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FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Presented papers contain result of researches conducted by various universities. The number consists of 36 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: digital economy; smart city; logistics; strategic management; industrial management; finances; the implementation of AI in management; e-commerce; entrepreneurship; knowledge management; safety management; quality management; environmental management; sustainable development; human resources management; startups; managerial competences; healthcare management; internationalization; and project management.

Radosław Wolniak

FACTORS DEMOTIVATING TO WORK IN DIGITAL ECONOMY. GENERATION Z PERSPECTIVE

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Purpose: The purpose of the paper is to present the results of research on expectations of young people entering the workforce for the first time in their lives. The research was conducted in order to identify factors influencing the shape of motivational systems offered to them.

Design/methodology/approach: The research was designed as an online survey. It was conducted among 693 representatives of Generation Z (18-26 years old). To analyze the results of the survey the following methods of statistical analysis were used: descriptive measures such as measures of mean and variance, statistical tests and measures of dependence (canonical correlation). Statistica 13.3 software was used.

Findings: The highest demotivating importance for respondents is low pay, unpleasant atmosphere at work and job stress. In the second group of importance are such factors as uninterrupted free time (working outside of working hours), lack of raises or financial bonuses, job insecurity, constant control and monitoring and excess responsibilities.

Research limitations/implications: Some limitations of the survey were that it was conducted among young people only in Poland. Thanks to the cooperation established in May 2025 with Professor Thomas Steger (University of Regensburg), future research directions include a Polish-German comparative analysis of the gap between the demands of today's labor market and the skills that young workers possess.

Practical implications: The results of the study can provide valuable guidance for employers (entrepreneurs and HR managers) in shaping modern HR strategies (approach to recruitment, development programs, construction of incentive systems, as well as working conditions and effective use of employee potential).

Social implications: The article provides an understanding of young people's expectations, values and preferences regarding working conditions and new knowledge valuable for public institutions responsible for shaping the model of professional education.

Originality/value: The formulated re-search conclusions can be used to build strategies for the professional development of the younger generation. There is an apparent research gap in the identification of demotivating factors for Generation Z employees (negative impact).

Keywords: HRM, Motivation to work, Gen Z.

Category of the paper: Research paper.

Introduction

Entrepreneurship plays a key important role in the economic development of Europe and the world. It leads to improvements in living standards, generates capital, raises the level of prosperity, and boosts employment and national income. The development of Industry 4.0 and the Covid-19 pandemic has introduced significant changes in the organization of work.

Key elements of the digital economy are data, referred to as the “new oil” of the digital economy. The economy is driven by platforms such as Amazon, Google, Facebook and Alibaba, which connect users to services, products and information. These platforms create ecosystems where companies and consumers can interact in unprecedented ways. E-commerce is revolutionizing traditional retail.

The purpose of this article is to present the results of a study on the expectations of young people regarding the shape of incentive systems offered to those taking up their professional challenges for the first time. The authors considered that gaining knowledge in the given field can be valuable both for employers and for public institutions responsible for shaping occupational safety and vocational education. As it seems, the formulated research conclusions can also serve to build a strategy for the professional development of young people. The importance of the issue undertaken is important in the context of the changes that have occurred in recent years in the labor market, including the interest of young workers in working outside the country.

The authors' review of the domestic and foreign literature showed that a significant part of the research conducted concerns the identification of factors affecting the increase in the level of motivation (positive impact). There is an apparent research gap in the identification of demotivating factors for Generation Z employees (negative impact). In this context, the authors of this publication decided that an interesting research task would be to identify an important area of shaping employee motivation, which is the configuration of demotivating factors for work.

The importance of the issues undertaken in this paper is important in the context of the changes that have been occurring in recent years in the labor market, including the high interest of young workers in working outside the country.

The role of work motivation is particularly relevant in the context of Industry 5.0 as the next stage of industrial development. It extends the concept of Industry 4.0, focusing on humans and their role in production processes. While Industry 4.0 relies on automation, digitization and artificial intelligence, Industry 5.0 brings humans back into the spot-light, emphasizing collaboration between humans and intelligent machines. Industry 5.0 seeks harmony between modern technology and humans, creating a more sustainable, flexible and ethical manufacturing environment.

Digital technologies make it possible to work from anywhere in the world, contributing to the growth of the so-called on-demand economy (gig economy). Platforms such as Uber, Upwork and Fiverr are connecting freelancers with clients around the world. Technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, block-chain, and the development of 5G networks are the foundation of today's economy, enabling new opportunities and streamlining existing processes.

High work motivation has a significant impact on the quality of work. Motivation acts as an internal drive that influences commitment, creativity, efficiency and accuracy in performing tasks. Motivated employees put more effort into their duties, which leads to a more accurate and careful completion of tasks. High motivation fosters a sense of responsibility for work results, which in turn increases the quality of results. Motivated employees are more likely to take the initiative in solving problems, which increases the quality of processes and products. Motivation, especially intrinsic motivation, promotes the generation of new ideas and innovative solutions, which results in better quality. Motivated people are more focused on details, which reduces the risk of errors. Content of work and working conditions are main areas of the quality of working life (Wolniak, 2019).

The next generation of young people is entering the labor market under such conditions, which are quite different from those of the previous century. By 2025, Generation Z will make up 27% of the global workforce. This Generation is made up of individuals who strongly identify with issues of diversity, equality, inclusion and belonging, with as many as 68% of those representing Generation Z dissatisfied with their employers' efforts to create a diverse and inclusive work environment (Trends Report 2023. Compensation and the Labor Market).

The article includes a brief description of the research area of human resource motivation. In the following part, the characteristics of Generation Z will be described and an analysis of studies of domestic and foreign literature on the subject will be presented. The results of our own research and discussion will be presented. The conclusions of the survey will be formulated using methods of statistical analysis, including descriptive measures such as measures of mean and variance, statistical tests and measures of dependence (canonical correlation). Statistica 13.3 software was used.

It should be noted that in this publication the authors continue the presentation of the research results of their project, limiting them to the issue of demotivating factors for work. The research conclusions covering the determinants of work and factors of work quality in today's digital economy, along with a discussion of the competencies of the future, were included by the authors in their last papers.

The research approach of the Authors is in line with the concept of the trichotomy of motivation factors at work, which is an extension of Frederick Herzberg's two-factor theory. It was developed by one of the main Polish researchers in labor economics - Professor Leszek Koziol. He distinguished three groups of factors: "motivators", which when present, cause satisfaction; 'hygiene factors' - when they do not occur, cause dissatisfaction;

and “demotivators” - when they occur, they cause dissatisfaction. As the aforementioned author notes, “their vectors of influence on job satisfaction differ dramatically, although they occur simultaneously in the work environment. Therefore, this concept is a methodological directive suggesting the extension of the field of analysis of the conducted re-search to factors that reduce motivation at work” (Kozioł, 2011).

Literature review

In 2022, 83% of companies raised salaries for their employees, and despite the cost optimizations implemented in some organizations, as many as 81% of employers plan further increases in 2023. Other key challenges on the labor market include:

- the continuing instability of employment, causing financial insecurity and difficulties for workers in planning for the future,
- strong demographic changes, determining the structure of the human resources of economy 4.0,
- the need to match the competencies of the workforce to technological transformation, including increasing robotization and automation,
- lack of flexibility in the organization of work in some sectors and industries lack of flexibility in the organization of work in the context of growing expectations among employees to be able to provide work remotely,
- growing wage inequality,
- expectations about the need to maintain a work-home balance, occurring in an in-creasing number of employees, especially the younger generation now supplying the labor market on the supply side.

