Osładacz, Chalabala, Książek, 2019).

Innovation is a necessary condition for companies to operate on contemporary markets. Enterprises in the Lower Silesian Voivodship have a good level of innovative potential, but numerous stimuli are needed to trigger the growth of innovativeness, because at present SMEs, similarly to other Polish enterprises, are moderately innovative in comparison with organisations from other European Union countries. State aid, EU funds and other external factors are important, but the most important are internal determinants which- being functional resources shape innovative potential. SMEs are able to increasingly introduce innovations and, in this way, ensure growth in their competitiveness on the market.

References

1. Aga, G., Francis, D.C., Meza, J.R. (2015). SMEs, Age, and Jobs: A Review of the Literature, Metrics, and Evidence. *Policy Research Working Papers*.
2. Białoń, L. (Ed.). (2010). *Zarządzanie działalnością innowacyjną*. Warszawa: Placet.
3. Bretas, V.P.G. Alon, I. (2020). The impact of COVID-19 on franchising in emerging markets: An example from Brazil. *Glob. Bus. Organ. Excell*, 39.
4. Cankar, S., Petkovsek, V. (2013). Private And Public Sector Innovation And The Importance Of Cross-Sector Collaboration. *Journal of Applied Business Research (JABR)*, 29(6).
5. Cassia, L., Minola, T. (2012). Hyper-growth of SMEs towards a reconciliation of entrepreneurial orientation and strategic resources. *International Journal of Entrepreneurial Behavior & Research*, 18(2).
6. Clauss, T., Breier, M., Kraus, S., Durst, S., Mahto, R.V. (2022). Temporary business model innovation—SMEs' innovation response to the Covid-19 crisis. *R&D Management*, 52(2).
7. Dambal, M., Chandrashekar, V. (2010) Measuring R&D Demographics to Assess the Potential for Technological Innovation of SMEs in India. *Journal of Technology Management for Growing Economies, Vol. 1, No. 1*.
8. Das, S., Kundu, A., Bhattacharya, A. (2020). Technology Adaptation and Survival of SMEs: A Longitudinal Study of Developing Countries. *Technol. Innov. Manag. Rev.*, 10.

9. Emejulu, G., Agbasi, O., Nosike, C. (2020). Strategic agility and performance of small and medium enterprises in the phase of Covid-19 pandemic. *Int. J. Financ. Account. Manag.*, 2.
10. Fitriasari, F. (2020). How do Small and Medium Enterprise (SME) survive the COVID-19 outbreak? *J. Inov. Ekon.*, 5.
11. Galvez, D., Camargo, M., Rodriguez, J., Morel, L. (2013). PII – Potential Innovation Index: a tool to benchmark innovation capabilities to international context. *Journal of Technology Management & Innovation*, vol. 8(4).
12. Gherghina, S., Botezatu, M., Hosszu, A., Simionescu, L. (2020). Small and Medium-Sized Enterprises (SMEs): The Engine of Economic Growth through Investments and Innovation. *Sustainability*, 12(1).
13. Gregurec, I., Tomičić Furjan, M., Tomičić-Pupek, K. (2021). The impact of COVID-19 on sustainable business models in SMEs. *Sustainability*, 13.
14. Hadi, S., Supardi, S. (2020). Revitalization strategy for small and medium enterprises after Corona virus disease pandemic (Covid-19) in Yogyakarta. *J. Xian Univ. Archit. Technol.*, 12.
15. Haffer, M. (Ed.) (2004). *Innowacyjność i potrzeby proinnowacyjne przedsiębiorstw regionu kujawsko-pomorskiego*. Toruń: Wydawnictwo UMK.
16. Hosmer, D.W. Jr, Lemeshow, S., Sturdivant, R.X. (2013). *Applied logistic regression*, Vol. 398. John Wiley & Sons.
17. Kliuchnikava, Y. (2022). The Impact of the Pandemic on Attitude to Innovations of SMEs in the Czech Republic. *International Journal of Entrepreneurial Knowledge*, 10 (1), 34-45.
18. Kozubíková, L., Belás, J., Ključnikov, A., Virglerová, Z. (2015). Differences in approach to selected constructs of entrepreneurial orientation in sme segment regarding the selected sociodemographic factors. *Entrepreneurial orientation in sme segment regarding socio-demographic factors*.
19. Lachiewicz, S., Matejun, M. (2012) Specyfika zarządzania małymi i średnimi przedsiębiorstwami. In: M. Matejun (Ed.), *Zarządzanie małą i średnią firmą w teorii i w ćwiczeniach*. Warszawa: Difin.
20. Le, H., Nguyen, T., Ngo, C., Pham, T., Le, T. (2020). Policy related factors affecting the survival and development of SMEs in the context of Covid-19 pandemic. *Manag. Sci. Lett.*, 10.
21. Madrid-Guijarro, A., Garcia, D., Van Auken, H. (2009). Barriers to innovation among Spanish manufacturing SMEs. *Journal Of Small Business Management*, 47(4).
22. Malecki, I. (1965). Ogólne zagadnienia efektywności badań naukowych. *Zagadnienia naukoznawstwa*, 1.
23. McGeever, N., McQuinn, J., Myers, S. (2020). SME Liquidity Needs during the COVID-19 Shock. *Financial Stability Notes*, 2/FS/20. Central Bank of Ireland.
24. McGuinness, G., Hogan, T., Powell, R. (2018). European trade credit use and SME survival. *J. Corp. Financ.*, 49.

25. Norek, T., Costa, L. (2015). Evaluation of the impact of the innovative potential of the companies from the SMEs sector on the efficiency of innovative actions: Suggestion of the evaluation method. *The International Journal of Management Science and Information Technology (IJMSIT)*, 16, 61-81.
26. North, D., Smallbone, D., Vickers, I. (2001). Public Sector Support for Innovating SMEs. *Small Business Economics*, vol. 16.
27. Nyanga, T., Zirima, H. (2020). Reactions of small to medium enterprises in masvingo, Zimbabwe to Covid-19: Implications on productivity. *Bus. Excell. Manag.*, 10.
28. OECD (2020). *New OECD outlook on the global economy*. Retrieved from <https://www.oecd.org/coronavirus>, 28.09.2022.
29. Omar, A., Ishak, S. (2020). The impact of Covid-19 movement control order on SMEs' businesses and survival strategies. *Geografia. Malaysian Journal of Society and Space*, 16(2), 139-150
30. Osiadacz, J., Chalabala, M., Książek, E. (2019). *Diagnoza stanu innowacyjności Dolnego Śląska*. Wrocław.
31. Padilla-Ospina, A.M., Medina-Vásquez, J.E., Ospina-Holguín, J.H. (2021). Financial Determinants of Innovation in SMEs: A Machine Learning Approach. *Journal of Small Business Strategy*, Vol. 31, Iss. 5.
32. Pertuz, V.P., Perez, A.B., Geizzelez, M.L. (2018, November). Determinants of innovation capacity in medium-sized firms. *Journal of Physics: Conference Series*, Vol. 1126, No. 1, p. 012060. IOP Publishing.
33. Popa, A.E., Ciobanu, R. (2014). The Financial factors that Influence the Profitability of SMEs. *International Journal of Academic Research in Economics and Management Sciences*, July, Vol. 3, No. 4.
34. Poznańska, K. (1998). *Uwarunkowania innowacji w małych i średnich przedsiębiorstwach*. Warszawa: Dom Wydawniczy ABC.
35. Prahalad, C.K., Krishnan, M.S. (2010). *Nowa era innowacji*. Warszawa: PWN.
36. Pu, G., Qamruzzaman, M., Mehta, A., Naqvi, F., Karim, S. (2021). Innovative Finance, Technological Adaptation and SMEs Sustainability: The Mediating Role of Government Support during COVID-19 Pandemic. *Sustainability*, 13(16).
37. Puriwat, W., Tripopsakul, S. (2021). Customer Engagement with Digital Social Responsibility in Social Media: A Case Study of COVID-19 Situation in Thailand. *J. Asian Financ. Econ. Bus.*, 8.
38. Rothwell, R., Zegveld, W. (1985). *Reindustrialisation and Technology*. London: Longman.
39. Skowrońska, A., Tarnawa, A. (Eds.) (2022). *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce 2022*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.
40. Skowrońska, A., Zakrzewski, R. (Eds.) (2020). *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce 2020*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.

41. Sneader, K., Singhal, S. (2020). *Beyond coronavirus: The path to the next normal*. McKinsey & Company.
42. Spruch, W. (1973). *Strategia postępu technicznego*. Warszawa: PWN.
43. Svatošová, V. (2019). Identification of financial strategy in small and medium-sized entrepreneurship. *ACTA Universitatis Agriculturae ET Silviculturae Mendelianae Brunensis*, 65(4).
44. Wahyudi, I. (2014). Default risk analysis in micro, small and medium enterprises: Does debt overhang theory occur? *Asian Academy of Management Journal of Accounting and Finance*, 10(1), 95-131.
45. Wang, C.L., Ahmed, P.K. (2004). The Development and Validation of the Organisational Innovativeness Construct Using Confirmatory Factor Analysis. *European Journal of Innovation Management*, 7(4).
46. Wonglimpiyarat, J. (2010). Innovation index and the innovative capacity of nation. *Futures. The Journal Of Policy, Planning And Futures Studies*, vol. 42, Iss. 3, April.
47. Zhang, Y., Duysters, G., Cloudt, M. (2013). The role of entrepreneurship education as a predictor of university students' entrepreneurial intention. *Int. Entrep. Manag. J.*, Vol. 10.
48. Żołnierski, A. (2005). *Potencjał innowacyjny polskich małych i średniej wielkości przedsiębiorstw*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości, p. 5.

COORDINATED MEDICINE - ASSUMPTIONS FOR A MODEL OF MEDICAL FACILITY MANAGEMENT

Krzysztof SKOWRON

Silesian University of Technology, Faculty of Organization and Management; krzysztof.skowron@polsl.pl,
ORCID: 0000-0001-5458-6738

Purpose: The main purpose of the paper is to provide an introduction to the issues of the coordinated medicine model and the management of the medical facility. Due to the comprehensiveness of the topic, the paper is only a theoretical introduction to a further, more detailed publication series encompassing research assumptions.

Design/methodology/approach: The paper is based on a theoretical analysis and literature review.

Findings: The paper describes the theoretical assumptions of the model setting the directions for further research.

Research limitations/implications: The content presented is an outline of the further research area.

Practical implications: The considerations presented and references to international experience provide a basis for further research to identify possible impacts on improving the availability and quality of health service provision in Poland.

Social implications: Undertaking research based on the theoretical assumptions of the model described should improve the health of the population and make more rational use of resources to improve access to services.

Originality/value: The paper is primarily addressed to health care managers, as well as economists and government employees dealing with management issues in health care and public health.

Keywords: management, quality management, coordinated medicine, medical facility, healthcare system.

Category of the paper: General review.

1. Introduction

The development of health care systems in Poland and worldwide is taking place in two major directions. The dynamic growth of medical knowledge and technological progress result in increasing specialisation both within the medical professions and in the ways in which health

services are organised. This makes it possible to provide medical services based on the latest available diagnostic and therapeutic technologies, but also requires cost-intensive maintenance of complex organisational structures and multidisciplinary human resources. A side effect of the specialisation process within the health care system has been the weakening of organisational ties between individual providers. This phenomenon is exploited by some patients who skip the primary care level and go directly to specialists, both in outpatient and inpatient care. This leads to the over-consumption of expensive specialist services, causing a rapidly progressive increase in the operating costs of the entire health care system, without, however, translating into adequate results in terms of length and quality of life. Excessive specialisation also leads to an increase in inequality in access to services, as specialised services, which are individually expensive and limited, are addressed to a relatively small group of patients (Zapaśnik, Skłucki, Tumas, Szykiewicz, Jędrzejczyk, Popowski, 2016).

It is important to emphasise that, in parallel with increasing specialisation, highly developed countries provide citizens with free access to primary health care (PHC). Strong primary health care, due to its universal accessibility, has a significant positive impact on public health (Shi, 1994; Starfield, Shi, Macinko, 2005). By the same token, it must be added that other countries, including highly developed countries, which have consistently developed primary health care, have achieved significant improvements in the health of their populations (Macinko, Starfield, Shi, 2003). In Poland, there has been a discussion for many years about the need to increase the scope of competence of primary care and to transfer to the primary level some of the services hitherto performed only in specialist clinics, thus increasing its organisational complexity. However, in order to limit the adverse effects of progressive specialisation, there is a need to strengthen the role of the primary care physician as an effective coordinator of the entire treatment process (Suominen-Taipale, Koskinen, Martelin, Holmen, Johnsen, 2004).

The Polish health care system has a mixed financing system: capitation - in primary care and per service - for all other types of services. In many countries, where outpatient care (OPC) billing for services based on so-called unit products was introduced earlier than in Poland, this system has been heavily criticised as economically inefficient and unfriendly to the patient. In particular, opponents pointed out that billed points become more important than the real health needs of the patient (Kozierkiewicz, 2016).

Currently, changes have been initiated in Poland with the aim of creating a public payer financing system for health services provided as part of comprehensive care. Attempts of this type of action, with currently unknown results, may be: comprehensive care for women and children, combining invasive cardiology and orthopaedic services with rehabilitation, or the announced projects for reform of psychiatric care. However, the above changes in the way funding is provided are limited in scope and focus on particular health problems of limited patient groups. They do not, however, solve the fundamental problems facing health care in Poland, such as: limiting the negative effects of civilisation diseases, ensuring continuous preventive care for entire local populations, transferring diagnostic, therapeutic and

rehabilitation competencies to the lowest effective level of care, control and optimisation of costs. These challenges can only be met by a far-reaching change in the services provision process in outpatient healthcare.

2. Review of definitions

An alternative to the contemporary management of healthcare facilities at the level of primary care and OPC is the coordinated care model. This term is the most commonly used Polish translation of the English term *managed healthcare* or *managed care*. Other terms, less commonly used in Poland, are 'oriented care', 'comprehensive health care' or 'integrated health care'. All these terms attempt to encapsulate both the purpose and the approach to healthcare in the name. It should be emphasised that management plays a key role in it, and in turn both the coordination and integration of different levels of medical care providing a broad complex of health services and the way they are financed are important (Kowalska, Kalbarczyk, 2013).

The concept of coordinated medicine was born in the United States and is deeply rooted in American culture. It has proved so accurate that, transformed into business practice over several decades, it has resulted in the creation of many organisations guided by its principles, which in turn has helped to revolutionise the functioning of the US healthcare sector. It is worth mentioning that coordinated medicine is widespread in the United States, but it cannot be identified solely with this country, as elements of it can be found in many health care systems (the United Kingdom, Germany, Spain, Switzerland, Hungary, Australia or the countries of South-East Asia). Certainly, however, this expansion has been made possible by the success that the concept of healthcare management has had in the USA (Skowron, 2014).

According to the definition prepared by the WHO Regional Office for Europe (2016), coordinated care is "the concept of services related to diagnosis, treatment, care, rehabilitation and health promotion in terms of inputs, delivery and organisation of services and management". Coordinated healthcare leads to improvements in the availability, quality and efficiency of care, as well as patient satisfaction. From a practical perspective, an integrated delivery system can be described as a close working relationship between different services and services, such as hospitals, police, home care, public health, social care and other health-related services. Co-ordinated care is not an end result, but an important factor in improving the quality of care. There is extensive research outlining the different elements and definitions of such care, revealing different perspectives that influence the design and shape of the change process (AHRQ, 2007).

According to D. Kodner and C. Spreeuwenberg, coordination is a coherent set of methods and models at the funding, administrative, organisational, service delivery and clinical levels, designed to create connectivity, unify and stimulate collaboration within and between the

treatment and care sectors. The aim of these methods and models is to improve quality of care and life, patient satisfaction and system efficiency (...). Where such multi-faceted efforts to promote integration lead to benefits for recipients, the result can be referred to as coordinated care" (Kodner, Spreeuwenberg, 2002).

Of course, one *can* also encounter other functioning terms, for example: *patient's centred care, integrated care, shared care, collaborative care* (Kozieł, Kononiuk, Wiktorzak, 2017). However, it should be noted that some of these terms are used interchangeably, even though they do not always mean exactly the same thing. Co-ordinated (or integrated) care is also: methods and ways of organising care that make it possible to provide preventive and curative services of high quality and, at the same time, cost-effectiveness, ensuring continuity and coordination of treatment for patients with the greatest health needs (Øvretveit, 1998); a system that combines health care (emergency, primary and specialist) with social/environmental care (long-term care, home care, education) to improve system efficiency and patient outcomes (Leutz, 1999); a system that binds together inputs, staff, etc.; necessary for the system design, provision of services, organisation and management of care related to disease diagnosis, treatment, rehabilitation and health promotion to increase accessibility and quality of care, patient satisfaction and system performance (Gröne, Garcia-Barbero, 2001); models of payment, system organisation, delivery and professional pathways for health professionals that foster collaboration, coherence and consolidation of linkages between levels of care contributing to increased quality of care and patient life and system performance (Kozieł, Kononiuk, Wiktorzak, 2017).

The classification of coordinated care can also be presented through the following functions (Nolte, McKee, 2008; Fulop, Mowlem, Edwards, 2005; Shortell, Gillies, Anderson, Morgan, Mitchell, 2000): functional integration, i.e. coordination at a level not directly related to the provision of services (financing, information, management); organisational integration, i.e. coordination of care between institutions; interdisciplinary integration, understood as the creation of interdisciplinary teams; service integration, i.e. coordination of services within a single therapeutic process; normative integration, i.e. the definition of common norms and values and their orientation in the provision of services; systemic integration as the alignment of strategies and incentive systems at the organisational level. It should be added here that care coordination - to be effective and long-lasting - must take place at all levels of the system.

In a way, this can be confirmed by the rainbow model developed in 2000 by the team of P.P. Valentijn, S.M. Schepman, W. Opheij and M.A. Bruijnzeels (Valentijn, Schepman, Opheij, Bruijnzeels, 2000), i.e. a graphical elaboration of a definition representing the mechanisms and dimensions of coordinated care. While it is true that this model only considers coordinated care in the context of primary health care in the Netherlands, the model is still a useful tool to analyse the different levels of the health care system and to identify what needs to be changed, combined or coordinated to achieve better outcomes. Furthermore, the team of P.P. Valentijn, I.C. Boesveld, D.M. van der Klauw, D. Ruwaard, J.N. Struijs, J.J.W. Molema, M.A. Bruijnzeels

and H.J.M. Vrijhoef argue that coordination at all levels (clinical, specialist, organisational and systemic) ultimately results in a system of care that focuses on the needs of the service recipient and the population.

In contrast, D. Kodner and C.K. Kyriacou write about coordination at the level of: funding, understood as the consolidation of funds at different levels; administration, as the consolidation of tasks; institutions, as the planning and management of budgets within a group of providers; services provided, i.e. the coordination of treatment; and evaluation, understood as uniform and comprehensive evaluation procedures (Kodner, Kyriacou, 2000).

Following W.N. Leutz, it is possible in turn to present degrees of coordination based on three levels: as little change as possible - ad hoc cooperation; coordination within existing structures - defining mechanisms to facilitate communication and information exchange between different actors; full coordination - the creation of a new institution, encompassing all tasks, resources and funding (Leutz, 1999).

It is worth noting that a key feature of coordinated care is that it varies according to the level of activity and the degree of integration. Although coordinated care can take different forms in different health systems, a common feature is that gaps in integration at one level can have a negative impact on integration at other levels.

Despite the lack of a clear definition, the vast majority of coordinated care programmes have the same aim - to support chronically ill people. The result of these programmes is very often a reduction in hospitalisations (by up to 19%) and an increase in patient satisfaction (Dorling, Founaine, McKenna, Suresh, 2015).

In conclusion, it is worth being aware that the concept of "coordinated medicine" cannot currently be described as homogeneous. Over the decades, its development, depending on conditions, needs and opportunities, as well as the management mechanisms in place, has taken different organisational forms in practice.

In the most general terms, for the purposes of this paper, 'coordinated medicine' will be defined as a network of healthcare providers working together, formed by managers assuming financial and organisational responsibility for providing access to a relatively wide range of healthcare services, coordinating the care of their patients, ensuring continuity of treatment and internal supervision of its quality. Thus, it is a certain system in which the institution of a 'patient care coordinator' is created, i.e. a person or entity who would act as an agent. This agent could be an autonomously operating PHC, a primary or multispecialist outpatient healthcare facility, a network of facilities that includes primary healthcare within its scope, a hospital or an organisation of an administrative and organisational nature.

From the point of view of the management of a medical facility in the context of the principles of coordinated medicine, based on international experience, it is possible to identify the main objectives that significantly change the ways in which they have been managed to date. These include:

- improving the design and delivery of patient-centred healthcare,
- improving the quality of services for the elderly, chronically ill and disabled,
- reducing fragmentation, closing the gap and removing surplus/increasing efficiency in the use of existing resources,
- ensuring continuity and coordination of treatment,
- prevention of medical errors,
- increasing public satisfaction with the healthcare system and treatment processes,
- increasing the cost-effectiveness of ongoing processes,
- greater freedom in the selection of partners and subcontractors,
- more efficient management.

3. Diagnosis of the Polish health care system in the context of coordinated medicine

Issues related to the functioning of health care arouse great emotion around the world. In Poland, these discussions are most focused on a few persistent problems. Citizens regularly hear in the media about difficulties in accessing health care services, the exhaustion of limits on services, contracts that are too low in relation to hospitals' capacity to fulfil them, or the failure to provide needed services in a timely and sufficient manner. The problem of hospital indebtedness and the discussion on how to solve it has been growing louder in recent months.

If the overall level of outlays on health care, the number of consultations or hospitalisations, as well as the level of outlays on the treatment of patients within the framework of highly specialised treatment or drug programmes for rare and very serious diseases are taken as the measure of fulfilment of the health care needs of Poles, then certainly in this area enormous progress should be emphasised. Looking only at the level of public spending on health between 1999 and 2011, there has been an increase of almost 170 per cent. Public outlays increased from PLN 25 to 67 billion. In the same period, private expenditure on health rose from PLN 14 to 33 billion. As a society, more than PLN 100 billion is spent on health, which is approximately 7% of Poland's GDP. However, taking the level of the percentage of public expenditure on health as a measure of accessibility to benefits in the public sector, Poland, with the current level of wealth of its citizens and a 67% share of public expenditure on health, would be classified as a country with a problem of accessibility and equity in access to publicly funded benefits under WHO assessments. Thus, the bulk of private expenditure on benefits is due to unavailable (or far from adequate) access to publicly funded services.

An attempt is made below to indicate the essence of the problem to be tackled on a systemic basis, assuming the implementation of the coordinated medicine model.

First of all, it is important to note that effective treatment requires getting to the causes and making an effort to eliminate them, rather than just dealing with the prevailing symptoms. In this respect, the Polish system of publicly financed health care has, admittedly, undergone significant transformations over the last twenty years, but the reason for its inefficiency and low effectiveness is the lack of sufficient cohesion of the "contractual" relationship with the organisation of the health care system. Competition dominates the cooperation between healthcare providers, and the lack of incentives to promote the coordination of investment and the use of resources, as well as the continuity of patient care, mean that the system is constantly struggling financially. This creates an atmosphere full of mutual accusations and an almost permanent conflict between the public payer and the healthcare providers, with patients becoming a bargaining chip.

The second element is the problem of waiting queues. In the Polish health care system, the contract has a hugely important function in moving away from the safe world of guaranteeing money to maintain the resources of health care institutions without any particular analysis of their use, costs and results to providing - within the available resources - those services that are needed by sick people at a given time.

It is worth noting that, while at the beginning of their operation, both the health insurance funds and the branches of the National Health Fund did not have information precise enough to be able to correctly determine the structure of the health needs of the insured, subsequent years allowed for a process of "learning by experience". The needs of the insured were gradually better recognised, but in the absence of coordination of health policy and tools for their implementation both at the state and regional level, the public payer is unable to meet them. In such a situation, with financial constraints on the part of the payer, the main tool for limiting demand for services has become the rationing of access through the institution of the 'limit' - the creation of a waiting queue. The limit, on the other hand, contradicts the idea of universal accessibility to healthcare and is a solution unaccepted by society and the medical community.

Another element worth pointing out is cost shifting. The institution of the limit, although it has helped the health insurance funds and now the branches of the National Health Fund to balance revenues and expenditures, has not, however, protected the system from cost shifting. Incentives for cost shifting are hidden in the ways in which services are financed, and those who were susceptible to them were primarily those managing primary health care (PHC), which is financed using simple capitation techniques. PHC providers received funding in the form of a capitation rate to pay for the costs of providing primary care services. With rates set for narrow ranges of services, in the absence of appropriate standards of medical conduct, poor supervision of contract performance and, above all, the possibility of retaining surpluses due to 'frugal' management of funds, there is a strong incentive to refer patients for more expensive treatment in institutions with a so-called higher reference level. On the other hand, the forms of remuneration of individual GPs are important. If GPs do not manage budgets and do not also perform ownership functions, and if their remuneration systems are not linked to the number of

patients and do not use capitation techniques (usually a salary is the form of remuneration), then there are hidden motivations to refer patients to specialist treatment, linked to the reduction in the scope of responsibility and the amount of work in the PHC. These motivations, stemming from the way in which the services of the PHC are financed and related to the scope of responsibility and the intensity of the work performed, were reinforced by implicit incentives in the ways in which specialised services are financed, according to the *fee-for-service* individual payment rule. Lacking in the funding model for primary care physicians are incentives to provide better care in the form of payment for expected outcomes or to take on the role of a real coordinator of patient care, resulting in costs being passed on to higher levels of care, 'getting rid' of troublesome patients by referring them to specialists and generally poor quality healthcare in the public perception. In a solution to improve and relieve the burden on higher levels of care, including hospitals, it would be advisable to use arrangements similar to the UK - whether *GP-fundholding* or more advanced pay-for-performance.

The next handicap of the system is the decomposition of structures and fragmentation of medical care. The problem of cost shifting, mentioned earlier, is also strongly linked to the phenomenon of quality deterioration - the fragmentation of medical care and the weakness of incentives to oversee the standard of medical services. The problem of fragmentation of medical care is present in most health care systems, but is sometimes more acute where GPs work with a high degree of autonomy while suffering no financial consequences for their therapeutic decisions. Another consequence of such freedom of action may also be an increasing variation in the approach to identical health problems (*small area variation*), resulting from different styles of patient care. The disadvantage of the new allocation mechanisms in the universal insurance system at the health insurance fund stage was undoubtedly the unit contracts, which encouraged the decomposition of integrated structures (primary care, outpatient and inpatient care and ambulance services in one organisation covering a large population with care). Some structures were weak, but in many cases valuable bonds of cooperation between doctors of different specialities (formal and informal networks) were destroyed. These ties are very important for maintaining continuity of treatment and coordinating patient care. The problem of the dispersion of primary care providers, outpatient specialised care and hospitals, with the lack of financial incentives to consolidate and coordinate medical care, only reinforces the inefficient structure of health care in Poland. It seemed that the changes introduced in the scope of obligations of creating entities by the Healthcare Institutions Act of 15 April 2011 were to bring the desired results in a few years' perspective and, as a result of consolidation and restructuring processes related to the commercialisation of healthcare entities, bring about the adjustment of the number and type of healthcare entities to the real health needs of Poles. Improvements in efficiency in this respect should be attributed to the key elements of coordinated healthcare - appropriateness and substitution of treatment, as well as disease management and quality management tools.

Another element in the diagnosis of the health care system in Poland is the role of the general practitioner. An important change that was implemented in 1999 was to grant the patient the right to freely choose his or her general practitioner (as well as a nurse and a midwife), while at the same time being able to receive specialist services dependent on referrals issued by GP. The idea was that the doctor would become the patient's 'guide' through the healthcare system. However, this objective of the reform was not reflected in the designed institutions. The allocation mechanisms created meant that the *gatekeeper* function of the system was strengthened above all. Due to the incentive structure, which is inconsistent with the philosophy of family medicine, the actual responsibility of GPs has been limited to a narrowly defined scope of primary care, including diagnostic tests allocated within the capitation rate to primary care physicians. As a result, few people provide information about test results and appointments with other doctors to their GP. In turn, there is no legally enforceable obligation on the specialists to whom GPs send their patients to send back information on the diagnosis and recommended treatment. The result of all this is that there is no real possibility of coordinating the patient pathway in the healthcare system. This problem is clearly visible in Poland (Skowron, 2014).

One of the final elements is the issue of information. A peculiar feature of the healthcare sector is the uncertainty between doctor and patient related to the patient's illness. The strong asymmetry of information between patient and doctor is the most characteristic feature of the healthcare sector. The doctor usually has adequate expertise information to make a diagnosis and recommend the optimal therapy, while the patient is aware that he or she is not qualified to make rational choices. As a result of the asymmetry of information, a relationship of agency is created between the doctor and the patient, in which the doctor becomes an advocate for the patient's interests. In the Polish medical care system, the problem of inequality in access to information is additionally caused by the scarcity of information and the lack of mechanisms and tools for collecting and transmitting it. This problem concerns both the National Health Fund and, above all, medical entities at all levels of care. It is also compounded by the discrepancy between provinces in reporting on epidemiological parameters such as incidence, prevalence and causes of death. This results in a lack of data on the basis of which adequate health care can be planned, its delivery coordinated and its quality monitored. It should be added that in the Polish health care system, computerisation still stands at a relatively low level of development, and the IT integration of various health care entities in terms of access to information is also difficult and costly. An additional obstacle to the unification of these standards and the exchange of information is the fragmentation of the system and the multiplicity of creating entities.

A final element worth noting is the importance of contracting health services. Designing a functional and efficient healthcare system is a very complicated task - as it must take into account the economic specificities of the healthcare sector. The incompleteness and lack of symmetry of information between economic actors is the cause of market failures that prevent

the achievement of equilibrium states. Therefore, in order to eliminate or weaken the negative effects of such imbalances, assistance is sought in the sphere of institutional solutions that constrain the Polish health care system. Nevertheless, it has been assumed that the contract, together with the entire 'auxiliary apparatus', is considered the most serious instrument, with the proviso that the process of constructing contracts should be preceded by an analysis of the behaviour and relations between the subjects of economic activity. Such a research perspective sets the horizon for the increasingly frequent analyses undertaken today. They allow us to focus not on the outcome, but on the mechanisms that determined the final decisions on the allocation of financial resources. A contract between an insurer and a health care provider, which is part of the concept of coordinated health care, should (Kowalska, Kalbarczyk, 2013):

- be based on the principles of capital funding and its modification in certain spheres of benefits,
- whose implementation is guided by the 2S principles of appropriateness and substitution,
- allow for the management of the healthcare process and mechanisms in areas such as access to and quality of healthcare services,
- whose evaluation criterion is a measurable effect about which information is available to patients,

This is an opportunity to improve the situation that the Polish health care system needs at the moment.

4. Current problems for the management of medical facilities

The results of the Supreme Audit Office inspections, carried out periodically in recent years, indicate the need for urgent changes, both in terms of financing and organisation of the health care system. The system is not patient-friendly, does not ensure the efficient use of public funds, and creates problems for the managers of treatment entities and the staff employed in them. Among the main scopes, concerning the management of treatment facilities, five basic ones can be identified, the elements of which translate into problems related to the management of treatment facilities. These are (SAO, 2019):

In terms of organisation and resources:

- lack of a target vision for the system and a strategy for state policy in key areas of health system functioning,
- uneven distribution of healthcare providers, inadequate for the health needs of the population
- disparities between regions and between rural and urban areas,
- limited coordination between the different actors in the health system,
- lack of sufficient staff,

- decapitalisation of assets, failure to meet current building and equipment standards,
- indebtedness of healthcare entities,

In terms of funding the system:

- low public funding for health care. High share of patients in the financing of Benefits,
- financial flows incompatible with the health needs of the population,
- inefficient use of resources, including those caused by a flawed structure of expenditure on health services,
- payment for a benefit and not for its effect,
- inadequate pricing of services. Significant price spreads of contracted benefits,
- shortcomings of the contracting the services,
- control and systems for verifying the accounts sent by treatment providers,

In terms of benefit availability:

- limited and territorially differentiated access to services,
- lack of security of access to selected benefits,
- limited coverage of coordinated healthcare, fragmentation of care,
- access to selected benefits,
- lack of access to innovative medicines and treatments,

In terms of patient rights and safety:

- disrespect for the dignity and intimacy of patients and the right to pain treatment,
- failure to respect patients' rights when it comes to nutrition and conditions of stay in hospitals,
- lack of organisational standards for most types of benefits,
- poor quality of services provided,
- ineffective system of supervision of entities operating in the health system,
- an ineffective system of out-of-court redress for patients,

In terms of information resources of the system:

- lack of a coherent concept for the development of health care information systems,
- no data exchange between distributed registers,
- incomparability of data contained in dispersed registers,
- unreliability of the data contained in the scattered registers and the underestimation of the role and importance of medical registers,
- unreliability of the data contained in the medical records.