In this context, it is worth noting that an important role in the development of enterprises is played by having sufficiently competent and motivated human resources (Koradecka, 2010). Work motivation can be seen as a person's need, his desire to take action. It is important, managers motivated employees, providing them with motives to take action. It can also be said that motivation is the result of a need, prompting behavior, or some kind of reward (Pettinger, 2018). The process of motivation requires influencing a person with forces (factors), resulting in his behavior oriented towards achieving planned goals. Encouraging a person to act requires identifying his expectations, desires, identifying needs of psychological nature, activating his behavior in order to effectively achieve the chosen goal (Edun, Adenuga, 2011).

Work motivation is also defined by a positive emotional state as a result of the work experience. It requires an employee's attachment to his or her job, which heightens the sense of fairness of the employer's assessment (Badubi, 2017). This includes a set of forces stemming from both inside and outside the individual that are capable of initiating the employee's

behavior, determining its forms, directions, intensity and duration (Meyer, Becker, Vandenberghe, 2004). Sometimes it is necessary to encourage the employee to make an effort, which may be due to his internal pleasure in the task or the result achieved (Emily, Yawson, 2021). It is also important to effectively determine the direction a person is aiming for, the effort (level of effort) and persistence in pursuit of the goal (Armstrong, 2014).

Employees' level of motivation and job satisfaction is reflected in their commitment and level of performance. Supervisors should take care of employees' attitudes, through the implementation of motivational activities, in order to reduce the inefficiency of existing organizational arrangements (Lohela-Karlsson, Jensen, Björklund, 2022). The level of efficiency of human resource management depends largely on the motivation of employees. This means that the existing motivational system, including the optimality of the selection of motivational factors, by shaping the attitudes and behavior of employees plays a key role in the success of the organization (Roslon, 2020, p. 327).

The research conducted by Moczydlowska shows that the following are important for employees: the possibility of constant contact with people (51%), a sense of stability in employment and the security obtained thanks to it (45%), the atmosphere in the team (39% of respondents), or the need to feel the sense of the tasks performed (37%). This means that non-material factors motivate respondents to get involved and perform their work effectively. It has been confirmed that stimuli with a negative impact on people and material non-material factors only slightly motivate them to work (Moczydlowska, 2007, pp. 70-73). This is confirmed by the results of a study conducted by Dolot, which shows that respondents considered the following factors as important: atmosphere at work (93%), salary (91%), stability of employment (88% of respondents) (2018, pp. 232-236).

Failure to select the right motivational factors means that an employee may feel discouraged at work. Demotivation is the result of actions in the organization leading to the fact that the individual psycho-physical or moral needs of the employee are not met. This leads to a state in which he feels disappointment and frustration. The lack of appreciation of his achievements or a sense of fairness of evaluation discourages him from engaging in the activities undertaken.

Demotivation is often the result of inappropriate attitudes and behavior of managers, their lack of managerial skills and experience. In fact, it can also be a deliberate action, leading to discouragement of further cooperation and departure of the employee. Thus, the success of an organization depends not only on competence in designing and improving motivational systems, but also on neutralizing the impact of demotivators on the feelings of employees (Radecka, 2022, pp. 297-317). Demotivators can arise at the following levels (Stelmach, 2005):

- economic (e.g., lack of clear criteria for bonuses, awards, promotions, increase in duties performed during unpaid overtime),
- organizational (e.g., non-ergonomic workstation, undermining employee competence, lack of participation in decisions, limiting employee independence, excessive control, ineffective delegation of tasks),

- psychological (e.g., lack of support from the supervisor and co-workers, bad atmosphere, constant competition, unconstructive criticism and ignoring the employee's achievements, monotonous work, lack of development opportunities),
- external (e.g., lack of consideration for the interests of employees, lack of a sense of job stability, selection of penalties inadequate to the situation).

In business practice, the following causes of employee demotivation can be identified: the organization's policies, lack of precise definition of the employer's expectations (scope of duties), ineffective communication and information management system, failure to pay attention to the employee's input and suggestions for improvement, frequent need for change. Thus, demotivating factors often arise from the lack of effectiveness and efficiency of the system, inefficiency of procedures or situations that discourage the employee from working (Mikolajczewska, 2018, pp. 123-131).

Demotivation of an employee can be temporary. Its source is, among other things, the need to perform excessive or too difficult tasks that exceed the employee's capabilities. The combination of such a work situation with personal problems can result in prolonging and strengthening the level of employee demotivation. This is very dangerous, since the result of prolonged demotivation is usually the achievement of a state of incapacity or job burnout (Clutterbuck, 2003).

The sources of demotivation can be found both in the total duties performed and in individual tasks. Performing tasks that frustrate an employee for a long time leads to a loss of motivation to perform them. Certainly, then the employee does not use the potential he or she possesses, as he or she is not engaged in performing duties or does not report opportunities to improve existing organizational arrangements (Sidor-Rządkowska, Sienkiewicz, 2023, pp. 11-16).

A demotivated employee does not strive to effectively achieve the set goals, and his behavior may be characterized by passivity or even a tendency to take actions that harm the interests of the employer (sabotage). Demotivation of an employee is the result of the negative impact of both external and internal factors, and most often their accumulation. In the practice of organizational functioning, an employee can also adopt an indirect attitude (neutral in action), when he performs tasks in accordance with the guidelines, without showing positive or negative behavior (Dobrosielska, 2019, pp. 6-9).

Representatives of Generation Z, who take their first job, are characterized by certain distinctive features in the labor market, both of a personal and sociological nature. It is worth pointing out some of them here (Bińczycki, Łukasiński, Dorocki, 2023):

- ability to find oneself in the world of the Internet and modern digital technologies (growing up with a smartphone in hand),
- good knowledge of foreign languages (language education from kindergarten),
- positive attitude towards mobility (Erasmus), which allows young people to easily find their way outside the country,

- positive attitude to the challenges of professional development and seeking a work-place that allows them to develop their passion,
- preference for electronic communication (employee portals),
- diversity of interests and desire for self-development,
- an assertive attitude, resulting in a quick desire to have what they want,
- pragmatic approach to life,
- ability to multitask, which sometimes conflicts with the need to focus on one thing,
- openness to other cultures and ecology,
- expectation of work-life balance (the role of the employer).

The presentation of the above characteristics reveals that researchers' interest in the factors affecting Generation Z's work motivation also stems from its difference from previous generations.

Method

In order to achieve the set research goal of identifying the factors that demotivate representatives of Generation Z to work, it was decided to make a study of domestic and foreign literature and conduct a survey. The following research questions were formulated for the research objective thus defined:

- what are the key demotivators for representatives of Generation Z?
- are there significant differences in the assessment of the importance of demotivating factors for work between men and women?
- can Generation Z's demotivating factors to work be grouped into certain categories?
- do working and non-working people similarly assess the role of individual demotivating factors to work?

The survey was conducted among 693 representatives of Generation Z (18-26 years old). Among the respondents, 390 are working and there is a noticeable slight surplus of women. Residents of cities, including those with more than 500,000 residents and those working for more than a year, predominated among the respondents (Tables 1 and 2). The survey was conducted by the authors of the article mainly among students of three Polish economic universities in the academic years 2022/2023 and 2023/2024. It was considered particularly valuable to obtain responses from part-time students who already have some work experience.

The analysis of the survey results used statistical analysis methods, including descriptive measures such as measures of mean and variance, statistical tests and measures of dependence (canonical correlation). Statistica 13.3 software was used.

Results

This section of the article will provide answers to the research questions posed. The analysis of the data will be carried out with a distinction between the results obtained in the working group and the non-working group. The importance of demotivators, as indicated by working respondents, is shown in Figure 1, while a full summary of demotivators and indications by respondents (working and non-working) is presented in Table 3.

Table 1.