Of course, the scopes indicated above are very general and only show the most important problems to be solved in the health care system, which in turn is necessary to ensure that citizens realise their constitutional right to health care. One such direction could be the introduction of a well-designed model of coordinated medicine.

The impairments mentioned above will form the basis for the Author's research in this area.

5. Summary

Coordinated care can be a solution to the problems of Polish health care. It will not only improve the quality of patient care, but also increase its effectiveness. At the moment, the issue of introducing such a model of health care system management faces many challenges, which may hinder its introduction or discourage further expansion to new groups of patients. When deciding on such a management model, it should be emphasised that a prerequisite for this model is information sharing, so it is important to connect different IT systems (or build new dedicated solutions) - doctors must have full information about their patients (both administrative and medical data) delivered in a timely and usable manner. Finances and economic pressures on healthcare systems can also be a significant impediment to integrative care projects. It takes several years to implement a project and a short-term approach to efficiency gains can overshadow the benefits of long-term, systematic improvements. Another major challenge is overcoming a lack of understanding on the part of the patient and physician about the needs of the evolving system. Integrated care prioritises the needs of the patient, focusing on managing health with the help of information and assistive technologies. It is also worth bearing in mind that the governance model under discussion raises concerns for both doctors (due to the change in the way funding is directed - there is a greater focus on the outcomes of treatment rather than the delivery of the service itself, as in the traditional model) and other system staff working with the doctor (there is an issue of independence and subordination of individuals and processes within the redefined model). In addition to the above challenges, there are also issues of different types of integration (coordination) and differences in the priorities of different groups caring for the patient, e.g. medical staff or social workers, who have their own standards and regulations.

References

1. AHRQ (2007). *Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies, Vol. 7, Care Coordination*. Rockville: Agency for Healthcare Research and Quality Report.
2. Dorling, G., Founaine, T., McKenna, S., Suresh, B. (2015). *The Evidence for Integrated Care*. London: McKinsay & Company.
3. Fulop, N., Mowlem, A., Edwards, N. (2005). *Building Integrated Care: Lessons from the UK and Elsewhere*. London: The NHS Confederation.

4. Gröne, O., Garcia-Barbero, M. (2001). Integrated care: A position paper of the WHO European Office for Integrated Health Services. *International Journal of Integrated Care*, 1(21).
5. www.sprawnepaństwo.pl, 30.09.2022.
6. Kodner, D., Kyriacou, C.K. (2000). Fully integrated care for the frail elderly: Two American models. *International Journal of Integrated Care*, 1(1).
7. Kodner, D., Spreeuwenberg, C. (2002). Integrated care: Meaning, logic, applications and implications – a discussion paper. *International Journal of Integrated Care*, 2(3).
8. Kowalska, K., Kalbarczyk, W.P. (2013). *Raport: koordynowana opieka zdrowotna. doświadczenia międzynarodowe, propozycje dla Polski*. Warszawa.
9. Kozieł, A., Kononiuk, A., Wiktorzak, K. (2017). *Zdrowie Publiczne i Zarządzanie*, 15(3), 251-257.
10. Kozierkiewicz, A. (2016). *Konsolidacja i integracja opieki zdrowotnej*. Akademia NFZ, <http://akademia.nfz.gov.pl/wp-content/uploads/2016/04/AKOZIERKIEWICZ.pdf>, 30.09.2022.
11. Leutz, W.N. (1999). Five laws for integrating medical and social services: Lessons from the United States and the United Kingdom. *The Milbank Quarterly*, 77(1), 77-110.
12. Macinko, J., Starfield, B., Shi, L. (2003). The Contribution of Primary Care Systems to Health Outcomes within Organization for Economic Cooperation and Development (OECD) Countries, 1970-1998. *Health Services Research*, 38(3), pp. 831-865.
13. NIK, Raport: system ochrony zdrowia w Polsce – stan obecny i pożądane kierunki zmian, KZD.034.001.2018 Nr ewid. 8/2019/megainfo/KZD, 30.09.2022.
14. Nolte, E., McKee, M. (2008). Integration and chronic care: A review. In: E. Nolte, M. McKee (eds.), *Caring for People with Chronic Conditions. A Health System Perspective* (pp. 64-91). World Health Organization on behalf of the „European Observatory on Health Systems and Policies”.
15. Øvretveit, J. (1998). *Integrated Care: Models and Issues*. Briefing Paper. Gothenburg: The Nordic School of Public Health.
16. Shi, L. (1994). Primary Care, Specialty Care, and Life Chances. *International Journal of Health Services*, 24(3), pp. 431-458.
17. Shortell, S., Gillies, R., Anderson, D., Morgan, K., Mitchell, J. (2000). *Remaking Health Care in America: The Evolution of Organized Delivery Systems*. San Francisco: The Jossey-Bass HealthCare Series.
18. Skowron, K. (2014). Model medycyny koordynowanej jako alternatywa dla realizacji celów polityki społecznej państwa. In: K. Głębicka (ed.), *Rola aktywnej polityki społecznej w rozwiązywaniu problemów społecznych, Tom I, Wdrażanie aktywnej polityki społecznej w środowisku lokalnym*. Radom: Wydawnictwo UTH.
19. Starfield, B., Shi, L., Macinko, J. (2005). Contribution of Primary Care to Health Systems and Health. *Milbank Quarterly*, 83(3), pp. 457-502.

20. Suominen-Taipale, A.L., Koskinen, S., Martelin, T., Holmen, J., Johnsen, R. (2004), Differences in older adults' use of primary and specialist care services in two Nordic countries. *European Journal of Public Health, 14(4)*, pp. 375-380.
21. Ustawa 15 kwietnia 2011 r. o działalności leczniczej, Dz.U. 2011, Nr 112, poz. 654.
22. Valentijn, P.P., Boesveld, I.C., van der Klauw, D.M., Ruwaard, D., Struijs, J.N., Molema, J.J.W., Bruijnzeels, M.A., Vrijhoef, H.J.M. (2015). Towards a taxonomy for integrated care: A mixedmethods study. *International Journal of Integrated Care, 15(1)*.
23. Valentijn, P.P., Schepman, S.M., Opheij, W., Bruijnzeels M.A. (2013). Understanding integrated care: A comprehensive conceptual framework based on the integrative functions of primary care. *International Journal of Integrated Care, 13*.
24. WHO Regional Office for Europe (2016). *Strengthening People centered Health Systems in the WHO European Region: Framework for Action on Integrated Health Services Delivery*. Copenhagen.
25. Zapaśnik, A., Skłucki, J., Tumas, J., Szykiewicz, P., Jędrzejczyk, T., Popowski, P. (2016). *Koncepcja Koordynowanej Ambulatoryjnej Opieki Zdrowotnej*. Gdańsk: Polskie Towarzystwo Programów Zdrowotnych.

PROJECT KNOWLEDGE MANAGEMENT IN LOCAL GOVERNMENT ORGANISATIONS

Barbara SORYCHTA-WOJSCZYK^{1*}, Anna MUSIOL-URBANCZYK²

¹ Silesian University of Technology, Faculty of Organization and Management, Zabrze;
Barbara.Sorychta-Wojczyk@polsl.pl, ORCID: 0000-0002-5237-8908

² Silesian University of Technology, Faculty of Organization and Management, Zabrze;
Anna.Musiol-Urbanczyk@polsl.pl, ORCID: 0000-0002-4109-1063

* Correspondence author

Purpose: The purpose of this paper is to identify the importance of project knowledge management in local government organisations in Poland.

Design/methodology/approach: The analysis carried out for this paper included a literature analysis, survey research and analysis of the research results. The hypotheses set for the research were verified using statistical methods on the basis of the collected data from a questionnaire survey addressed to randomly selected district offices and town halls in Poland.

Findings: Based on the literature review, the paper confirms the relevance of knowledge management and project knowledge management in the activities and development of organisations. Based on the results of the study, it can be concluded that local government organisations in Poland manage project knowledge because they are aware of its importance in effective project management.

Originality/value: Project knowledge management is not only important in companies, but also in local government organisations for effective project management. Collecting and documenting project knowledge and experiences from projects helps to reduce errors during subsequent projects.

Keywords: project knowledge management, project management, local government organisations.

Category of the paper: research paper.

1. Introduction

The rapid and effective use of knowledge is extremely important in the operations of today's organisations. Knowledge is not only one of the main resources of a company, but as Peter Drucker writes, it is the driving force behind the development of a company and a key factor of creativity in all areas of life (Grudzewski, Hajduk, 2005).

Knowledge is closely linked to the human factor, as people are the main carrier of the knowledge resource. The mere possession of knowledge by individual employees, does not condition the development of an organisation, proper knowledge management is necessary.

Knowledge management is equated with a certain process that contributes to the achievement of measurable results. From a process perspective, knowledge management is defined differently by many authors in the literature. W.R. Bukowitz and R.L. Williams indicate that "knowledge management is the process by which an organisation generates wealth from its intellectual or knowledge-based organisational assets (Bukowit, Williams, 1999). NASA, on the other hand, defines knowledge management as "providing the right knowledge, to the right people, at the right time, and helping to create, share and make decisions based on that knowledge in such a way as to achieve measurable impact". In a similar vein is K.M. Wiig, who defines knowledge management as "the systematic, explicit and deliberate creation, renewal and application of knowledge to maximise the effectiveness of the enterprise and achieve a return on its knowledge assets" (Wiig, 1993). J.P. Perez and P. Ordonez de Pablos define knowledge management as the process of producing or capturing knowledge, organising and delivering the value of accumulated knowledge, transferring knowledge, and establishing mechanisms for use, including reuse, by both individuals and groups of people in an organisation (Perez, Ordonez de Pablos, 2003).

Initial interest in knowledge management practices included knowledge creation, organisation, sharing and application (Jashapara, 2004). Later, research covered adjacent areas including, inter alia, project knowledge management (Wyrozębski, Pawlak, 2021). As A. Kozarkiewicz notes, knowledge management is an important element of project management, and the specificity of knowledge management in projects is shaped by their characteristics, primarily their temporality (Kozarkiewicz, 2012). Nowadays, organisations, including local government organisations, implement many projects. During the planning and implementation of projects, knowledge and experience should be accumulated and then used to avoid potential mistakes in subsequent projects.

The aim of this paper is to identify the importance of project knowledge management in local government organisations in Poland.

2. Project knowledge management

Knowledge is of key importance in the activities of organisations including the implementation of project projects. In the area of research, the understanding of the role of knowledge in project management has resulted in publications by many authors (Hanisch et al., 2009; Kasvi et al., 2003; Wyrozębski, 2014; Spalek, 2012). Each successive project implemented by an organisation contributes to the growth of knowledge and experience, which

should be collected and stored appropriately so that these knowledge resources do not dissipate with the end of the project and the dissolution of the project team.

The importance of knowledge and the need to use it effectively in organisations is therefore increasing (Grillitsch et al., 2007). Project team members learn from experience, especially if they repeat similar activities. Knowledge management enables them to reduce project planning and execution time, and the sharing of lessons learned leads to improvement in project management (Ireland, 2007).

Leading project management methodologies and standards (Project Management Institute (PMI), 2017; Office of Government Commerce (OGC), 2017; ISO 21502:2020; Sutherland, Schwaber, 2020) emphasise the importance of project knowledge management including gathering and documenting lessons learned, implementing process improvement. This applies to all organisations, including those whose business is not for profit.

Project management and the characteristics of projects place specific demands on project knowledge, i.e. knowledge related to the implementation of projects. In this context, it is important to acquire and store documents collected during project management, to share knowledge, experience and important information within the project team, to supplement project knowledge and to create conditions for knowledge transfer.

Knowledge management should therefore be seen as activities that strengthen the ability of local government organisations to achieve their objectives. In order for this to be possible, it must be remembered that knowledge management should not only be considered in terms of managing information as a basic component of knowledge, but also in terms of managing knowledge workers. The key to this kind of analysis seems to be the so-called process approach (Skica, 2011). According to this approach, knowledge management is the totality of processes that enable knowledge to be collected, disseminated and used to achieve organisational goals. In this context, three main stages of the knowledge management process can be distinguished:

- collection of knowledge,
- sharing knowledge,
- transforming knowledge into decisions.

The literature review carried out for this study shows that this topic is important and valid in today's world. Project knowledge management in companies has been the subject of research by many authors, whereas with regard to local government organisations, the topic has not yet been frequently addressed.

3. Test procedure

For the purpose of preparing the paper, a research mode was adopted in line with the methodological principles applicable in the management sciences. The research mode consists of the following stages: formulation of the research problem and research questions, formulation of research hypotheses, verification of hypotheses as a result of the research conducted, analysis of the collected empirical material and formulation of conclusions.

Efficient project knowledge management is related to the acquisition and storage of documents collected during project implementation. This provides a source of knowledge that can and should be used on subsequent projects to save time and avoid problems. Knowledge management is also, sharing knowledge, information and experience. When implementing multiple projects, local government organisations should manage project knowledge to improve future project planning and implementation. In this context, the question should be asked: do local government organisations in Poland manage project knowledge? i.e.:

- Do they collect and store project knowledge?
- Do they use the knowledge and experience from projects carried out in subsequent projects?
- Do project managers and project team members share knowledge and experience?
- Is the project experience documented during the project?
- Is there a correlation between the role of project management in a local government organisation and the project knowledge management process.

The research hypotheses in this study addressed issues related to project knowledge management in a local government organisation. The research hypotheses, to be verified by statistical tests, took the following form:

- H1. Local government organisations in Poland manage project knowledge to a considerable extent.
- H2. There is a statistically significant relationship between awareness of the importance and value of project management and the stages of the project knowledge management process.
- H3. There is a statistically significant relationship between the collection, documentation and use of project knowledge, with project managers' and project team members' attitudes to knowledge sharing.
- H4. There is a statistically significant relationship between awareness of the importance of knowledge in effective project management and project knowledge management.

In order to verify the above-mentioned research hypotheses, the following section of the paper analyses the data obtained from own studies conducted in local government organisations in Poland.

The studies yielded data from 200 local government organisations in Poland, i.e. 145 city councils and 55 poviats councils, which, with a significance level of $\alpha = 0.05$ and a permissible error of $e = 5\%$, constitutes a representative research sample.

The study was based on a survey questionnaire conducted in Poland at the local level in December 2019 and January 2020 among randomly selected Polish poviats and cities. In the study, data collection was based on the CAWI (Computer-Assisted Web Interview) method, which is a technique for collecting information in quantitative research by means of an electronic questionnaire to be filled in online. The survey questionnaire consisted of 8 statements rated on a 5-point Likert scale. The statements adapted from the questionnaire were based on the literature review and adapted to the specific activities of local government organisations. The study was conducted among local government officials.

4. Study results

4.1. Characteristics of the research sample

The statements in the questionnaire relate to the opinions and experiences of local government officials with regard to project knowledge management in these organisations.

The survey questionnaire was completed by representatives of such organisational units as: deputy mayors/deputy presidents (2.5% of respondents), head/deputy head (11.5% of respondents), director/department head/deputy director (17% of respondents), city/poviat secretaries (10% of respondents), specialist (30.5% of respondents), inspector (28.5% of respondents). Among the respondents, the largest number of people (29.5%) are office employees with seniority of more than 20 years. An equally large group of respondents are those with seniority of 16-20 years (26%), and with seniority of 11-15 years (25%). Respondents with seniority of 6-10 years accounted for 11%, with seniority of 4-5 years (3%), and with seniority of up to 3 years (5.5%). By far the largest group of people who completed the survey were those with a university degree (97%). Among them, it is possible to identify those with a bachelor's or engineering degree (6%), those with a second-degree university education (89%), and those with a third-degree education (2%). Respondents with secondary education accounted for 3%.

The questionnaire adopted a verbal description of the answers given: 1 – definitely no/never, 2 – rather no/rarely, 3 – neither yes nor no/sometimes, 4 – rather yes/frequently, 5 – definitely yes/always.

As there were no significant differences in the responses obtained from city and poviat offices, the analysis of the results obtained was carried out for both groups together.

4.2. Verification of research hypotheses

4.2.1. Hypothesis 1: Local government organisations in Poland manage project knowledge to a significant extent

According to the adopted process model, project knowledge management is the totality of processes that enable the collection, dissemination and use of knowledge for effective project management. In this context, three main stages of the project knowledge management process can be distinguished, i.e.: gathering project knowledge, sharing project knowledge, transforming knowledge into decisions.

With regard to the results obtained in terms of collecting and storing knowledge and experience from completed projects, the largest number (almost 42%) of local government organisations often collect project knowledge, while 37% of organisations always do so. 14.5% of local government organisations collect knowledge sometimes. 1.5% of local government organisations never collect project knowledge and rarely 5% of organisations do. The details are shown in Figure 1.

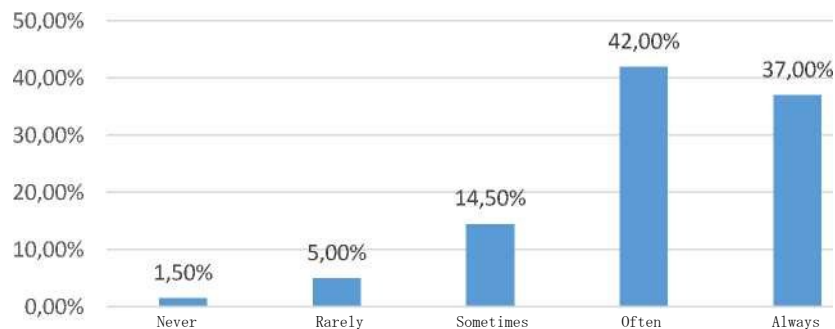


Figure 1. Frequency of knowledge gathering from ongoing projects in surveyed local government organisations.

Source: own work.

Project experience that is gained during project implementation is often documented; such a response was given by as many as 42% of the organisations and in 26% of the organisations this experience is always documented. Only in 3% of the organisations the project experience is never documented and in 10% it is rarely documented. The details are shown in Figure 2.

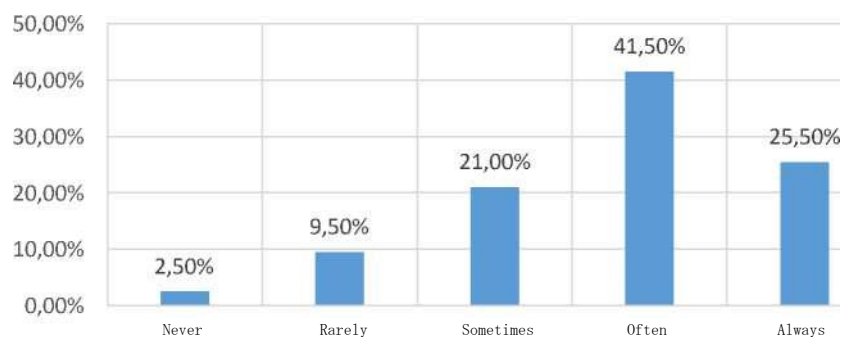


Figure 2. Frequency of documenting experience gained during project implementation in surveyed local government organisations.

Source: own work.

Sharing project knowledge, is about disseminating knowledge and making it accessible to those involved. In project management, it is important that the transfer of knowledge takes place between the participants in the process, so that the intellectual capital of each actor can be increased.

The research carried out on project knowledge sharing in local government organisations showed that both project managers and project team members in the vast majority of organisations are willing to share their knowledge and experience (Figure 3, Figure 4).

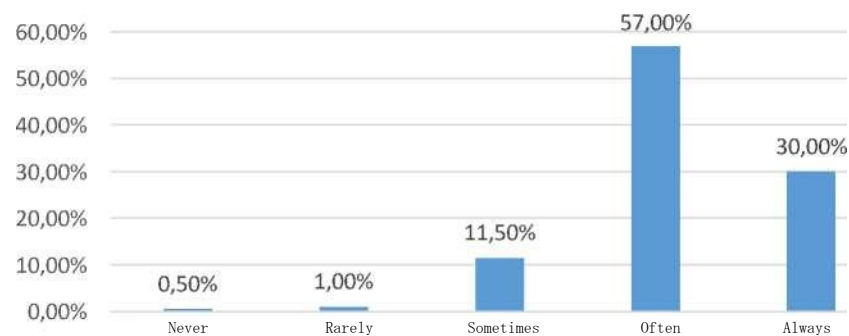


Figure 3. Frequency of sharing project knowledge and experience gained by project managers in surveyed local government organisations.

Source: own work.

It is worth noting that both project managers and project team members in most offices are willing to share knowledge and experience gained during project implementation. Such a practice is not found in about 2% of the surveyed offices, and in more than 10% of the offices sharing knowledge and experience is not a generally accepted practice and this is done selectively.

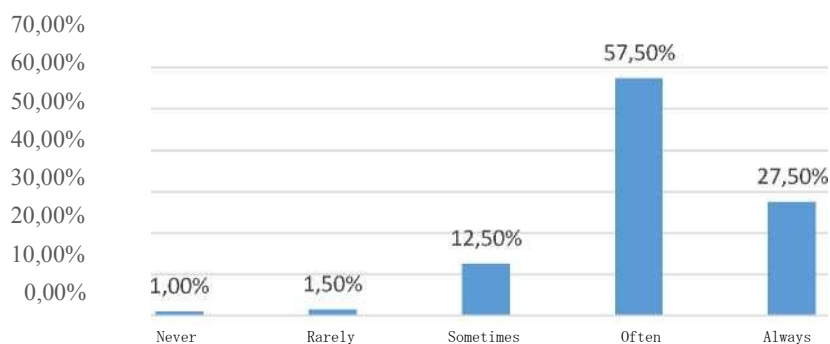


Figure 4. Frequency of sharing project knowledge and experience gained by project team members in surveyed local government organisations.

Source: own work.

The final stage of the process view of project knowledge management is knowledge utilisation. The success of this stage is highly dependent on the earlier stages of knowledge gathering, documentation and sharing.

In local government organisations, this stage of project knowledge management is also highly rated by respondents. The research carried out showed that in the vast majority of city and poviát offices (89%) the knowledge and experience gained from completed projects is used.

Only in two offices this practice is not applied, and in 19 offices (9.5%) project knowledge and experiences are sometimes used (Figure 5).

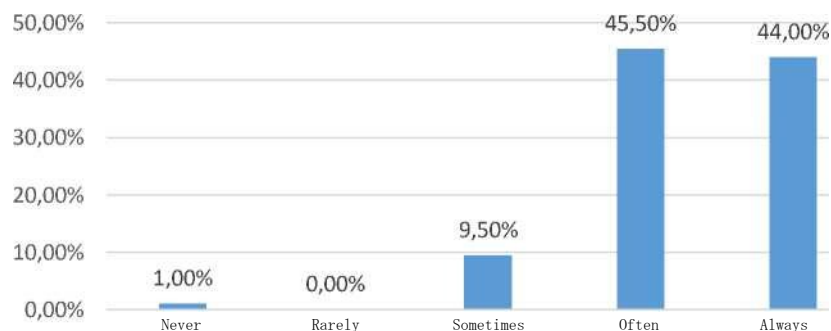


Figure 5. Frequency of use of knowledge and experience from follow-up projects in surveyed local government organisations.

Source: own work.

The results of the research carried out show that in local government organisations in Poland knowledge is accumulated and used in subsequent projects. There is also knowledge transfer especially between individual project team members.

Table 1.

Parameters of the distribution of local government officials' assessments of project knowledge management in these organisations

Process steps		Average	Standard deviation	Median
Gathering project knowledge	Knowledge and experience from completed projects is collected and stored	4.08	0.92	4
	During the project experience is documented	3.78	1.01	4
Sharing project knowledge	Project managers are keen to share their knowledge and experience	4.15	0.69	4
	Project team, members are keen to share knowledge and experience gained during projects	4.09	0.74	4
Use of project knowledge	Knowledge and experience from completed projects is used in subsequent projects	4.32	0.73	4
	The office has a system in place to support project knowledge management	2.73	1.23	3

Source: own work.

Based on the research results presented, it can be concluded that hypothesis one has been positively verified. The vast majority of surveyed local government organisations in Poland manage project knowledge (Figure 1-5). This is also confirmed by the parameters of the distribution of local government officials' assessments of project knowledge management in these organisations. The median for individual stages of the project knowledge management process is 4, with mean scores ranging from 3.78 to 4.32 and standard deviation from 0.73 to 1 (Table1).

However, many local government organisations lack a system to support project knowledge management (Table 1). For today, this form of collecting and distributing project knowledge seems sufficient, as evidenced by the completed projects in these local government

organisations. However, looking at the long term, from the perspective of the development of such an organisation, the formalisation of the project knowledge management process should be considered.

4.2.2. Hypothesis 2: There is a statistically significant relationship between awareness of the importance and value of project management and the stages of the project knowledge management process

Hypothesis two on the relationship between awareness of the importance and value of project management and the stages of the project knowledge management process was verified using the rho-Spearman correlation testing method (Table 2).

The rho-Spearman correlation coefficient can take values in the range $(-1,1)$. A positive sign at the value of the coefficient indicates that an increase in the value of one variable defines an increase in the value of the other variable, while a negative sign at the value of the correlation coefficient means that an increase in the value of one variable defines a decrease in the value of the other variable. The strength of the relationship between the variables is expressed by the absolute value of the correlation coefficient, with a value of 0 indicating no relationship and a value of 1 being a perfect correlation. In this study, a significance level of 0.05 was adopted. If the significance level p is less than 0.05, the relationship between the variables should be considered significant.

All stages of the project knowledge management process are related to awareness of the importance and value of project management in local government organisations. All relationships tested (moderate to strong) proved statistically significant, so the hypothesis was tested positively.

Table 2.

Results of the rho-Spearman correlation test for hypothesis 2

	There is a general awareness in the office of the importance and value of project management	
	R	p
There is an awareness in the office of the importance of knowledge in effective project management	0.70	4.10E-31
Knowledge and experience from completed projects is collected and stored.	0.59	3.06E-20
Knowledge and experience from completed projects is used in subsequent projects	0.52	2.35E-15
Project managers are keen to share their knowledge and experience	0.58	2.41E-19
Project team, members are keen to share knowledge and experience gained during projects	0.58	3.71E-19
During the project experience is documented	0.60	2.79E-21

R - correlation coefficient, p - significance level

Source: own work.

4.2.3. Hypothesis 3: There is a statistically significant relationship between the collection, documentation and use of project knowledge with project managers' and project team members' attitudes towards knowledge sharing

Hypothesis three on the relationship between the collection, documentation and use of project knowledge with project managers' and project team members' attitudes towards knowledge sharing was verified using the rho-Spearman correlation testing method (Table 3).

All examined relationships between the collection, documentation and use of project knowledge with project managers' and project team members' attitudes towards knowledge sharing proved statistically significant, so the hypothesis was tested positively.

Table 3.

Results of the rho-Spearman correlation test for hypothesis 3

	Project managers are keen to share their knowledge and experience		Project team members are keen to share knowledge and experience gained during projects	
	R	p	R	p
There is an awareness in the office of the importance of knowledge in effective project management	0.56	5.65E-18	0.58	2.92E-19
Knowledge and experience from completed projects is collected and stored.	0.62	1.34E-22	0.59	5.82E-20
Knowledge and experience from completed projects is used in subsequent projects	0.68	1.05E-28	0.65	1.27E-25
During the project experience is documented	0.61	5.42E-22	0.63	9.48E-24

R - correlation coefficient, p - significance level

Source: own work.

4.2.4. Hypothesis 4: There is a statistically significant relationship between awareness of the importance of knowledge in effective project management and project knowledge management

Hypothesis four on the relationship between awareness of the importance of knowledge in effective project management and project knowledge management was verified using the rho-Spearman correlation testing method (Table 4).

The tested relationship between awareness of the importance of knowledge in effective project management and project knowledge management proved statistically significant, so the hypothesis was tested positively.

Table 4.*Results of the rho-Spearman correlation test for hypothesis 4*

	There is an awareness in the office of the importance of knowledge in effective project management	
	R	p
Knowledge and experience from completed projects is collected and stored	0.66	2.94E-26
Knowledge and experience from completed projects is used in subsequent projects	0.56	7.09E-18
Project managers are keen to share knowledge and experience	0.56	5.65E-18
Project team members are keen to share knowledge and experience gained during projects	0.58	2.92E-19
During the project experience is documented	0.61	3.79E-22

R - correlation coefficient, p - significance level

Source: own work.

4.3. Discussion of results

The literature emphasises that knowledge is one of the most valuable resources that needs to be properly managed. Knowledge management, including project knowledge, is just as important in private organisations as in public organisations.

Surveys conducted in local government organisations showed that in terms of collecting and storing project knowledge and experience, almost 42% of local government organisations often collect project knowledge and 37% of organisations always do so. Similarly, the documentation of project experiences was rated similarly highly, with 26% of organisations always documenting and 42% of organisations documenting frequently.

Research conducted by Paweł Wyrozębski on project knowledge management practices in Polish organisations in 2011 on a group of 397 respondents from various industries (including 33 respondents from public administration) shows that in Polish organisations project experiences are documented. The use of this practice often, usually and always was indicated by 52.4% of respondents. This is slightly lower than the result obtained in the research conducted in local government organisations, but it should be noted that the research conducted by P. Wyrozębski was carried out much earlier, which undoubtedly influences the results obtained.

A similar difference between these studies concerns the sharing of project knowledge. Research conducted in local government organisations shows that both project managers and project team members are willing to share knowledge and experience gained during project implementation. This practice occurs frequently and always in more than 85% of the surveyed offices. On the other hand, in P. Wyrozębski's study, the practice of sharing knowledge applies to almost 74% of organisations.

The practice of using knowledge and experience from implemented projects in local government organisations was rated highly by the respondents (89% of city and county offices use the acquired knowledge and experience always or often). A significantly lower result was

obtained in P. Wyróżewski's study, where such practice is always, often or usually used by a total of 67% of the surveyed organisations. Such a difference in the results obtained in both studies is influenced not only by the periods in which these studies were conducted, but also by the specific nature of the organisation. Local government organisations implement projects co-financed by external funding to a large extent, and this makes the project documentation created on the basis of which funding was successfully obtained a good source of knowledge used to prepare subsequent project applications.

Project knowledge management can be improved by implementing a publicly accessible system for collecting, storing and sharing project knowledge. However, research has shown that only 26% of local government organisations have elements of such a system in place. Research conducted by S. Spalek in enterprises (Spalek, 2013a), shows that only 34% of the surveyed enterprises had a centralised, publicly available system for collecting, storing and sharing project knowledge. Although this is not an impressive result, it is higher than that obtained in local government organisations.

As B. Jałocha, the attempt to implement a uniform centralised system for collecting, storing and sharing project knowledge supported by an IT tool may result in negative reactions from employees of public institutions, who may be passive or even oppose the implementation of such an IT system, fearing greater control and more objective measurement of the effectiveness of their work (Jałocha, 2011). Furthermore, the author notes that as a result of the implementation of such a system, employees will be burdened with additional duties resulting from new processes related to the collection of project experience.

5. Conclusions

As a result of the research, it was possible to obtain a picture of the state of project knowledge management in local government organisations in Poland. The research conducted provided answers to the research questions posed and positively verified the research hypotheses.

1. In the surveyed city and poviát offices, project knowledge is collected and used in subsequent projects. According to the survey results, in 79% of the surveyed city and poviát offices in Poland, project knowledge from implemented projects is "often" and "always" collected, and in 67% of the surveyed city and district offices, the experience gained during project implementation is "often" and "always" documented.
2. Project managers and project team members ensure proper knowledge transfer by sharing their experience and knowledge gained during project planning and implementation. This practice is applied in more than 85% of the surveyed city and poviát offices in Poland. What is noteworthy is the frequency with which knowledge

and experience from projects implemented in subsequent projects is used in the surveyed local government organisations. In more than 89% such practice is 'often' and 'always' applied. This indicates that local government organisations recognise the need to manage project knowledge.