Structure of respondents by place of residence and length of service (working)

Seniority	City			Village	Total
	up to 100.000 residents	100.000-500.000 residents	above 500.000 residents		
up to 12 months	12	5	38	27	82
1-5 years	27	19	101	81	228
6-10 years	3	3	22	9	37
above 10 years	6	2	27	8	43
Total	48	29	188	125	390

Source: results of own study.

Table 2.

Structure of respondents by place of residence and gender (not working)

Gender	City			Village	Total
	up to 100.000 residents	100.000-500.000 residents	above 500.000 residents		
Woman	34	18	60	92	204
Male	25	10	25	39	99
Total	59	28	85	131	303

Source: results of own research.

Answering the first research question, the highest demotivating importance for respondents is low pay (15.64% share among all indicated factors), unpleasant atmosphere at work (10.56%) and job stress (8.77%). In the second group of importance are such factors as uninterrupted free time (working outside of working hours), lack of raises or financial bonuses, job insecurity, constant control and monitoring, and excess responsibilities (between 6.67% and 7.95%).

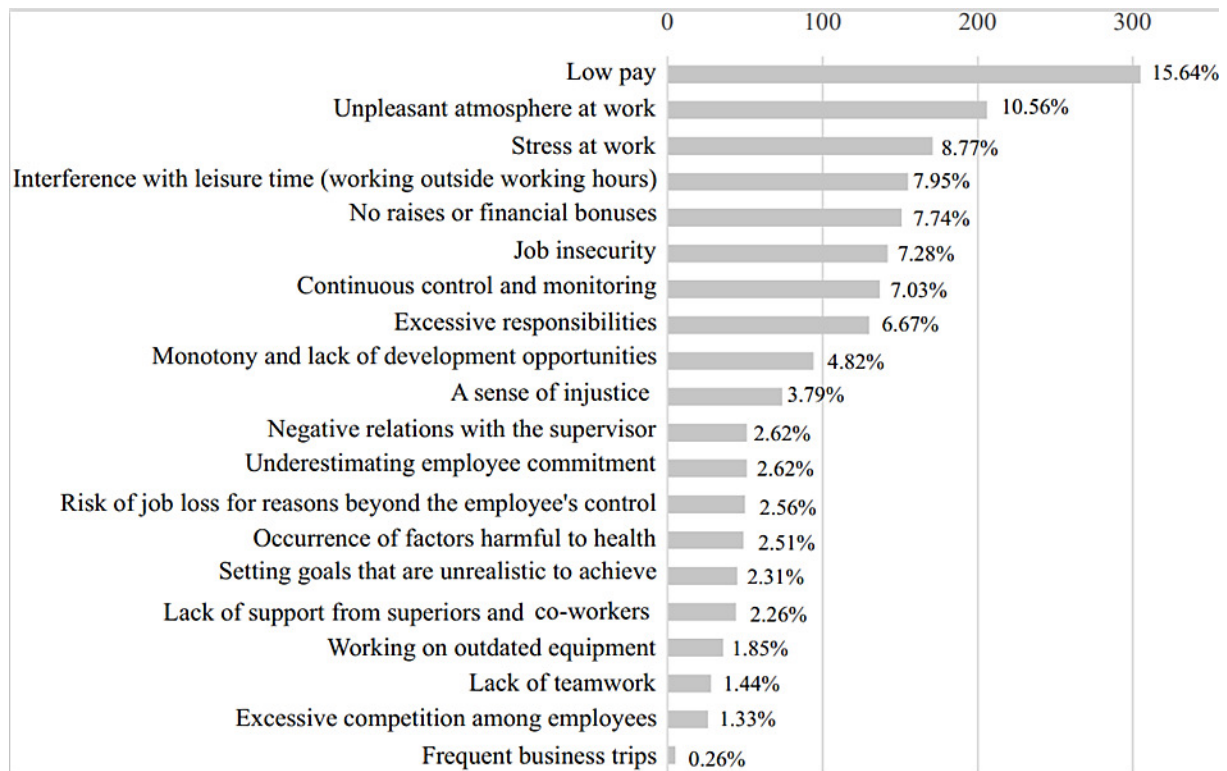


Figure 1. Role of demotivators as identified by working people (share of each factor).

Source: results of own research.

With regard to non-working people, the hierarchy of demotivators was similar to that of working people, however, it is possible to notice clear differences confirmed by the Chi2 structure test, which ruled out the similarity of the two groups of respondents at the 0.05 confidence level. Working people were more likely than non-working people to point out the lack of raises or financial bonuses. Also, constant control and monitoring and underestimation of the employee's commitment were more often indicated by those with work experience.

Table 3.

Demotivators indicated by respondents (working and non-working) in absolute numbers

Demotivators	Not working	Working	Difference standardized by the number of non-workers
No raises or financial bonuses	98	151	-20.09
Continuous control and monitoring	93	137	-14.14
Underestimating employee commitment	27	51	-12.88
Job insecurity	104	142	-7.05
Lack of support from superiors and co-workers	29	44	-5.41
A sense of injustice	54	74	-3.87
Working on outdated equipment	25	36	-3.15
Low pay	236	305	-2.53
Lack of teamwork	22	28	0.10
Excessive responsibilities	102	130	0.33
Interference with leisure time (working outside working hours)	122	155	0.78
Frequent business trips	5	5	1.09
Excessive competition among employees	22	26	1.67
Occurrence of factors harmful to health	41	49	2.68

Cont. table 3.

Monotony and lack of development opportunities	78	94	4.49
Stress at work	142	171	8.27
Risk of job loss for reasons beyond the employee's control	49	50	9.90
Unpleasant atmosphere at work	174	206	12.90
Negative relations with the supervisor	53	51	13.12
Setting goals that are unrealistic to achieve	49	45	13.81
Total	1525	1950	0.00

Source: results of own research.

Other demotivators more often indicated by those who were working were Job insecurity and Lack of support from superiors and co-workers. On the other hand, non-working people were more likely than working people to indicate Setting goals that were unrealistic to achieve, Negative relations with supervisor and Unpleasant atmosphere at work. The normalization values of the demotivators indicated by men and women are given in Figure 2.

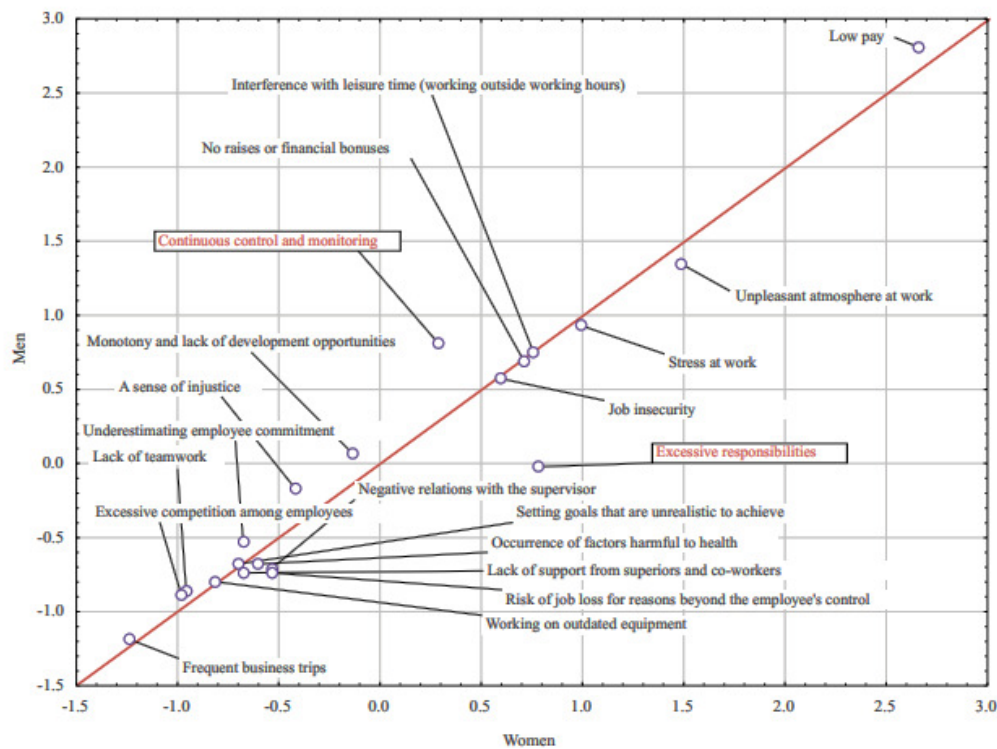


Figure 2. Normalizing values of demotivators indicated by women and men.