3. Admittedly, many local government organisations lack a system to support project knowledge management, which may indicate a lack of a formalised project knowledge management process. These considerations suggest future research into the benefits of project knowledge management and research to identify success factors for implementing a project knowledge management system in such organisations.
4. Statistical tests conducted for this research showed significant correlations between awareness of the importance and value of project management and project knowledge accumulation, project knowledge sharing and project knowledge use.

References

1. Bukowitz, W.R., Williams, R.L. (1999). *The Knowledge Management Fieldbook*. London: Financial Times/Prentice Hall.
2. Grillitsch, W., Müller-Stingl, A., Neumann, R. (2007). Successful Sharing of Project Knowledge: Initiation, Implementation and Institutionalisation. *The Electronic Journal of Knowledge Management, Vol. 5. Iss. 1*, pp. 19-28.
3. Grudzewski, W.M., Hejduk, I.K. (2005). Zarządzanie wiedzą w organizacjach. *E-mentor, 1(8)*.
4. Hanisch, B., Lindner, F., Mueller, A., Wald, A. (2009). Knowledge management in project environments. *Journal of Knowledge Management, 13(4)* pp. 148-160.
5. Ireland, D. (2007). Sharing Experiences In Project Management. *Prez, sez. 2*.
6. ISO (2020) ISO 21502:2020 Project, programme and portfolio management — Guidance on project management. International Organization for Standardization.
7. Jałocha, B. (2011). Problematyka wdrożeń projektów informatycznych w instytucjach publicznych. *Zarządzanie Publiczne, 2(14)*.
8. Jashapara, A. (2004). *Knowledge management: An integrated approach*. Harlow: Pearson Education Limited.
9. Kasvi, J.J.J., Vartiainen, M., Hailikari, M. (2003). Managing knowledge and knowledge competencies in projects and project organizations. *International Journal of Project Management, 21*, pp. 571-582.
10. Office of Government Commerce (OGC) (2017). *Managing successful projects with PRINCE2*. London: The Stationery Office.

11. Perez, J.R., Ordonez de Pablos, P. (2003). Knowledge management and organizational competitiveness: A framework for human capital analysis. *Journal of Knowledge Management, Vol. 7(3)*.
12. Project Management Institute (PMI) (2017). *A Guide to the Project Management Body of Knowledge*. Newton Square, PA: Project Management Institute.
13. Skica, T. (2011). *Zarządzanie wiedzą w samorządzie terytorialnym*. Rzeszów: Wydawnictwo Wyższej Szkoły Informatyki i Zarządzania.
14. Spalek, S. (2012). The role of project management office in multi-project environment. *International Journal of Management and Enterprise Development, 12(2)*, pp. 172-188.
15. Sutherland, J., Schwaber, K. (2020). *The Scrum Guide. The Definitive Guide to Scrum: The Rules of the Game*, <https://scrumguides.org/index.html>.
16. Wiig, K.M. (1993). *Knowledge management Foundations: Thinking About Thinking – How People and Organizations Create, Represent, and Use Knowledge*. Arlington: Schema Press.
17. Wyrozebski, P., Pawlak, R. (2021). The role and meaning of lessons learned in project knowledge management in organizations in Poland. *Procedia Computer Science, 192*.
18. Wyrozebski, P. (2014). *Zarządzanie wiedzą projektową*. Warszawa: Difin.

INTELLECTUAL PROPERTY ISSUES IN MANAGING A SMART CITYTomasz SZEWC^{1*}, Szymon RUBISZ²

¹ Faculty of Organization and Management, Silesian University of Technology; tomasz.szewc@polsl.pl,
ORCID: 0000-0001-6326-4626

² Faculty of Organization and Management, Silesian University of Technology; szymon.rubisz@polsl.pl,
ORCID: 0000-0002-0999-5855

* Correspondence author

Purpose: The aim of the paper is to examine the specific issues concerning intellectual property protection in the development and functioning of smart city. The authors describe Polish law of intellectual property protection and interpret it in terms of actions carried out when the smart city is created, implemented, and then managed.

Design/methodology/approach: This work uses the formal and dogmatic method typical of legal sciences. It contains the content of legal norms and their interpretation, and is based on the analysis of the literature as well.

Findings: There are many areas where the law of intellectual property protection is directly related to acts taken when a city is transformed into smart city, covering the scope of copyright and industrial property. They are mentioned and analysed and their implications for city management are discussed.

Practical implications: We have shown what smart city managers should know from the scope of intellectual property regulations. This lets them to avoid infringement of someone else's intellectual property on the one hand and to be aware of how to protect the effort put into development work.

Social implications: The article enriches the theory both of legal sciences and management sciences. From the managerial point of view, it broadens the competences of local government managers. From a legal point of view, the work analyzes provisions on the protection of intellectual property in the context of reforming the city towards a smart city as well as of its functioning.

Originality/value: It is one of the few, if not the first, study in Polish literature dedicated to the issues of intellectual property protection in smart city.

Keywords: smart city, intellectual property, copyright, industrial property.

Category of the paper: research paper.

1. Introduction

The smart city concept is certainly an innovative approach to city management. Its creation is preceded by enormous intellectual work consisting in planning, designing, predicting and adjusting all elements of the already living city. It requires the cooperation of many actors including, above all, city authorities, business sector and citizens. The result of such collaboration is the creation of intellectual capital, including urban architecture, organizational resources, community qualities, intellectual property, etc. (Dameri, Ricciardi, D'Auria, 2014).

Smart cities generate huge amounts of data thanks to the extensive and constantly expanding network of devices connected to the system (cell phones, cameras, drones, service machines, personal computers, cloud computing) and sensors (motion, twilight, infrared, RFID). They support various types of services, such as monitoring, control and optimization of energy flow, intelligent transport systems improving urban traffic, parking systems, vehicles communicating with each other and with the city system, remote health monitoring programs, environmental monitoring sensors, information systems for cities' users, and more. This entire structure is controlled by dedicated software that coordinates the operation of the system through computer networks, including the Internet. Artificial intelligence and blockchain may also be involved in more advanced projects.

These issues raise questions about intellectual property, which seems to be a key component of a smart city. On the one hand, the very concept, design and related powers of the city, on the other hand, the implementation and use of already existing solutions, inventions and software. Therefore, when managing a city implementing the smart city concept, due to the particularly innovative nature of the ideas created and implemented, the multitude of entities participating in it, it is important to be aware of the legal conditions in relation to the possible scope of protection and the possible measures that may need to be taken to obtain this protection for the benefit of the city, as well as with regard to the rights of third parties. Hence the purpose of this study is to examine the specific issues concerning intellectual property protection in the development and functioning of smart city with the aim of pointing out some possible problematic issues.

2. The idea of smart city in modern world

There is probably no universally accepted definition of a smart city (Szymańska, Korolko, 2015; Baraniewicz-Kotasińska, 2017). A common interpretative approach is to focus pragmatically on the hardware and software aspects of technical infrastructure and its security: information systems, big data, Internet of things, sensors and beacons (Butt, Afzaal, 2019; Joy,

McGoldrick, Gerla, 2016; Al-Dhubhani, Mehmood, Katib, Algarni, 2018). This technological aspect is obviously an interesting field for engineers, IT and automation specialists, software developers. But ICT is not the only determinant of making city smart because there is also a soft side of the issue – a social side including economy, management, governance, natural resources, human capital, quality of life etc. Such a distinction can be seen in some works (Picon, 2019; Rudewicz, 2019; Tota, 2017).

The concept of smart city gives new tools for city management as an aggregate of objects, communication routes, population and relationships between them; Thanks to various types of innovative solutions, city authorities can make better decisions. Abosaq (2019) indicates that it is a combination of many different, integrated with each other small projects, which are joint initiatives of the public and private sectors. Barrionuevo, Berrone and Ricart (2012) say that the idea of a smart city is largely based on the integration of advanced information technologies in order to find intelligent solutions and obtain a better quality of life. Cretu (2012) also draws attention to the use of intelligent sensors, tools and data sets that are to support the improvement of quality of life. Thanks to this, communities living in such cities are to have a happy and healthy life guaranteed (Guan, 2012). There are also attempts to define the concept of smart cities through a multi-dimensional approach. According to Cohen (2011) it shall be based primarily on such areas as smart people, smart economy, smart environment, smart governance, smart living and smart mobility.

Thus, it can be concluded that the technologies in combination with large-scale data, machine learning incorporated into the city structure make it more efficient and interactive. They also leave their mark on the community by involving it in the city management process, raising awareness and improving people's standard of living. As follows from the classic definition of local self-government, it is the right and ability of local communities, within the limits set by law, to regulate and manage a substantial share of public affairs under their own responsibility and in the interests of the inhabitants (ECLSG, 1985). As a result, residents benefit from living in a well-managed city, which expresses their interest, i.e., the benefit they receive from the functioning of local government administration (Szewc, 2005). At the same time, the financial situation of the city is related to the number of inhabitants and their income, as a significant part of local income is made up of shares in income tax. As a result, the city is interested in attracting residents and the development of entrepreneurship, thanks to which they have more financial resources. Undoubtedly, one of the arguments when making decisions by individual people about moving to one or another town is the quality of life in it, i.e., the implementation of modern solutions.

So, the initiator of a smart city may be the city itself, especially when its authorities consciously agree with Kitchin's (2015) statement that it is a "path to socio-economic progress and better quality of life" and, perhaps, when they are aware of different political benefits. Apart from local government authorities, there is of course the business sector – global ICT companies and smaller suppliers, providing technological solutions and services. They rather

perceive the smart city from the angle of its business goals – the ability to easily reach customers with the most accurately addressed offer, sales opportunities, public contracts. Regardless of the perspective taken, however, technology and related innovations are of key importance in this matter. They are smart city enablers (Paquet, 2001). This, in turn, is related to the implementation of solutions that are some forms of intellectual property, the beneficiaries of which are cities and its users. Thus, these solutions create a space for interaction between authorities, businesses, citizens and other entities, and within its framework it comes to interesting issues related to intellectual property rights.

3. Scope of intellectual property and its role in smart city

Overview of the principles of legal protection should begin with a general observation, which shows that the discussed aspects of smart city are not material in nature, they are different concepts or ideas, which are then expressed in various types of documents and on the basis of these documents can then be implemented, produced or realized. Moreover, they are various types of goods that function in the digital world, are creative, inventive, novel and innovative. Even if there are physical goods in use, the idea behind them has an intangible, additional value, sometimes even greater than the good itself. As a result of the legal protection of the smart city elements, one should look for in the regulations establishing the protection of ideas, solutions, works and inventions. The rules of intellectual property law are such laws.

Intellectual property (IP) is most commonly associated with patents, trademarks and copyrights, that is, everything original and creative what a human can come up with (Kostański, Jyż, 2020). World Intellectual Property Organization (2019) defined IP as “creations of the mind: inventions, literary and artistic works, and symbols, names, images and designs used in commerce”. Generally speaking, these are all kinds of exclusive rights granted respectively to inventors and businesses as well as to authors, producers and publishers for protecting their inventions, business ideas or other intellectual resources. These rights are protected by the field of law, which covers two basic areas (from the point of view of this study): industrial property and copyright (which in continental law is called the authors' rights). Industrial property relates to inventive designs, trademarks and geographical indications. The above-mentioned inventive projects are inventions, utility models, industrial designs, topographies of integrated circuits and rationalization projects. Generally speaking, they rely on a technical solution to a specific problem. Another words industrial property includes the creator's right (“ownership”) to a certain intangible concept that can generally be used in industrial production, or even more broadly, in economic activity. Copyright law, on the other hand, regulates the protection of works, objects of related rights and an image of the person. However, the most important difference between the two legal regimes is the fact that copyright objects are automatically

protected, and the protection of industrial property must be preceded by a formal procedure. Finally, it is necessary to mention that the issue of intellectual property also includes the protection of databases.

Intellectual property is a relevant issue in the context of smart cities. In essence, their smartness is based on collecting, analysing and using data to improve city life and achieve goals mentioned before – for the benefit of both the city administration and city residents. So, first of all, it comes with an idea, concept and design of transforming the existing city into an intelligent one. This process requires the selection of implemented solutions, both technical and organizational, often the development of a long-term plan or action strategy, as well as the establishment of legal acts that are the basis for activities. All this leads to the need to consider the principles of legal protection of these ideas. In other words, we may wonder whether the thought and documentation created in this process could be subject to copyright protection? The problem of copying or imitating solutions, strategies and legal acts of one city by other cities may arise, which raises the question of possible ways of legal protection. For example, is the concept (strategy) of implementing a smart city subject to protection (e.g., Smart City Strategy – Vienna 2022)? Or devices used in a smart city (e.g., sensors, cameras), software (e.g., digital customer service system of the city hall), databases of collected information (e.g., water meter readings) and finally legal acts formalizing the adopted strategies.

Further issues arise when the smart city is already functioning. Let's remind that such a city works thanks to a variety of types of technologies, devices, sensors, counters and, of course, software. These, in turn, are very often covered by exclusive rights in the field of, respectively, industrial property law and copyright. After all, cities are mostly not independent and self-sufficient in such projects. They actually have to cooperate with private sector and frequently these are not just bilateral agreements, but more comprehensive and complicated contracts involving many different stakeholders and suppliers. Some kind of a conflict of interest concerning intellectual property can be seen here. On the one hand, these will be the economic interests of private entities wanting to protect their intellectual property and constantly earn money from it. On the other hand, there is the public interest in improving infrastructure, the quality of life etc., for which it is necessary to use innovative, elastic hardware and software technologies but sometimes even cultural goods, such as music. Finally, there are also citizens these facilities are meant to serve very often free of charge. An important issue, therefore, is the appropriate creation of agreements regarding the use of intellectual property and its licensing.

4. Copyright and related rights issues in smart city

There is no doubt that the smart city concept is an innovation in city management (Kidyba, Malinowski, 2017). The implementation of innovations, in turn, implies the need to generate intellectual property value. This applies primarily to the preparation of documentation or analyses, both preliminary and in the form of a detailed project. Considering that changes aimed at transforming a city into a smart city often require deep reforms in city management, they must begin with a certain idea, a general concept about the direction and scope of changes, drawn up in writing in the form of documentation, because smart city solutions are too complex to be content with merely verbal expression. Sometimes a need may arise to establish legal acts constituting a formal legal basis for the activities undertaken. On the other hand, the implementation may involve the production and installation of devices, software, data collection and their use. Due to the fact that the production of these values is often expensive (requires high qualifications) and time-consuming, cities may be interested in protecting them against their appropriation by other local government units.

Considering the initial stages of the smart city implementation process, taking the form of ideas, and then analyses, reports or even legal acts, it is possible to consider their protection under copyright law. This is due to the fact that a work is the primary object of protection, and the listed intellectual property values can be considered as works (Barta, Markiewicz, 2011). Polish Act on Copyright and Related Rights of 1994 (ACRR) defines work as every manifestation of a person's creative activity of an individual character, established in any form, regardless of value, purpose and manner of expression. A work defined in this way can be expressed in words, mathematical symbols, graphic signs; the works may be works of fine art, photographs or audio-visual works. However, the concept of a work and its protection is not absolute – they are subject to certain limitations and exceptions.

First, it concerns discoveries, ideas, procedures, methods and principles of operation, mathematical concepts. This means that the work is an expression of certain content that can occur in many ways, however, this expression must meet certain conditions as to its nature. At this point, the most important observation is that in the case of works, protection concerns the form itself, i.e., the way of expressing certain content or concepts (which should be understood primarily as the selection of words, photos), while it does not cover the ideas themselves. This leads to the conclusion that the concept of implementing a specific solution in the field of smart city is not protected and that subsequent towns may imitate the precursor of an idea, e.g., the concept of establishing city bike rentals. On the other hand, the moment an idea is clarified, written as a report, analysis, project, roadmap, strategy, etc., it begins to be expressed in a certain way and becomes a work. This is due to the fact that the author or authors of such a document adapt the idea to the specific conditions of a given locality and – most importantly from the point of view of the definition of the work – express it in a way

characteristic of them i.e., they present a certain individual style (Judgement, 2012). Thus, when compiled, it begins to fulfil the legal requirements of protection: such a document is creative (new to human achievements), has an individual character (expresses the style, character and personality of the creator) and is fixed, i.e., available to people other than the creator (Barta, Markiewicz, 2011; Późniak-Niedzielska, 2017).