Source: results of own research.

At a significance level of $p = 0.002$, we can conclude that responses between men and women based on the Chi-square test are different. Of all the variables, the biggest difference was in the area of excessive responsibilities, which was indicated by women to a much greater extent than in the case of men. However, these were variables that were among half of all demotivators indicated.

As for the most frequently cited demotivator, which was low pay, it was indicated more often by men, while an unpleasant atmosphere at work was indicated more often by women. Other variables indicated more often by men than women included monotony and lack of

development opportunities, a sense of injustice, and undervaluation of employee commitment. In contrast, women were more likely to indicate negative relations with their supervisor and lack of support from superiors and co-workers (Figure 3).

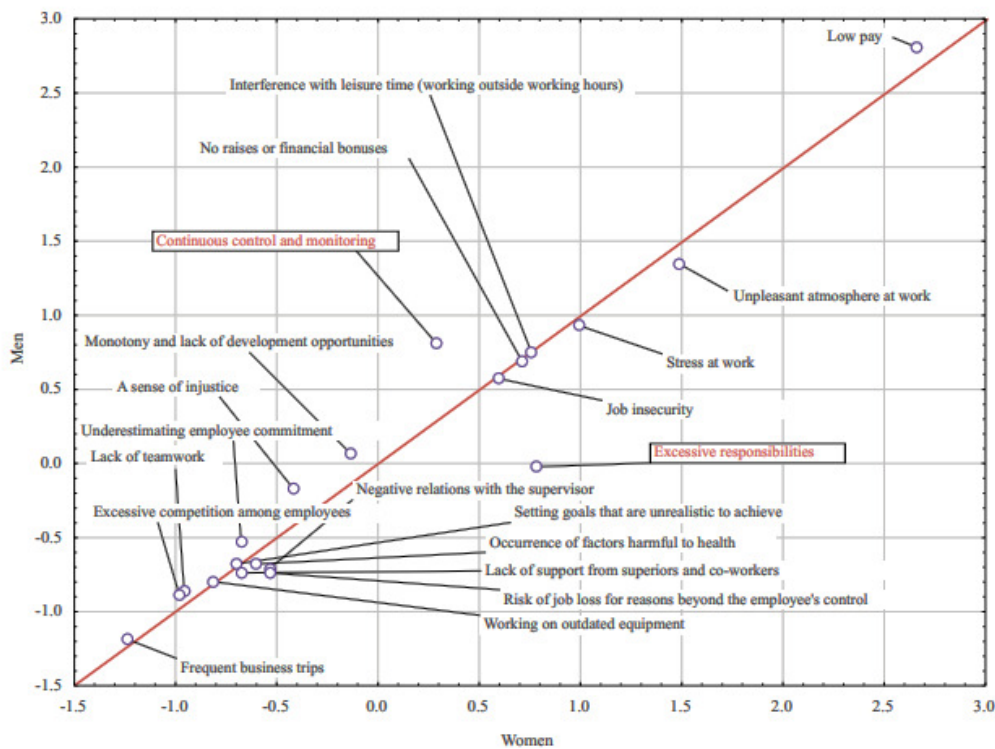


Figure 3. Normalization values of demotivators indicated by men and women in relation to the difference between working and non-working people.

Source: results of own research.

Comparing the responses for working and non-working people, the biggest differences for women are in the case of frequent business trips and excessive competition between employees, when working women showed these traits more often than non-working women, while they more often indicated monotony and lack of development opportunities.

Experienced women were also more likely to indicate setting goals that were unrealistic to achieve and interference with leisure time (working outside of work hours). In the case of working men, they were less likely to indicate setting goals that were unrealistic to meet, the risk of losing their jobs for reasons beyond the employee's control, or negative relations with their supervisor than those without work experience. In contrast, they were more likely to indicate a lack of raises or financial bonuses, constant control and monitoring, and low pay than those without work experience.

Referring to the question about the possibility of combining factors into certain groups, doing the grouping on the basis of Euclidean distances confirms the earlier analysis: low work and unpleasant atmosphere at work clearly stand out - while there is a block of 10 variables that did not receive a large number of indications (Figure 4).

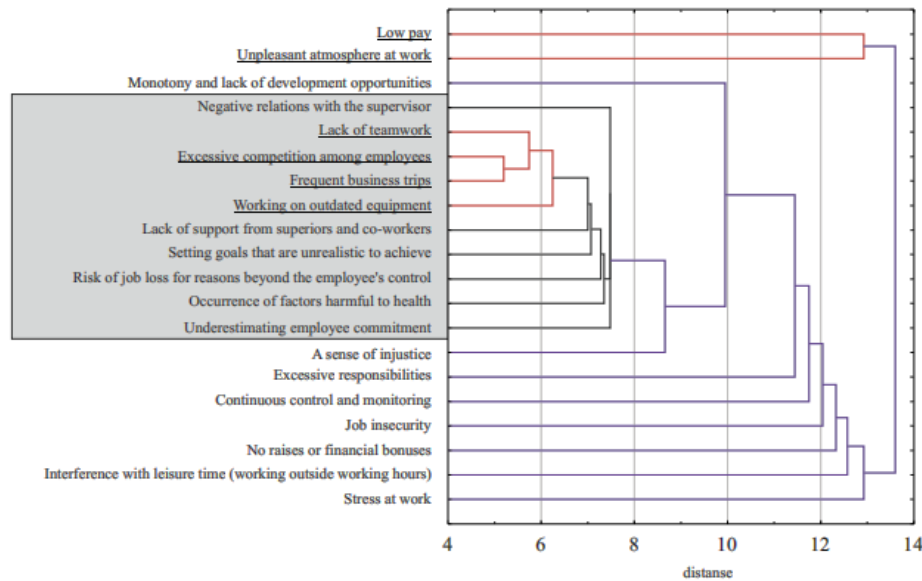


Figure 4. Grouping of demotivators.

Source: results of own research.

In the next question, respondents were asked to indicate the value of each variable, which are demotivators, on a scale of 1 to 5. As with the number of indications, low pay reached the highest average (4.66). This was followed by the group named A, which includes: unpleasant work atmosphere, undervaluing the commitment of the vaporizer, and lack of raises and bonuses.

Next are two groups of variables that have a similar mean value of the variables, but differ in the value of the standard deviation. In the case of group C, the variation among the weight given was significantly greater than in the case of group B. The lowest weight among demotivators was assigned to frequent business trips (Figure 5).

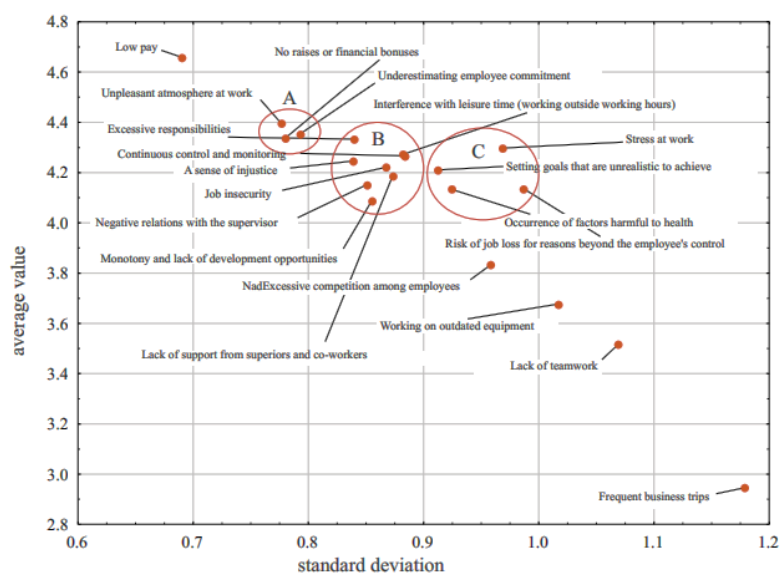


Figure 5. Average demotivators and standard deviation.

Source: results of own research.

For the cluster analysis, four groups were distinguished based on the weight of each demotivating factor. The first A is financial. Group B refers to an unpleasant atmosphere at work. Group C is nuisances that occur frequently at work. Group D are demotivators related to cooperation and working conditions (Figure 6).

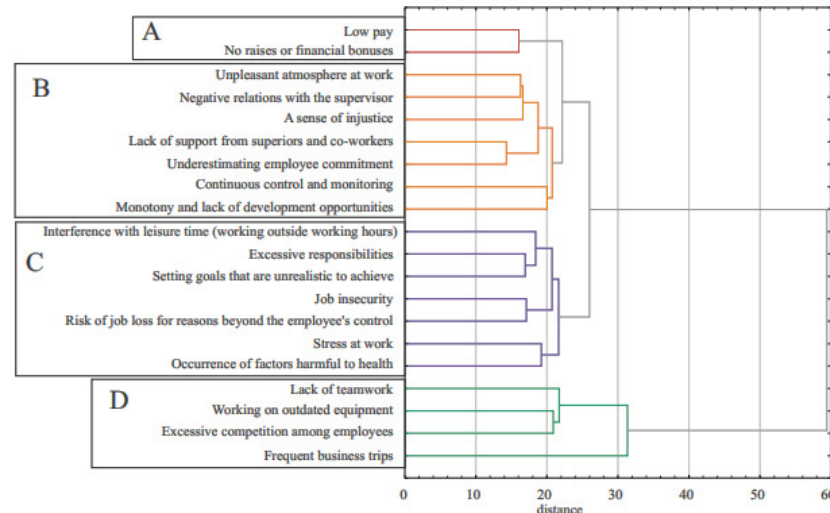


Figure 6. Cluster analysis of demotivator values.

Source: results of own research.

When comparing the importance of individual variables, only the lack of raises or financial bonuses, monotony and lack of development opportunities, and frequent business trips show no gender differences. Women assigned significantly more weight to individual demotivators than men. This is particularly evident in the case of the risk of losing one's job for reasons beyond the employee's control and excessive responsibilities (Table 4). In contrast, for education and other characteristics, the differences are not statistically significant (Table 5).

Table 4.

Average indications of demotivating factors among men and women

Variables	Average		<i>t</i>	<i>p</i>
	Male	Woman		
Risk of job loss for reasons beyond the employee's control	3.85	4.37	-5.3054	0.0000
Excessive responsibilities	4.10	4.53	-5.1711	0.0000
Job insecurity	4.00	4.40	-4.6449	0.0000
Lack of support from superiors and co-workers	3.97	4.36	-4.5045	0.0000
Excessive competition among employees	3.61	4.02	-4.3214	0.0000
Setting goals that are unrealistic to achieve	3.99	4.39	-4.3052	0.0000
Negative relations with the supervisor	3.95	4.31	-4.2094	0.0000
Underestimating employee commitment	4.17	4.50	-4.1797	0.0000
A sense of injustice	4.06	4.40	-3.9614	0.0001
Stress at work	4.10	4.46	-3.7426	0.0002
Occurrence of factors harmful to health	3.97	4.27	-3.2674	0.0012
Unpleasant atmosphere at work	4.26	4.50	-3.0572	0.0024
Lack of teamwork	3.34	3.66	-2.8999	0.0039
Working on outdated equipment	3.51	3.81	-2.8723	0.0043
Interference with leisure time (working outside working hours)	4.14	4.38	-2.7401	0.0064
Continuous control and monitoring	4.15	4.36	-2.3935	0.0172

Cont. table 4.

Low pay	4.57	4.73	-2.2699	0.0238
No raises or financial bonuses	4.27	4.39	-1.4081	0.1599
Monotony and lack of development opportunities	4.05	4.12	-0.8628	0.3888
Frequent business trips	2.89	2.99	-0.8258	0.4094

Source: results of own research.

Table 5.

Mean values of indications of demotivating factors among working and non-working people

Variable	Average		<i>t</i>	<i>p</i>
	I work	I don't work		
No raises or financial bonuses	4.34	4.18	2.56566	0.010507
Occurrence of factors harmful to health	4.13	4.30	-2.40496	0.016435
Risk of job loss for reasons beyond the employee's control	4.14	4.29	-2.16895	0.030426
Stress at work	4.30	4.45	-2.14757	0.032094
Lack of teamwork	3.52	3.35	2.09325	0.036689
Continuous control and monitoring	4.27	4.14	1.93564	0.053318
Underestimating employee commitment	4.35	4.24	1.84525	0.065428
Negative relations with the supervisor	4.15	4.23	-1.21704	0.224002
Job insecurity	4.22	4.30	-1.21504	0.224766
Lack of support from superiors and co-workers	4.19	4.11	1.21313	0.225495
Excessive responsibilities	4.33	4.40	-1.09974	0.271829
Monotony and lack of development opportunities	4.09	4.02	0.9613	0.336735
Low pay	4.66	4.62	0.76688	0.443415
A sense of injustice	4.25	4.20	0.7564	0.449667
Working on outdated equipment	3.68	3.62	0.75215	0.452215
Setting goals that are unrealistic to achieve	4.21	4.26	-0.72991	0.465691
Frequent business trips	2.95	2.91	0.4062	0.684722
Excessive competition among employees	3.83	3.86	-0.30943	0.75709
Interference with leisure time (working outside working hours)	4.27	4.29	-0.25824	0.796301
Unpleasant atmosphere at work	4.39	4.40	-0.14084	0.888035

Source: results of own research.

Referring to the averages for working and non-working people, only in the cases of lack of raises or financial bonuses, the presence of factors harmful to health, the risk of losing one's job for reasons beyond the employee's control, stress at work and lack of teamwork showed significant statistical differences. Those who were working paid more attention to the lack of financial raises or bonuses, while in other cases it was the non-working who indicated the greater importance of the demotivators highlighted.

Discussion

It is worth referring at this point to the findings of other research teams. It should be noted, however, that they relate overwhelmingly to the study of factors positively affecting the working man, hence the comparative possibilities are limited.

Research on motivation to work among young Poles and Croats was conducted by T. Kawka (2021). It turned out that, despite cultural differences and different nationalities, representatives of generation Z from Poland and Croatia are characterized by very similar results in terms of surveyed expectations and attitudes. This author draws a conclusion about the “global, homogeneous perception of their professional role by the youngest generation entering the labor market in the studied sample of students”. Among the key determinants of work that are important to them at the initial stage of life and work regardless of where they work and what kind of offer they receive from their employer, young Croats indicated, in order: the supervisor's leadership style; the organization of work; the expression of appreciation for the employee by superiors and the organization. In the case of Polish students, the highest ratings were given to the attributes: the opportunity for professional development and competence improvement, achievements and professional success at work, clear and open communication of rules and criteria for payment and awarding of remuneration.