Of course, there are more exceptions provided. Some categories of creativity are not considered as works and are explicitly excluded from protection. It is a fairly extensive catalogue from which, in relation to a smart city, exemptions from the protection of legal acts and their official projects, official documents, materials, signs and symbols as well as published patent or protection descriptions may apply (ACRR, Art. 4). These circumstances lead to the conclusion that the adoption of a specific regulation by one city does not exclude the adoption of an identical or even similar regulation by another city.

An important aspect of smart city are computer programs, which, for example, operate databases, collect information from sensors and process them, support the work of various devices, or to contact residents with the city hall. This raises the question about their protection. In the light of the law, computer programs are considered as works and are protected like literary works (ACRR, Art. 74 1.), which means that if a city is the owner of the rights to software (because, for example, it commissioned it), other cities cannot use this program without its consent. This consent can be granted, of course, for a fee or free of charge. It is also likely that the city will use the vendor's software or another available on the market. It is obvious that it will then do so on the basis of a general license. However, the problem may arise of the possibility of adapting the functionality of the program to the specific needs of the city, modifying these functionalities later, interoperability with other systems (closed resources), sharing data and their structure. This, of course, is associated with significant costs. However, one can also indicate a different option, namely the choice of software under the open-source license. Adaptation of such software to the city's needs is usually legally possible, as is its further development, the possibility of securing or ensuring cooperation with other systems, etc. At the same it is necessary to know that the open code of the basic version of the program is available to everyone and in this aspect, there are some issues regarding system safety and threat of attacks. Another issue that there are different types of licenses providing for different use and if a project would go beyond their framework, perhaps the extension of the license would not be possible at all.

The creation of related rights can be associated with the creation and functioning of smart city. These are various intangible goods, protected just like songs. Phonograms and videograms seem the most important from the point of view of the subject of consideration. A phonogram is the first fixation of the sound layer of the acoustic phenomenon or sequence of moving images, with or without sound, regardless of whether it is an audio-visual work (ACRR, Art. 94 1.). A characteristic feature of smart city is that their monitoring is very extensive, in the form of a camera system. Recordings from such cameras are videograms (ACRR,

Art. 94 2.) because they record the course of certain events (phonograms will occur rather sporadically, although such a possibility cannot be ruled out). Such phonograms and videos are also subject to legal protection for their producers.

Databases may be another subject of protection in smart city. The database is a set of data or any other materials and elements collected according to a specific systematics or method, individually available in any way, including electronic means, requiring a relevant to the quality or quantity, investment expenditure to prepare, verify or present content (DBA, Art. 2 1.). So, it is a set of data that can be different types (e.g., information about the air temperature, subsequent monitoring recordings, car traffic information, the level of filling in public transport, etc.), which are arranged according to a specific systematics. In addition, it is necessary to incur expenditure on gathering this data. These outlays can be both quantitative (e.g., spending time to search for information or financing the appropriately capacious disk spaces) and qualitative (which means the features of the base or qualifications of the creators). It should be mentioned here that a database may also be a work and be subject to copyright, however, this only applies to databases that are creative in terms of the selection or compilation of materials (DBA, Art. 1). Typically, however, the database is organized according to commonly accepted criteria, such as alphabetical or chronological, which are self-explanatory and not creative. Then the rights to such a database are vested in the producer.

In this case, the city can be a producer (if it commissioned the creation of such a base) or a user if it uses a database made by someone else, e.g., available on the market. In the first case, only the city will be entitled to download data from the database and secondary use in whole or in a significant part. When it comes to the use of the database by other cities, two situations should be distinguished here. Firstly, it will be used with the consent of the city that created the database, which requires the conclusion of a rental or lending agreement) or making the database available on a computer network, or without consent, if it takes place within an institution called fair use or permissible use as provided by Polish law. As the name suggests, it includes situations in which the use of the database is allowed and the possible lack of consent of the database manufacturer is irrelevant here. These are different cases from which the application of the law of citation may be considered for the implementation of a smart city. The right to quote covers the use of the database (even in a significant part) for illustration, teaching and research purposes, provided that the source is indicated and the database is used non-commercially (DBA, Art. 8 1.). Thus, it is possible to imagine a situation that when developing analyses, a city will use a database of another city that has already implemented a specific smart city strategy for research or illustration purposes.

When it comes to a database, it is worth mention the data themselves. They can have a very different character. In smart city it will be different information from neutral numerical statistics (traffic, use of infrastructure) to images and personal data, including sensitive (monitoring, tracking). Especially the collection of the latter raises specific concerns about basic rights, such as the right to privacy (Rubisz, 2020). In this paper, we won't actually raise the issue of personal

data, nevertheless it is worth mentioning that a special regulation on the level of the European Union is provided, i.e., the General Data Protection Regulation of 2016, as well as constitutions and national laws, which include these sensitive spheres of human life with due protection. From the point of view of intellectual property law, an interesting question is, for example, who owns the collected data? The answer to this question is of key importance in the context of the aforementioned actors who create and manage a smart city. They will want to know what was created, by whom, thanks to whose solution and who has the right to such information, especially if it is a product that can be protected by copyright. Municipal agreements with the private sector should regulate these issues by defining the status of collected data as public (which does not mean that all of them should be generally available), as well as setting the limits of their use, taking into account the public interest balanced with business goals.

5. Industrial property issues in Smart City

The implementation of the smart city concept often requires the design of various devices or, more broadly, the creation of technical methods of solving various problems, e.g., mobile health monitoring equipment (Winkowska, 2021). The technical thought contained therein will be protected as intellectual property, but on different terms depending on the category. And so, from the legal point of view, a technical solution may be an invention, utility model, topography of an integrated circuit, or finally a rationalization project.

According to the universal legal norms concerning industrial property, an invention is a technical solution that is new, has an inventive step and is suitable for industrial use (IPL, Art. 25-27). In other words, a given solution cannot be known anywhere else in the world before, it must be ground-breaking and surprising even for a skilled person, it cannot be a cliché or routine use of technical knowledge, and the invention must be possible to implement in industrial production, regardless of its type. It is worth knowing that there are different categories of inventions: products (substances or mixtures), devices (e.g., machines), methods (production methods) and applications (new uses of already known substances). If the invention meets the above criteria, the inventor may formally seek an exclusive right to use the invention, e.g., for commercial purposes. A patent, because this is what we are talking about, is a document confirming this exclusivity for a specified period of time (max. 20 years), provided that regular payments are made. However, in a situation where a given solution is not patentable, the inventor can use the procedure intended for utility model. It's also a new technical solution, however, it is required to refer to the shape, structure or composition of an object in a permanent, material form (IPL, Art. 94 1.). Instead of the requirement of an inventive step, a utility condition appears here, which means satisfying the needs so far not satisfied by any device, or satisfying them to a greater extent. Satisfying needs should be understood here

broadly, not only as covering the use, but also as arising at the production stage, e.g., making it cheaper or accelerating it. For this reason, utility models are called "small inventions" as less technically significant (Wojcieszko-Głuszko, 2020).

Taking into account the specificity of a smart city, it seems that it will most often use solutions that are devices. We can think of some examples, like a novel sensor (sensor capable of measuring soil moisture allowing to optimize the use of water in public squares and parks), inventive connectivity mechanisms (public transport, security alerts), new ways of processing information, etc. They may use modern information technologies like machine learning, artificial intelligence, blockchain, cloud computing, collecting and sharing data with highest bandwidth via LTE and 5G mobile networks (since 2021 LG Electronics is testing 6G network which allows 1TB/s data transfer). It may be added here that if the device uses a computer program to operate as intended, such a program can then be protected as part of the invention. The development of this type of products certainly requires enormous resources, extensive R&D departments and significant financial outlays.

It turns out that patenting smart city solutions has been quite common for over a dozen years (Statista, 2020). Asian companies are in the lead here: Japanese (Denso, Panasonic, Toyota), Korean (LG, Samsung) and – the most numerous – Chinese (Huawei; State Grid Corporation of China was the worldwide biggest owner of active smart city patent families, more than 7000). Such, sometimes global, companies compete with each other looking for various possibilities of obtaining a monopoly for a specific solution for a smart city, using various tricks (e.g., linguistic, legal) to convince others that their idea is not obvious, and therefore meets the criteria for obtaining an exclusive right. Moreover, they carefully research the market and protect their interests against unauthorized, unlicensed use of their patented solutions. They are also experienced in protecting these interests through the courts in various jurisdictions. The city, when designing and implementing intelligent solutions, building infrastructure, using devices and methods, must therefore be aware that these may be subject to patent or similar protection. In such a situation, it is therefore necessary to properly prepare for the need to conclude appropriate license agreements or to adopt a more complex model of cooperation with rightsholders.

However, the willingness to patent one's solutions is not only the domain of great players. Local actors in the private sector compete with each other in smart cities. They are well aware of the potential value of technologies that cities are equipped with, hardware and software solutions and the use of the Internet of Things, so they will certainly want to protect their interests and secure a profit in exchange for investments in innovation. Contractual provisions adopted under the smart city project should provide opportunities to protect innovative companies, although obtaining exclusive rights under industrial property law and the desire to license solutions to other cities may become part of their strategy.

The above overview shows that the technical solutions must meet relatively high requirements, for example in terms of novelty and for bringing a certain added value to the technique, whether in the form of an inventive step, non-obvious or usefulness. These conditions eliminate the possibility of protecting minor improvements. The legislator anticipated such a situation and created a category of rationalization projects including all other solutions that could be used, but not meeting the premises of a protected solution. Thus, rationalization projects do not benefit from the *erga omnes* protection, but can only be protected as a trade secret or a contractual secret (i.e., regulated in an agreement obliging to keep the confidentiality). The legal regulation of such projects only emphasizes the right of their authors to remuneration, however, on condition that rationalization regulations are established in a given entity.

As we mentioned before, one of the arguments when making decisions by individual people about moving to one city or another is the quality of life in it. A modern and intelligent city attracts even more. It can therefore be assumed that smart cities would be interested in having distinguishing features that would easily identify them, the content of which would indicate its modern character. In a word, they would be interested in having a logo with which they could promote and stand out (e.g., the city of Wrocław has the Smart City Wrocław logo, THE SMART CITY word mark of Beverly Hills). And this conclusion leads to the need to consider another subject of industrial property law, which are trademarks.

A trademark is a sign that enables to distinguish the goods or services of one enterprise from the goods of another enterprise and can be presented in the register of trademarks in a way that allows for the determination of an unambiguous and precise subject of the protection granted (IPL, Art. 120 1.). In the case of a smart city, one can therefore consider a service mark. When explaining the definition, it can be indicated that the design of such a mark must ensure distinctive and representational ability (Trzebiatowski, 2020). The first concerns the functioning of the mark in market trading. In this sense, such a mark is not only an emblem that a given entity uses when presenting its offer, but covers the entirety of information and ideas about a product distinguished by this sign among goods of the same type (Skubisz, 2001), intended to evoke certain associations among buyers, such as of course, *mutatis mutandis* can be applied to the services provided by the smart city administration. The second ability – representational, concerns the preparation of documentation in order to obtain a sign protection as a result of registration at the patent office. Such a sign should be independent and uniform. Independence is differently the separateness of the sign from the characteristics of the goods or service to which it refers, e.g., a sign of smart city cannot be a photo of a city landscape (IPL, Art. 129¹ 3.), but it can be stylized by the graphic contour of city buildings. In turn, uniformity is a conciseness or shortness of the sign – the sign cannot be too complex and difficult to take with one cognitive act. So, a trademark is a great marketing tool which can be used by a city to promote itself as smart and great for living. Therefore, more and more cities in the world, which can boast of their smartness, take action promoting their brand.

6. Conclusion

The above analysis of the basic issues related to intellectual property and the smart city concept proves that the implementation and operation of a smart city requires the production and use of intellectual property resources. It also shows that it is a broad topic with different treads. They can be also examined in detail in other works. It is clear that exclusive rights can affect many different aspects that are relevant to smart city technology. It also seems obvious, and one can agree with Shapiro (2020), that the future of smart cities will depend on intellectual property and its elements.

Designing a modern and well-managed city is not only time-consuming, but also requires high qualifications and high expenses. On the other hand, using the effects of someone else's work is relatively simple and usually comes down to copying it. As a result, it is worthwhile for local officials and politicians managing the city to be aware, on the one hand, of the possibility of protecting the expenditure incurred, and, on the other hand, of the risk related to unlawful infringement of someone else's intellectual property rights, in case of taking shortcuts and appropriating the results of someone else's work. Cities must adapt to this, but at the same time they should remember to focus on the goal. They must take care of properly constructed contracts, pay attention but also create clear licensing rules, and at the same time not be limited to one supplier and ensure interoperability.

Works, databases, phonograms and videograms created in the process of implementing smart city concept are subject of copyright or related rights protection. However, it is worth considering that the law protects only the way of expressing certain content or concepts while it does not cover the ideas themselves. So the concept of implementing a specific solution in the field of smart city is not protected and that subsequent towns may imitate the precursor of any idea. There are also exemptions from the protection of legal acts and their official projects, official documents, materials, signs and symbols as well as published patent documentation. This means that the adoption of a specific regulation by one city does not exclude the adoption of similar or even identical regulation by another city.

The city should also grant protection or buy rights to devices used to implement the idea of smart city. A trademark of a smart city can be also protected. Unfortunately, minor improvements can't be protected *erga omnes* as inventions or utility models. They can be only rationalization projects and have a status of a trade secret or a contractual secret (protection *inter partes*). It means that when revealed, they can be used by everybody.

References

1. Abosag, N.H. (2019). Impact of Privacy Issues on Smart City Services in a Model Smart City. *International Journal of Advanced Computer Science and Applications, Vol. 10, Iss. 1*, pp. 1-9.
2. Act on Copyright and Related Rights (ACRR) (1994). Journal of Laws of the Republic of Poland.
3. Al-Dhubhani, R., Mehmood, R., Katib, I., Algarni, A. (2018). Location Privacy in Smart Cities Era. In: R. Mehmood, B. Bhaduri, I. Katib, I. Chlamtac (Eds.), *Smart Societies, Infrastructure, Technologies and Applications* (pp. 123-138). *SCITA 2017, LNICST, Vol. 224*. Cham: Springer.
4. Baraniewicz-Kotasińska, S. (2017). Smart city. Ujęcie nowych technologii w koncepcji inteligentnego miasta. *Nowoczesne Systemy Zarządzania, Vol. 12, No. 3*, pp. 29-40, doi: 10.37055/nsz/129410.
5. Barrionuevo, J.M., Berrone, P., Ricart, J.E. (2012). Smart Cities, Sustainable Progress. *IESE Insight, Iss. 14*, pp. 50-57.
6. Barta, J., Cwiąkański, Z., Czajkowska-Dąbrowska, M., Markiewicz, R., Traple, E. (2011), *Prawo autorskie i prawa pokrewne. Komentarz*. Warszawa: Wolters Kluwer.
7. Butt, T.A., Afzaal, M. (2019). Security and Privacy in Smart Cities: Issues and Current Solutions. In: A. Al-Masri, K. Curran (Eds.), *Smart Technologies and Innovation for a Sustainable Future. Advances in Science, Technology & Innovation* (n. pag.). Cham: Springer.
8. Cohen, B. (2011). The Top 10 Smart Cities On The Planet. *Fast Company*. Retrieved from <https://www.fastcompany.com/90186037/the-top-10-smart-cities-on-the-planet>, 10.09.2022.
9. Dameri, R.P., Ricciardi, F., D'Auria, B. (2014). Knowledge and intellectual capital in smart city, European Conference on Knowledge Management. *Kidmore End, Vol. 1*, pp. 250-257. Retrieved from https://www.proquest.com/openview/bb3467d3f57bc1f84174_f313a7cd1469/1?pq-origsite=gscholar&cbl=1796412, 10.09.2022.
10. Database Protection Act (DBA) (2001). Journal of Laws of the Republic of Poland.
11. European Charter of Local Self-Government signed on 15 October 1985, Council of Europe (1985).
12. Guan, L. (2012). Smart Steps to a Battery City. *Government News, Vol. 32, No. 2*, pp. 24-27.
13. Industrial Property Law (IPL) (2000). Journal of Laws of the Republic of Poland.
14. Joy, J., McGoldrick, C., Gerla, M. (2016). Mobile Privacy-Preserving Crowdsourced Data Collection in the Smart City. In: *Scientific Challenges in Data and Event-driven Smart City Service and Applications* (SDESS 2016), Irvine. Retrieved from