According to the aforementioned Manpower Group Report, “Generation Z expects their employers to take action on all global issues - from diversity, equality, inclusion and belonging, to climate change. According to 52% of representatives of this generation, those born between 1995 and 2012, companies are not doing enough to protect the environment. The role and expectations of business are the highest they've ever been, so organizations need to set a clear goal if they want to attract, develop, as well as retain Generation Z talent” (Trends 2023. Compensation and the Labor Market).

The authors' findings are in line with the conclusions of the 2022 Global Employee Survey. It shows that the top three reasons why people have changed jobs in the past 5 years include: low pay (29%), feeling undervalued (27%) and lack of promotion (23%). These researchers found that employees are less likely to leave companies offering higher wages (the average departure rate is 50% higher in the 20% of companies paying the lowest wages compared to the 20% of companies paying the highest wages). In addition, older workers (50-59 years old) are significantly less likely to switch to a job that provides better pay, compared to younger workers (Ageing and Employment Policies: Retaining Talent at All Ages, OECD, 2023).

The authors' findings are in line with the aforementioned analysis of human re-sources researcher Dolot (2018, pp. 227-242). Her respondents ranked the atmosphere at work as one of the most important factors for Generation Z. (Evaluation mainly by those with work experience.) In second place came a factor related to salary, while third place in the hierarchy of motivating factors was occupied by job security in her study. This was followed by elements such as experienced and friendly management, factors related to development (e.g., training) or work related to the employee's interests and passions.

In a study conducted by Domagalska-Gędys on representatives of Generation Z, one in three respondents chose the value of self-realization. This was followed by interpersonal relations and atmosphere at work as well as employer ethics. The purpose of the author's study was to determine the value at work using the example of part-time students from an agricultural

university. The author found that high salaries are more important to Generation Z than to Generation Y, while for both groups, an important value is the atmosphere at work that helps their self-realization (2017, pp. 40-45).

Also in Ratajczak's research, it was found that the most frequently mentioned factor by young people was adequate pay, a good atmosphere at work, stability of employment, respect for the employee and constancy of work (2018, pp. 206-215).

On the other hand, a study by Gajda, who analyzed the expectations of students at the University of Economics, showed that the most important factors mainly included a high salary, access to modern technologies and work-life balance. The employer should show respect for the employee and his opportunities for development, offer adequate remuneration and flexible working hours, while the organization of work should allow the realization of creative thinking and rapid learning (2017, pp. 158-171). Similar results were obtained by researchers Kukla and Nowacka. According to them, young people who make up Generation Z, are a very diverse group (2019, pp. 176-181).

As Nabahaniand, Generation Z has unique characteristics that distinguish it from previous generations. According to these authors, this generation is known as "job changers". Their research confirms a high propensity to change jobs if their expectations are not met (2020, pp. 234-239).

Dwidienawati and Gandasari, on the other hand, detected that students in Indonesia are willing to work harder to earn higher wages and that Generation Z mainly expects stability and job security after graduation (2018, pp. 245-252).

The growth of digital technologies results in the economy and society in the need for competence in operating modern machines and equipment, contributing to significant changes in manufacturing processes (Sidor-Rządkowska, Sienkiewicz, 2023, pp. 11-16). The development of Economy 4.0, based on automation, robotization and digitization, triggers the need to adapt employees' competencies to the new reality, which may generate their reluctance to change. Some of them are afraid of new technologies. This necessitates the elimination of existing jobs (about 75 million) and the creation of new ones (about 133 million), which requires the development of employees' competencies, conditioning the implementation of tasks related to the automation of, for example, production processes. In the future, the following issues become important: willingness to learn and solve problems, self-awareness, flexibility, development of emotional intelligence or the ability to work in a virtual world and international teams (Dobrosielska, 2019, pp. 6-9).

Demotivating the employee may be the lack of competence among managers, who, in addition to their leadership skills, must be able to navigate the new reality. With the development of the Industry 4.0 concept, their technological competence is gaining importance. Currently, it is not enough to set goals and give instructions, as the management of an organization in Industry 4.0 is done by programming the principles and values of employees. The efficiency of the organization's functioning requires finding new solutions. The goal of

management becomes flexibility and autonomization, and decisions are made through algorithms (Moczydlowska, 2023, pp. 100-102).

Thus, the competitive advantage of the organization is provided by orientation to the use of instruments that support smart solutions, while meeting the challenges of the fourth industrial revolution requires primarily knowledge and financial resources (Masood, Sonntag, 2020). The limitations of the Industry 4.0 concept have already been recognized, as the Industry 5.0 concept emphasizes the sustainable and balanced development of the employee and the positive impact of the transformation on society (Industry 5.0...). However, this requires motivation and knowledge of employees, their openness to innovation and the elimination of the fear of change (Kumar, Singh, Dwivedi, 2021).

In order to ensure self-motivation, it is necessary to meet human psychological needs. It becomes necessary in organizations to offer employees programs and activities that promote autonomy and social ties. It is important to show support, give constructive criticism and encourage employees to make decisions on their own. One significant demotivator to work is the fear of failure. Costs resulting from stress or turnover in the workplace must be countered. It is necessary to shape a culture that promotes values such as solidarity, altruism or willingness to support colleagues. It seems that an effective solution is teamwork, which effectively affects the development of the organization (Vo et al., 2022, p. 15).

Inadequate communication between co-workers, low wages or working conditions that are different than expected should also be considered demotivating factors for work. Great importance is attributed to opportunities for career advancement. Regardless of external conditions, opportunities for promotion, are seen as recognition among co-workers and motivate a person to act, as it strengthens his sense of worth.

Appreciation by superiors and co-workers encourages commitment and development of existing competencies. It is important for managers to be able to appreciate an employee's willingness to participate in training programs and consider them important in the process of career development. Lack of progress in the development of employees' knowledge and skills usually results in a decrease in the quality of work. The success of the organization depends to a large extent on the employee's sense of worth, reinforced by the recognition expressed by his superiors (Fernandes, Santinha, Forte, 2022, pp. 14-15).

One of the key factors that demotivate employees is low wages (89% of those surveyed) and the occasional opportunity to receive a bonus or participate in training that conditions professional development. The wages earned should be adequate to both the needs of employees and the work they do. This is especially important for young people with short seniority, who, if they reach dissatisfaction with the level of salary, are willing to change it quickly (Maziarz, 2020, pp. 47-59; Kmiołek, Kopertyńska, 2018, pp. 103-113; Roslon, 2020, pp. 327-338). The availability of social benefits, e.g., Christmas packages, funds for holidays under the bushel, or mortgage subsidies or low-interest loans for housing renovation, should also be considered important factors. For seniors, trips are attractive, and for working parents, camps

for children or nurseries and kindergartens in the workplace area. It becomes important to properly match the offer to the employee's needs, as ineffective matching can negatively affect employee productivity. The organization's need to cut costs results in the abandonment of the social benefits offered, which reduces its competitiveness in the labor market (Liksza, 2022).

An ergonomic workstation makes the employee feel comfortable at work. It is important to eliminate the causes of accidents. It becomes necessary to ensure the safety of employees, eliminate the impact of harmful factors and hazards arising from the work environment (such as biological factors, radiation, noise, vibration) (Zwiech, 2022, pp. 69-76). It is also a serious problem to feel monotony or monotypical which results in discouragement, burnout and even depression. Industry 4.0 seeks to automate repetitive activities and enrich work that is considered monotonous. However, the level of feeling its monotony also depends on the employee's interests and predispositions.