- https://www.researchgate.net/publication/305186333_Mobile_Privacy-Preserving_Crowdsourced_Data_Collection_in_the_Smart_City, 10.09.2022
15. Judgement of the Court of Appeal in Katowice of October 9, 2012, Case V ACa 175/12.
 16. Kidyba, M., Malinowski, Ł. (2017). *Smart City. Innowacyjne rozwiązania w administracji publicznej a zarządzanie inteligentnym miastem*. Chorzów: Wyższa Szkoła Bankowa w Poznaniu.
 17. Kitchin, R. (2015). Making Sense of Smart Cities: Addressing Present Shortcomings. *Cambridge Journal of Regions, Economy and Society, Vol. 8, Iss. 1*, pp. 131-136.
 18. Kostański, P., Jyż, G. (2020). In: J. Sieńczyło-Chlabcz (Ed.), *Prawo własności przemysłowej. Komentarz* (pp. 3-65). Warszawa: C.H. Beck.
 19. Paquet, G. (2001). *Smart Communities and the Geo-Governance of Social Learning*. Ottawa. Retrieved from: <http://gouvernance.ca/publications/01-02.pdf>, 10.09.2022.
 20. Picon, A. (2019). *EDPL, Vol. 5, Iss. 2*, pp. 154-155, doi: 10.21552/edpl/2019/2/4.
 21. Późniak-Niedzielska, M. (2017). Przedmiot prawa autorskiego. In: J. Barta (Ed.), *System prawa prywatnego, t. 13, Prawo autorskie* (pp. 7-85). Warszawa: C.H. Beck.
 22. Rubisz, S. (2020). Some Issues with the Right to Privacy in Smart Cities. *Scientific Papers of Silesian University of Technology. Organization and Management Series, Vol. 147*, pp. 237-246, doi: 10.29119/1641-3466.2020.147.18.
 23. Rudewicz, J. (2019). Przemysł i technologie wobec wdrożenia wizji miasta inteligentnego (smart city) [Industry and Technologies in the Context of Implementing Smart City Concept]. In: *Studies of the Industrial Geography Commission of the Polish Geographical Society, Vol. 33, Iss. 4*, pp. 195-212, doi: 10.24917/20801653.334.12.
 24. Shapiro, A. (2020). 'Embodiments of the invention': Patents and urban diagrammatics in the smart city. *Convergence: The International Journal of Research into New Media Technologies, Vol. 26, Iss. 4*, pp. 751-774, doi: 10.1177/135485652094180.
 25. Skubisz, R. (2001). Funkcje znaku towarowego, In: *Księga pamiątkowa z okazji 80-lecia rzecznictwa patentowego w Polsce*, pp. 222-242. Warszawa: Pirpat.
 26. *Smart City Strategy*. Retrieved from: <https://smartcity.wien.gv.at/en/approach/>, 10.09.2022.
 27. Statista (2020). *Largest smart city patent owners worldwide from 2011 to November 2020, by number of active patent families*. Retrieved from: <https://www.statista.com/statistics/1032965/worldwide-smart-city-patent-owners-trend/>, 10.09.2022.
 28. Szewc, T. (2005). *Dostosowanie prawa polskiego do zasad Europejskiej Karty Samorządu Terytorialnego*. Katowice-Bydgoszcz: Branta.
 29. Szymańska, D., Korolko, M., (2015). *Inteligentne miasta – idea, koncepcje i wdrożenia*. Toruń: Wydawnictwo Naukowe UMK.
 30. Tota, P. (2017). Smart City – Accessible City. Newest urban technologies as a framework of universal design. *Środowisko Mieszkaniowe, Vol. 19*, pp. 4-12.
 31. Trzebiatowski, M. (2020). In: J. Sieńczyło-Chlabcz (Ed.), *Prawo własności przemysłowej. Komentarz* (explanations to art. 120-129). Warszawa: C.H. Beck.

32. Winkowska, J. (2021). Analiza wdrożeń smart city w Polsce i na świecie. *Akademia Zarządzania, Vol. 5, Iss. 3*, pp. 207-224.
33. Wojcieszko-Głuszko, E. (2020). In: J. Sieńczyło-Chlabicz (Ed.), *Prawo własności przemysłowej. Komentarz* (explanations to art. 94-106). Warszawa: C.H. Beck.
34. World Intellectual Property Organization (2019). *World Intellectual Property Indicators 2019, Vol. 1*, Geneva: WIPO.

FREIGHT TRANSPORT IN THE CITY AND ITS IMPACT ON THE LIVES OF RESIDENTS

Aleksandra WIERZBICKA

Silesian University of Technology, Institute of Management and Logistics; aleksandra.wierzbicka@polsl.pl,
ORCID: 0000-0003-2373-6830

Purpose: Transport has an impact on economic strength, product availability and the quality of life and attractiveness of urban areas. Transport has an impact on economic strength, product availability and the quality of life and attractiveness of urban areas. The aim of the article is to present the importance of freight transport and its nuisance from the point of view of a resident.

Design/methodology/approach: The document contains an analysis of the literature on freight transport in cities. In addition, GUS data on the transport of goods in Poland were analyzed and surveys were conducted in which respondents assessed the impact of goods flows on their quality of life.

Findings: During the literature search, a correlation was found between the transport of goods in the city and the functioning of the inhabitants. It turns out that residents largely generate the flow of goods themselves using on-demand deliveries.

Originality/value The study presents the results of proprietary research addressed to residents in order to learn their opinions about the transport of goods and deliveries carried out in the city. In addition, the article, based on the available statistical data, proves the relationship between the development of the e-commerce industry and the transport of goods in the city.

Keywords: logistic, transportation of goods in the city, Quality of life of city dwellers.

Category of the paper: Research paper.

1. Introduction

Transport is one of the elements that integrate most logistics processes. Transport is of great importance both for the inhabitants of a given area and for local entrepreneurs, which is an inseparable element of the functioning of residents. Transport has an impact on the economic strength, the availability of products and the quality of life and attractiveness of urban areas. Transport has an impact on the economic strength, the availability of products and the quality of life and attractiveness of urban areas (Macharis, 2011). Freight flows in urban areas account for 20-30% of total vehicle-kilometres (Dablanc, 2007). Cities need freight transport, but they

often underestimate its importance (Macharis, 2011). The subject of passenger transport is of greater interest from the city authorities, but also scientists, while 25% of carbon dioxide, one - third of nitrogen oxides and 50% of particulate matter that comes from transport are generated by vans and trucks (LET, 2006). The growing requirements of customers in terms of speed and punctuality of deliveries require an efficient forwarding system, the necessary but insufficient condition of which is a fast and synchronized flow of information with the flow of goods and documents (Rogaczewski, 2017). In addition, the time of the COVID-19 pandemic has significantly affected the number of freight transports. Restrictions on the possibility of shopping in the traditional, stationary way have resulted in an increase in online orders and thus will increase the demand for transport services. Therefore, in the city, the most common customer of transport services is a resident of the city, which in recent years has become the most important element of urban logistics, which makes the implementation of tools to improve the quality of life of residents more and more popular. All these aspects have made the opinion of residents in relation to the flow of goods in the city extremely important, which has become the goal of this article.

2. Literature review

2.1. Transport of goods in Poland

Transport enables the exchange of goods and services, which makes it one of the factors determining economic growth. It is acting simultaneously as a provider of transport services and as a recipient of services of, including enterprises producing metals, steel, etc. (Rydzkowski, 2009). In Poland, in order to move goods, mainly two modes of transport are used: road transport, also known as road transport, and rail transport. However, the only transport branch to which all cities in Poland have access is road transport, which is why the article will focus on issues related to road freight transport. Road transport of goods is one of the three largest sectors of the Polish economy, next to wholesale trade and retail trade. The direct share of the transport and storage sector in Polish GDP is 6 per cent, but its importance for the economy is significantly higher. Without transport, other industries could not function – especially trade and industry. According to TLP and SpotData estimates, transport is one of the critical cost items for industries that generate 50 percent of Polish GDP. In the years 2017-2021 (Road transport in Poland 2021+), the number of transported cargo by road transport increased from 1 747 266 thousand tons in 2017 to 1 952 465 thousand tons in 2021 (Table 1). The largest increase compared to the previous year, amounting to over 7%, was recorded in 2018. A slight decrease (0.1%) can be seen in 2020 compared to 2019.

Table 1.
Cargo transport in 2017-2021

	In thousands of tons				
	2017	2018	2019	2020	2021
Road transport	1747266	1873022	1921073	1 919 193	1 952 465
Including commercial	1104209	1183750	1206218	1203395	1203019
Including motor transport companies	867816	920924	926786	928395	949907
Percentage increase/decrease in road transport compared to the previous year	---	7,20%	2,57%	-0,10%	1,73%

Source: Own elaboration based on CSO data.

From the point of view of freight transport, a physical road has no direct value in itself, it is an added value during its use. The main advantage of road transport is, among others, flexibility allowing for quick change of route, delivery address or place of loading. Another important feature is the implementation of transport directly from the place of dispatch, loading to the place of delivery, without the need for reloading or changing the means of transport (Engström, 2016; Leończuk, 2011).

Increasing consumer expectations mean that the transport system of the twenty-first century should be characterized by high flexibility and frequency of deliveries, while maintaining high quality of services and safety of transported goods. An important element is also a short waiting time for delivery and low transport costs. All these features imply the need for constant changes in the transport system. Not without significance is also the development of e-commerce, which contributes to a large number of groupage shipments delivered to city centers. This transport is carried out to the greatest extent with the use of road transport due to the dispersion of consignees and senders in the city. In 2021, compared to 2020, an increase in the transport of many groups of goods was recorded (Table 2), including over 50% more clothing products transported, 7% more food and food products, and 10% more fish and agricultural products. One of the reasons for the growth may be the development of the ecommerce industry caused by the COVID 19 pandemic. In 2021, one ton of cargo was transported over an average distance of 240km.

Table 2.
Increase in transport of selected groups of goods in 2021 compared to the previous year

GROUPS OF GOODS	in thousands	2020 = 100
	Total	1 580 517
Products of agriculture, hunting, and forestry; fish and other fishery products	117 838	110,6
Coal and lignite; crude petroleum and natural gas	34 783	147,9
Metal ores and other mining and quarrying products; peat; uranium and thorium	363 224	102,3
Food products, beverages and tobacco	191 082	107,0

Cont. table 2.

Textiles and textile products; leather and leather products	6 501	150,1
Coke and refined petroleum products	48 196	101,5
Chemicals, chemical products, and man-made fibres; rubber and plastic products; Nuclear Fuel	85 420	111,0
Basic metals, fabricated metal products, except machinery and equipment	88 045	117,5
Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	30 483	125,5

Source: Goods road transport a by groups of goods in 2021, data provided by the CSO.

An important element affecting transport, both in the logistics system of the city and outside it, is its proper preparation for transport. The method of load formation is important, especially during combined or partial transport. It is important that the transported goods are packed in a way that allows the placement of further loads in order to replenish the transport space of the vehicle. In addition to the dimensions, the weight of the load is also important, which should be evenly distributed on the axles of the vehicle. In the city's logistics system, various types of cargo are transported, both with standard dimensions and requiring the use of specific containers or means of transport. This type of cargo includes food often delivered to recipients in the city. Logistics management of transported cargo is very difficult, not only because of the small amount of data and comparative models, but also because of the complexity of this process. No city is able to completely meet the needs of residents for goods that are imported from outside, most often by vans. Residents' expectations regarding quality, punctuality and flexibility of deliveries are growing. Manufacturers are obliged to deliver smaller quantities more frequently, thus directly contributing to the increased truck traffic in cities, which in turn adversely affects the surrounding environment (Zielińska).

2.2. Intra-city supplies of goods

Depending on the city, its financial and infrastructural capabilities, many systems supporting the management of flows in the city can be distinguished. One of them is Intelligent Transport Systems (ITS), whose task is to increase the efficiency and safety of all road users. The use of ITS tools has a positive impact on reducing the amount of carbon dioxide emissions in cities, shortening travel times, reducing the number of accidents in the city and increasing the capacity of transport networks (Jamroz, 2009). The advantage of modern transport solutions is also the ability to give priority to public transport. Intelligent transport systems cover the entire infrastructure of the city, depending on the access of a given area to airports, sea or rail means of transport. In order to reduce emissions and congestion during rush hour, many cities choose to regulate access to certain parts of the city. Most often this is related to the ban on daily deliveries or limiting the flow of vans during the busiest hours. In such cases, distributors can use the so-called time windows or make a delivery at night. An important issue in the case

of late delivery of goods is the need to comply with the legally sanctioned noise level (Gingerbread, 2016).

Comparing the different parcel delivery systems in the city, it can be seen that only delivery "personally" requires the direct involvement and presence of the customer, which is one of the reasons for the large percentage of undelivered parcels. Table 4 presents various ways of delivering parcels in the city.

Table 3.
Comparison of different delivery options in the city

	Delivery to your own hands	Delivery boxes	Access system	Collection banks	Pick-up point
Contractor of the last kilometer	Supplier	Supplier	Supplier	Client	Client
Customer presence at the pick-up	Yes	no	no	no	No
Product types	Every	Packages/Food	Packages/Food	Packages/Food	Packages/Food
Pick-up time	Pre-appointed	24h	24h	48h	Opening hours of the point
Investment cost Initial	Low	Medium/High	Medium	Medium	Low/Medium
Delivery costs	High	Low	Low	Lowest	Lowest
Potential operational problems	Large percentage non-delivery. Poor utilization of vehicle capacity	Requires a large number of boxes/ Boxes must be collected	Customer anxiety for safety. Necessary Good location Supply.	The customer must come after reception	The customer must come after reception

Source: own elaboration based on: Allen, J., Thorne G., Browne, M. (2007). The solution of the "last kilometer". In: BESTUFS Guide to good practices in urban freight transport, p. 49, http://www.bestufs.net/download/BESTUFS_II/good_practice/Polish_BESTUFS_Guide.pdf, 5.12.2019.

It should be emphasized that potential operational problems occur in any type of delivery. The lowest delivery costs were recorded for delivery to collection points and delivery banks, this is due to the fact that consolidated parcels are delivered to one place of delivery. The disadvantage of personal delivery of products is the need to use small vehicles, which can result in higher operating costs and a more negative impact on the environment than in the case of unconfirmed shipments. The use of banks, boxes and collection points gives you a greater opportunity to plan transportation route and travel schedule. The disadvantage is the limited size of the box and the generation of traffic at the pick-up point. Each of these methods of parcel delivery and intelligent traffic control systems to a greater or lesser extent affect the functioning of the city's logistics system.

3. Research methodology

The research tool used to conduct research among residents of cities, communes and poviats was a structured questionnaire. The research was carried out using electronic communication channels (CAWI technique – Computer Assisted Web Interview), therefore it was not possible to estimate the level of reflexivity of the questionnaire. The identified number of visits to the page containing the questionnaire was 623, of which 387 (62.1%) were obtained, including 386 full, correctly completed questionnaires and 236 (37.9%) impressions, visits, without completing the questionnaire¹.

The survey contained 28 questions of various nature: open, closed with the possibility of single and multiple choice, with nominal ranges and using the Likert scale. The survey included optional questions, assuming that not every respondent has sufficient knowledge to answer them. Below are presented the results of research on questions on the impact of freight transport on the quality of life in the city from the perspective of a resident.

4. Results

386 people took part in the survey, including 183 (47.4%) women and 203 (52.6%) men. The vast majority of respondents had secondary or higher education – a total of 75.9%. In addition, 100 (25.9%) of respondents were under 30 years old, 128 (33.2%) between 30-40 years old, 123 (31.9%) between 40-50 years of age, and 35 (9.1%) respondents over 50 years of age. This distribution of the age structure is largely due to the fact that the research uses an electronic form sent out using social networking sites and e-mail, which most people over 50 use to a minimal extent (Kuchta-Nykiel, 2018).