In many organizations, in order to reduce the effects of monotony, elements of games, for example, are introduced in order to obtain in the employee a state of higher commitment to tasks. It is important that he obtains a high level of concentration and commitment when performing routine, repetitive activities (Silva, Rodrigues, Leal, 2019, pp. 484-507; Para, 2021, pp. 21-29; Witoszek, 2019, pp. 35-47). It is also important to strive to form positive relationships between co-workers, which improves the atmosphere at work. When employees see work only as a source of livelihood and it does not give them satisfaction, competition even in the form of gamification can be perceived negatively. It becomes important for superiors to have the right approach to employees' performance and to be able to select elements of gamification directly to employees' needs in order to be able to stimulate their intrinsic motivation through the use of external incentives (Hammedi, Leclercq, Poncin, Alkire, 2021, pp. 256-269).

The Covid-19 pandemic obliged organizations to adapt to a new reality, in which it became necessary to limit face-to-face relationships for the sake of employees' lives and health. This has resulted in the widespread implementation of remote work, and therefore also in the blurring of the boundaries between work and private life. Lack of adaptation of equipment or insufficient support from IT teams, raises stress levels and the feeling of work overload, which often results in a decrease in job satisfaction (Irawanto, Novianti, Roz, 2021, p. 96). Technological advances made it possible during the pandemic to move work to the home, resulting in difficulties in dividing time between work and home life. The development of technology has ensured that employers are in constant contact with their employees, which can disrupt the work-life balance (Nowak, 2020, pp. 473-474).

Despite the apparent source of disruption, the crisis caused by the epidemic presented an opportunity for rapid development of the organization, as it was impossible to manage it in the same way as before - at a time of imminent danger to life and health. The new situation was a test of both the character and skills of managers and employees, as well as existing organizational and administrative solutions (Okada, Hering, McManus, 2021). The effect of the

pandemic was job insecurity and fear of losing financial stability, which adversely affects not only the level of employee engagement, but also their mental health (anxiety, depression). Minimizing the effects of this negative situation is possible with the support of the supervisor and his ability to create an atmosphere. It is necessary to create an organizational culture based on trust and mutual respect (Wilson et al., 2020, pp. 686-691; Asfaw, Chang, 2019, pp. 96-110).

An important factor influencing the level of employee motivation is the possibility of flexible work, which became particularly popular during the Covid-19 pandemic. Studies show that work flexibility is more attractive to young people than seniors (Grześ-Bukłaho et al., 2022, pp. 779-799).

Aghayeva and Slusarczyk conducted a study, which shows that the group of the most significant factors demotivating employees include: lack of safe working conditions, unsatisfactory pay and unacceptable (aggressive) management style. In turn, a study conducted by the team of Fratričová and Kirchmayer shows that the most frequently cited reasons for demotivation include: lack of pleasure from work on (57% of respondents) and inadequate team atmosphere - bad relations with co-workers and pressure from the employer (49% of respondents) (Fratričová, Kirchmayer, 2018, pp. 28-37). Respondents are also demotivated by an excessive workload, too high expectations in relation to a low salary, or a lack of interest in their work. Other demotivators include: lack of training, difficulty in getting promotions, ignoring employees' ideas and lack of opportunities for professional development on the job. Lack of promotion prospects and lack of development opportunities effectively discourage an employee from engaging in the performance of daily duties (Maziarz, 2020, p. 17; Rosłon, 2020, pp. 327-338).

Referring to the aforementioned motivation theories of F. Herzberg and L. Koziol, it should be noted that representatives of Generation Z attach great importance to both factors referred to as “motivators” (increasing their level of job satisfaction) and those referred to as “hygiene factors”, which cause their dissatisfaction (Herzberg, 1968). Motivators such as recognition, job content, and opportunities for personal development remain important. Hygiene factors such as pay and other working conditions, interpersonal relationships, job security, and social benefits are also significant.

In order to improve the incentive systems designed and implemented for young employees, it is necessary to develop L. Koziol's concept. It is important to identify the factors that most demotivate young employees. Measures aimed at reducing stress in the workplace, the need to adapt work to people's psychophysical capabilities (ergonomic approach) and their qualifications (Koziol, 2011) remain important. Demotivating factors should be eliminated in order to encourage Generation Z to engage in continuous learning and personal development. In a changing work environment, digital skills, the ability to work in a team, flexibility, and a willingness to develop in various areas are particularly important (Karpińska, Owczarczuk, 2024, p. 80).

The authors of modern HR strategies should ensure that Generation Z's technological curiosity and openness to innovation are used to their full potential. In this regard, it is worth drawing on the work of motivation researchers such as Deci and Ryan (2000) – theory of self-determination, Csíkszentmihályi (2016) - flow theory, and Hackman and Oldham (2010) - Job Characteristics Model.

It is also important to ensure conditions conducive to technology design and programming (World Economic Forum, 2023, pp. 256-286). According to Ernst&Young, professional practices are particularly important for Generation Z (Sawyer, 2021).

Future research directions include a European comparative study of the factors that motivate and demotivate people to work, as well as an analysis of the gap between the demands of today's labor market and the skills that young workers possess.

Conclusions

Humanocentricity as a key feature of Industry 5.0 includes a focus on the role of the human being as the main decision-maker and creator, the personalization of production processes according to the needs of customers and employees, and the creation of work-places that promote employee well-being.

The survey and statistical post-tests conducted allowed the study to achieve its goal. Generation Z is an extremely dynamic group for whom technology, authenticity and work-life balance are very important factors. They have changed the way companies and institutions must approach consumers, employees and citizens. They are entering the job market at a time when many are worried about financial stability and the availability of well-paying jobs. The rising cost of living and education is also a significant source of worry.

Motivation improves the ability to concentrate, which leads to higher quality work, especially in tasks that require precision. Motivation encourages effective time management, which allows tasks to be completed on time without reducing their quality. Motivated employees are less likely to postpone tasks, which gives them more time to work out the details. Motivation causes employees to derive greater job satisfaction, which translates into quality work performance. Motivation can reduce work-related stress, which has a positive effect on accuracy and efficiency. Motivated employees are more cooperative, leading to better team performance. Highly motivated individuals can inspire others in the team, which increases the overall quality of work in the organization. Motivation promotes the acquisition of new skills and the improvement of those already possessed, which increases the quality of work. Motivated employees often strive to improve their own performance and quality of work.

Generation Z is characterized by several traits that distinguish it from previous generations, especially in the context of technology, work and social values. Generation Z values flexible working conditions and work-life balance. Remote work, independence and freelance opportunities are attractive to them. They often seek work that not only provides financial stability, but also makes social sense or makes a difference in the world.

Generation Z grew up with technology and the Internet from an early age. This makes them extremely adept at using digital devices, social media and modern communication tools. Gen Z is accustomed to processing a lot of information at once. They are adept at using several platforms and applications simultaneously. Generation Z is often value-driven when making consumer decisions. Companies that care about the environment, sustainability and social responsibility are more attractive. They expect products and services to be tailored to their individual needs. They value originality and personalization, especially in fashion and technology.

The functioning and development of organizations depends on their competence to meet the challenges arising from the turbulent environment. Particular attention should be paid to the growing importance of digital transformation, globalization and the impact of economic and social crises (Jaki, Ziębicki, 2021, p. 9). The high dynamics of change means that solutions considered perfect are currently becoming obsolete (Klak, 2020, p. 177). Taking advantage of new opportunities promotes the competitiveness of the organization. Efficiency determines the sustainability of success, understood as the ability to develop the organization in the long term (Grabowska, 2017, pp. 30-33). An opportunity for this is to hire motivated employees, including representatives of the younger generation, who are committed to carrying out their duties.

Professional education prepares young people not only technically, but also mentally for professional challenges. In doing so, it improves the quality of work. By developing skills, building confidence and inspiring action, it positively influences their motivation to work. To make this impact even more effective, it makes sense to invest in practice-oriented education, soft skills development and mentoring support.