A significant part of respondents (as many as 61.4%) indicates the city center as their place of residence (52.1%) or the very center of the city in the vicinity of the pedestrian zone, market square (9.3%) The answers to the questions resulted from the observations and experiences of the respondents, and not from their personal participation in the deliveries. The aim of the study was to determine the burdensomeness of the deliveries from the point of view of residents. 60.1% of respondents declared that their place of residence is no more than 300m from the nearest company. 57.8% of respondents answered in the affirmative to the question whether in their opinion the delivery of goods in the city is burdensome for residents. From the analysis, it can be concluded that the value of burdensomeness of supply-related factors for respondents living up to 500 m from the service/commercial/production point is approx. 60%. For people

¹ The research was conducted 179 days from 14 January 2020 to 10.07.2020.

whose place of residence is more than 500 m from the undertaking, the burdensomeness of deliveries is approx. 24% (Fig. 1).

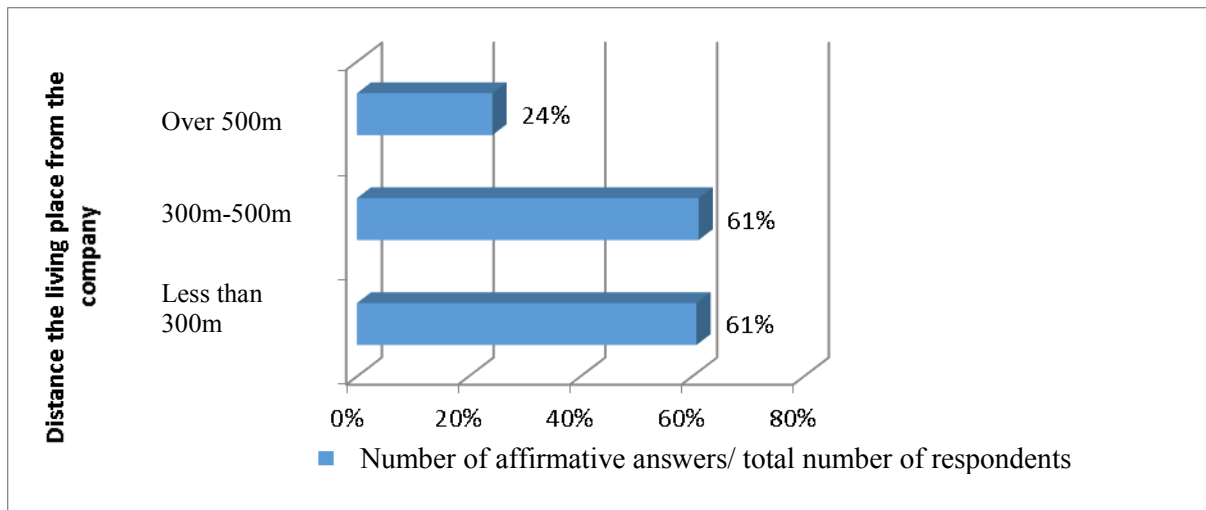


Figure 1. Ratio of the burdensome deliveries at service points to the number of responses about the distance of the undertaking from the place of residence.

Source: own elaboration based on empirical research.

Based on the literature review, 6 factors were identified that may be negatively perceived by residents. Respondents could indicate any number of answers. The research shows that the most common difficulties and factors negatively perceived by residents related to the delivery/unloading of goods are (Fig. 2):

- Difficulties related to blocking the road by a delivery vehicle – 74.1%.
- Delivery time – 46.7%.

Leaving the van at hazard lights in the middle of the lane, the lack of unloading places at retail and service outlets and blocking sidewalks is a common problem not only in large cities, but also in suburban areas, which is probably why this problem was indicated as the most burdensome factor. Other factors were assessed below 50% share. The least troublesome factor was the loud sound of the engine running (17 people (6.6%) marked this answer).

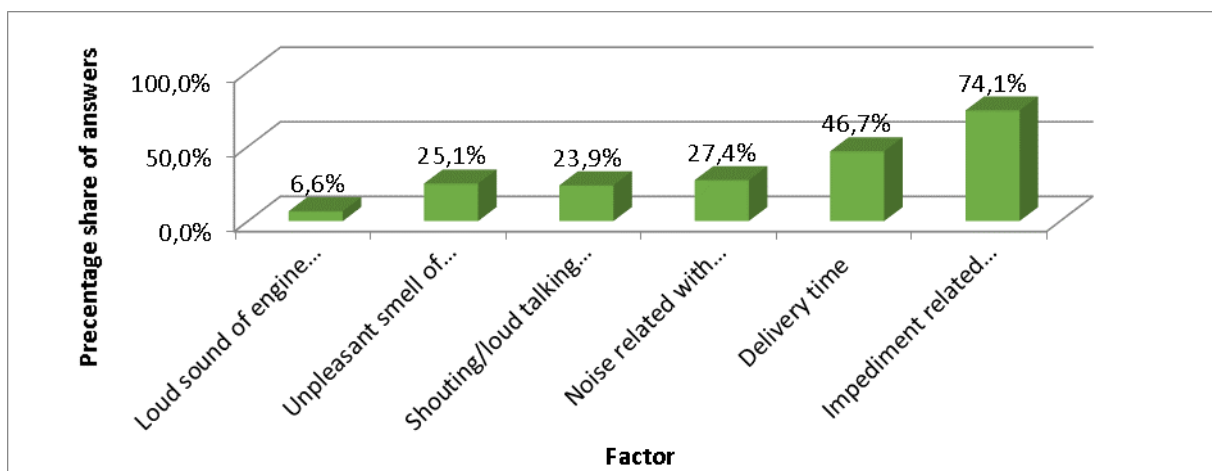


Figure 2. Factors negatively perceived by residents, occurring during delivery.

Source: own elaboration based on empirical research.

In recent years, online shopping with direct home delivery has become increasingly popular, with an estimated 600 million more people living in urban environments by 2030, exacerbating the problem of managing last-mile flows. Single loads are distributed along the route with several stops. These routes change depending on weather conditions, dispersion of pick-up points, traffic and many other factors. In the next question, the question was asked about the use of deliveries carried out directly to the home or collection point at the individual request of the resident. It turns out that 332 people (86%) use this type of delivery, only 54 respondents (14%) denied²³ (Fig. 3).

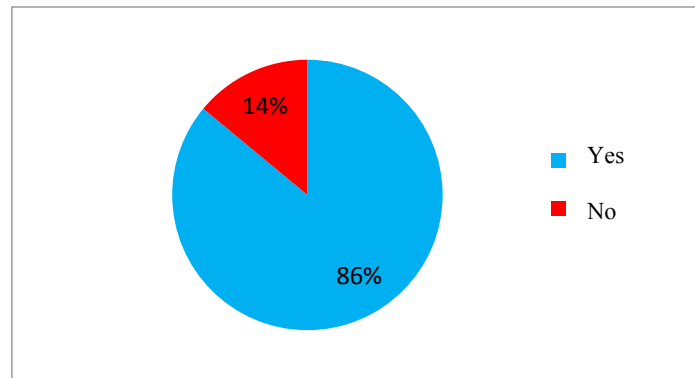


Figure 3. Use of online orders with individual delivery.

Source: Own elaboration based on conducted research.

Most of those declaring the use of individual delivery, 55.42%, indicated that they most often order products purchased online and through online auctions with home delivery (Fig. 4).

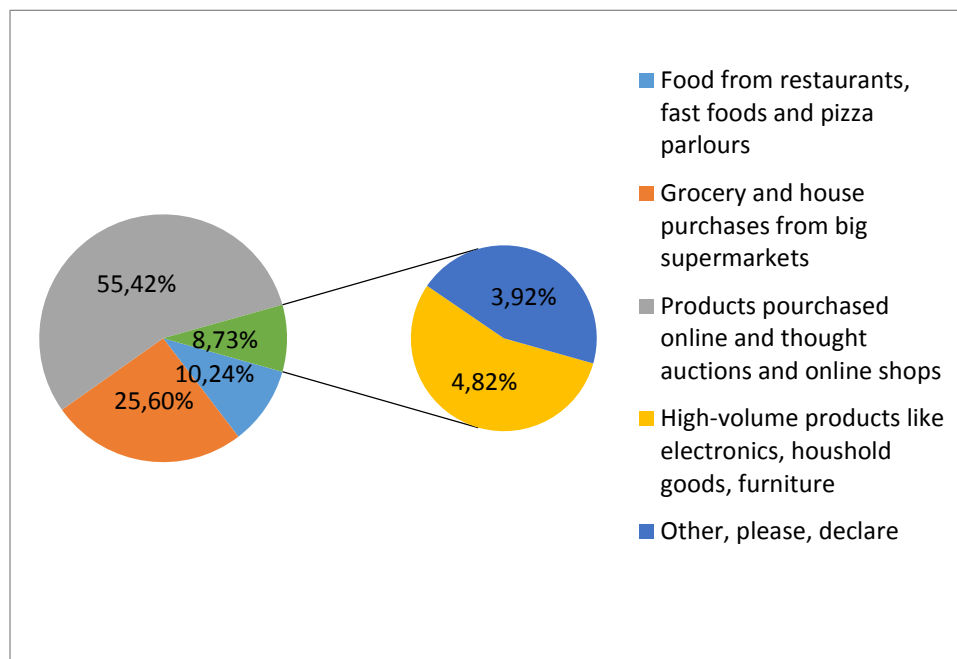


Figure 4. Most often ordered by residents for products with home delivery.

Source: own elaboration based on empirical research.

² <https://www.mhlnews.com/transportation-distribution/article/22055353/how-to-solve-the-last-mile-problem>.

³ <https://www.dfds.com/en/about/insights/newsletters/3-solutions-to-the-last-mile-transportation-problem>.

Grocery and household purchases from large-format stores with home delivery are very popular (25.6%).

On the basis of literature research, 13 factors related to the flow of goods and affecting the lives of residents were collected. Each of the respondents had the opportunity to evaluate them. The results of the conducted research and the list of factors are presented in Table 4.

Table 4.
Factors affecting the lives of residents

Answer	No impact(%)	Little impact(%)	Medium impact(%)	Huge impact(%)	Very big impact(%)
Noise level	2,6	13	19,2	58,3	7
Air pollution level	1,3	10,6	33,4	34,7	19,9
Air pollution level with other chemicals	3,9	15,3	30,6	38,6	11,7
The rate of smog formation in the city	2,1	14	29,3	36,3	18,4
The level of dirt in the city (under the influence of dust rising)	1,6	13,7	29,5	37,8	17,4
Safety of residents on sidewalks and pedestrian streets	3,9	14,2	25,6	36	20,2
Number of traffic accidents in the city	4,7	19,2	28,8	30,8	16,6
Incidence of congestion	3,9	11,9	28,2	39,4	16,6
Building new receiving-transmitting points	3,1	13,2	26,7	38,3	18,7
Access to goods and services	1,8	7,8	22,8	46,6	21
Numer of service and commercial points	1,8	8,3	30,6	41,2	18,1
Speed of delivery of individual courier parcels	1,6	6,5	23,6	48,7	19,7
Supply for catering outlets	1,3	7,8	24,4	42,7	23,8

Source: own elaboration based on empirical research.

Taking into account the obtained results, it can be concluded that the noise intensity of goods flows has a great impact on the lives of residents (58.3%). More than 2/3 of respondents (68.1%) believed that the level of air pollution with carbon dioxide has a medium or large impact on existence. Freight transport is important for the speed of smog formation in the city and the number of traffic accidents. The respondents considered that the flow of goods has a significant impact on the speed of courier delivery (48.7%) and the availability of goods and services (46.6%). The results of Table 22 show the great importance of freight flows to all spheres of life in the city, directly and indirectly involving residents. In order to check which of the factors is the most important for the respondents, another attempt was made to calibrate the results and the average of the grades of each element was determined, assuming that -2 means no impact and 2 a large impact. The results of the research are presented in Table 5.

Table 5.*Average for factors affecting the standard of living of residents*

Factor	Average	Factor	Average
Noise level	0,54	Number of traffic accidents in the city	0,35
CO2 air pollution level	0,61	Prevalence of congestion	0,53
Air pollution level with other chemicals	0,39	Building new receiving and sending points	0,56
The speed of smog formation in the city	0,55	Availability of goods and services	0,77
Level of dirt in the city (under the influence of floating dust)	0,56	Number of service and commercial outlets	0,66
Safety of residents on sidewalks and pedestrian streets	0,54	Speed of delivery of individual courier shipments	0,78
Supply of catering outlets	0,80		

Source: own elaboration based on empirical research.

The results presented in Table 16 show that all the presented factors are characterized by a similar degree of importance for the respondents. The highest average was obtained by such factors as:

- supply of catering outlets (average 0.80),
- speed of delivery of individual courier parcels (average (0.78),
- accessibility to goods and services (average 0.77).

The lowest average of 0.35 under the presented assumptions was obtained by the number of traffic accidents in the city.

5. Conclusions

Transport is one of the most important elements of the city's logistics. It contributes to many phenomena occurring in the city: positive and negative. Freight transport in the city plays a very important role, not only for businesses, but above all for the residents themselves. Research has shown that over 80% of respondents declare using online orders, thus generating an increased flow of goods in the city. From the residents' point of view, the most burdensome is blocking the road by the delivery car. The results of the survey addressed to residents show that the flow of goods in the city affects many elements of residents' lives, including the availability of goods and services, the number of traffic accidents in the city, the level of air pollution. Therefore, it would be necessary to look for solutions that will not only improve the flow of goods in cities, but also improve the quality of life of residents.

References

1. Allen, J., Thorne, G., Browne, M. (2007). The solution of the "last kilometer". In: *BESTUFS Guide to good practices in urban freight transport*, p. 49, http://www.bestufs.net/download/BESTUFS_II/good_practice/Polish_BESTUFS_Guide.pdf, 5.12.2019.
2. Dablanç, L. (2007). Goods transport in large European cities: difficult to organize, difficult is modernize. *Transportation Research Part A: Policy and Practice*, 41(3), pp. 280-285.
3. Engström, R. (2016). The roads' role in the freight transport system. *Transportation Research Procedia*, vol. 14, p. 1447.
4. Gingerbread, D. (2016). *Distribution of goods in urban logistics*, <https://samochody-specjalne.pl/2016/09/30/dystrybucja-towarow-w-urban-logistics/3/>, 4.12.2019.
5. Jamroz, K., Oskarbski, J. (2009). Intelligent transport system for Tri-City agglomeration. *Telecommunications and Information Technologies*, No. 1-2, p. 66.
6. Kuchta-Nykiel, M. (2018). *Social media in Poland – who uses social networking sites?* Socialpress, <https://socialpress.pl/2018/06/social-media-w-polsce-kto-korzysta-z-serwisow-spolesznosciowych>, 11.07.2020.
7. Leończuk, D. (2011). Transport Road Goods in Poland. *Economy and Management*, No. 4, p. 99.
8. Let, et al. (2006). *Méthodologie pour un Bilan (disambiguation environnemental physique du transport de marchandises)*. En Ville, Paris: ADEME/Ministère des Transports, p. 37.
9. Macharis, C. (2011). The Problem Situation and Possible Solutions. In: *City distribution and Urban freight transport: Multiple perspectives*, p. 13.
10. Macharis, C., Melo, S. (2011). Introduction – city distribution: challenges for cities and researchers. In: *City distribution and Urban freight transport: Multiple perspectives*, p. 1.
11. Report "Road transport in Poland 2021+" - production of half of Polish GDP dependent on road transport, <https://tlp.org.pl/raport-transport-drogowy-w-polsce-2021/>, 5.10.2022.
12. Rogaczewski, R., Zimniewicz, S., Zimny, A. (eds.). (2017). *Transport and logistics in the enterprise, city and region. Selected issues*. Katowice
13. Rydzkowski, W., Wojewódzka-Król, K. (eds.), (2009). *Transport*. Warsaw: PWN, p. 1.
14. Zielinska, L. *Challenges in managing urban cargo transport logistics*, https://wilis.pg.edu.pl/documents/2336321/48297385/Zieli%C5%84ska_Lidia_Wyzwania_w_zarz%C4%85dzaniu_miejsk%C4%85_logistyk%C4%85_transportu_%C5%82adunk%C3%B3w.pdf, 31.07.2019.

REVIEWERS

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