Education tailored to the needs of the labor market teaches competencies that are useful in working life. Young people feel better prepared for work, which builds their confidence and increases their motivation. Professional education programs often help young people discover their talents and strengths, which encourages them to develop their careers in a particular direction. Professional education systems help young people set realistic and ambitious career goals, which provide motivation to move forward. Meetings with mentors, apprenticeships or success case studies encourage young people to achieve their goals, prepare them for the realities of work and show the value of effort. Such education motivates commitment, as students see the results of their learning. Young people who understand how their work affects society are more motivated.

Education that takes into account the development of social and emotional competence helps young people cope with professional challenges. This increases their perseverance and motivation. Inspiring educators and career counselors often act as motivators, showing young people the value of work and commitment.

The compatibility of education with the labor market is crucial to maintaining quality work. When young people see that what they are learning corresponds to the demands of the labor market, they are more motivated to learn and work later. Professional education programs provide career prospects, which motivates young people to perform better and better.

Creating a sense of belonging and meaning is also important. Education that shows how work can contribute to social development or personal fulfillment increases intrinsic motivation. Meanwhile, participation in educational programs that promote cooperation, networking and social integration increases motivation to work in teams.

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MATURITY MODELS IN SMART CITY DEVELOPMENT MANAGEMENT – A SYSTEMATIC LITERATURE REVIEW

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Purpose: The subject of smart city development in the face of increasing challenges related to digitalization, as well as social, economic, and environmental pressures, remains highly topical. The aim of this article is to provide a systematic review and synthesis of the literature on maturity models in the context of managing smart city development.

Design/methodology/approach: The study was conducted in accordance with the PRISMA 2020 guidelines, ensuring the rigor, transparency, and reproducibility of the research process. An analysis of 33 smart city maturity models was performed based on criteria such as the conceptualization of the smart city notion, the number of maturity levels, the domains of intelligent solution implementation, and the practical application of the models for assessing city maturity.

Findings: The systematic literature review indicates that the evolution of smart city maturity models reflects a paradigm shift from a technologically oriented perception of the smart city as a set of ICT-based solutions towards an integrated, systemic approach in which governance, data, participation, and resilience constitute mutually interlinked pillars.

Research limitations/implications: The literature review covers publications in English, which may limit access to information on national or local maturity models developed for specific countries or communities.

Practical implications: Urban stakeholders – taking into account city size, historical and cultural background, and their own development objectives – may apply the most appropriate model identified in the review to suit their specific needs, as well as conduct comparative analyses with selected cities for which maturity assessments have already been performed.

Originality/value: The study provides a comprehensive and the most extensive literature review published to date on existing smart city maturity models, including an indication of their practical application.

Keywords: smart city, maturity model, systematic literature review.

Category of the paper: Systematic literature review.

1. Introduction

Contemporary cities operate under conditions of increasing complexity within socio-economic systems, intensified urbanization, demographic pressures, and escalating environmental challenges. According to projections by the United Nations Department of Economic and Social Affairs (2019), by 2050 more than 68% of the global population will reside in urban areas, creating the need for new approaches to managing space, resources, and the quality of life of residents. In light of these developments, traditional models of urban growth are giving way to concepts that integrate technology, data, and social participation to build cities that are more resilient, sustainable, and human-centred.

Within this context, the smart city paradigm has gained increasing significance. It brings together elements of public management, digital transformation, sustainable development, and social innovation (Höjer, Wangel, 2015; Ahvenniemi et al., 2017; Moura, de Abreu e Silva, 2019). Smart cities employ information and communication technologies (ICT), the Internet of Things (IoT), big data analytics, and artificial intelligence (AI) to optimize urban processes, enhance the quality of public services, and increase citizen engagement in co-governance (Nam, Pardo, 2011; Hashem et al., 2016; Winkowska et al., 2019; Zhuang et al., 2024). In contrast to traditional urban planning models, the smart city concept views the city as a complex, dynamic ecosystem in which infrastructure, technology, institutions, and residents interact. The implementation of digital solutions therefore requires not only investments in technological infrastructure but also the development of organizational capabilities, an innovation-oriented culture, and institutional openness (Gracias et al., 2023), as the notion of the smart city has evolved from technology-driven Smart City 1.0, through technology-enabled and city-led Smart City 2.0, and citizen co-created Smart City 3.0, to Smart City 4.0, which aims at economic, social, and environmental sustainability (Marchlewska-Patyk, 2023; Jonek-Kowalska, Wolniak, 2024). Key factors supporting the development of smart cities include access to external financing sources, advanced digital infrastructure, data integration, and high levels of cybersecurity and data protection. Conversely, barriers include low levels of integration among urban systems and a lack of data interoperability, limited financial capacity of local governments, and institutional resistance to change and to digital-climate transformation (Szpilko et al., 2025).

It may therefore be concluded that, as digitalization progresses and intelligent solutions proliferate in urban environments, the need to measure the degree of advancement of cities undergoing this transformation becomes more pronounced. Cities vary in terms of resources, development visions, stakeholder involvement, and regional conditions; consequently, no universal pathway to becoming a smart city exists. In response to this diversity, maturity models are increasingly used in both the academic literature and urban management practice. These models enable the diagnosis of the current state of development, the identification of gaps, and the planning of subsequent stages of transformation (Pliatsios et al., 2023).

Maturity models – particularly those originating in project management and organizational development – have become key tools for assessing the digital and organizational readiness of cities (Lombardi et al., 2012). They facilitate the classification of technological, social, and institutional development levels and support data-driven governance. Recent years have seen a significant increase in publications and tools based on smart city maturity models, which differ in scope, structure, and intended applications (Aljowder et al., 2019). Despite this diversity, however, a coherent comparative analysis capable of capturing shared features, methodological differences, and trends in the evolution of these models remains lacking.

Given the growing importance of sustainable digital transformation in urban environments, it is essential to systematically organize and critically evaluate existing maturity models. Such a review not only helps determine which aspects of “urban intelligence” are most frequently measured but also reveals conceptual gaps and opportunities for developing new, more comprehensive assessment tools that account for contemporary challenges such as resilience, cybersecurity, social inclusiveness, and alignment with ESG (Environmental, Social, Governance) principles (Kumar et al., 2023).

The purpose of this article is to conduct a systematic review and synthesis of the literature on maturity models in the context of managing smart city development. The study follows the PRISMA 2020 guidelines, which ensures rigor, transparency, and reproducibility throughout the research process. Its systematic character makes it possible not only to identify and classify existing maturity models but also to compare them critically in terms of theoretical assumptions, assessment criteria, and implementation contexts.

The article adopts an analytical and comparative perspective and seeks to structure the existing scientific body of knowledge on smart city maturity assessment, encompassing both conceptual and empirical approaches. The primary research problem concerns how the notion of maturity in smart cities has evolved – from approaches dominated by information and communication technologies to contemporary models that integrate sustainability, resilience, and social inclusiveness.

2. Methodology

The study was conducted as a systematic literature review in accordance with the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021), which ensured scientific rigor in synthesizing research on smart city maturity models. The process involved the following stages: (1) formulation of the research problem, (2) development of a protocol specifying inclusion and exclusion criteria, data sources, search strategy, publication selection procedure, data extraction approach, and assessment of study quality, and (3) synthesis of findings (Figure 1). The inclusion criteria covered all available

scientific publications presenting smart city maturity models from their emergence up to 2025. Given that the topic of urban maturity in terms of the implementation of information and communication technologies in various domains of city functioning is relatively new, the earliest publications date from the second decade of the twenty-first century. All articles were required to exhibit a clear focus on assessing the maturity of cities in terms of smart solutions.

The exclusion process followed two stages. Initially, duplicated or misclassified studies that did not include descriptions of urban maturity models were identified and removed. Subsequently, a qualitative assessment was carried out based on thematic relevance and methodological rigor. Titles, keywords, abstracts, and full texts were examined. Articles that merely applied existing, previously described maturity models to assess the maturity level of a given city were excluded.

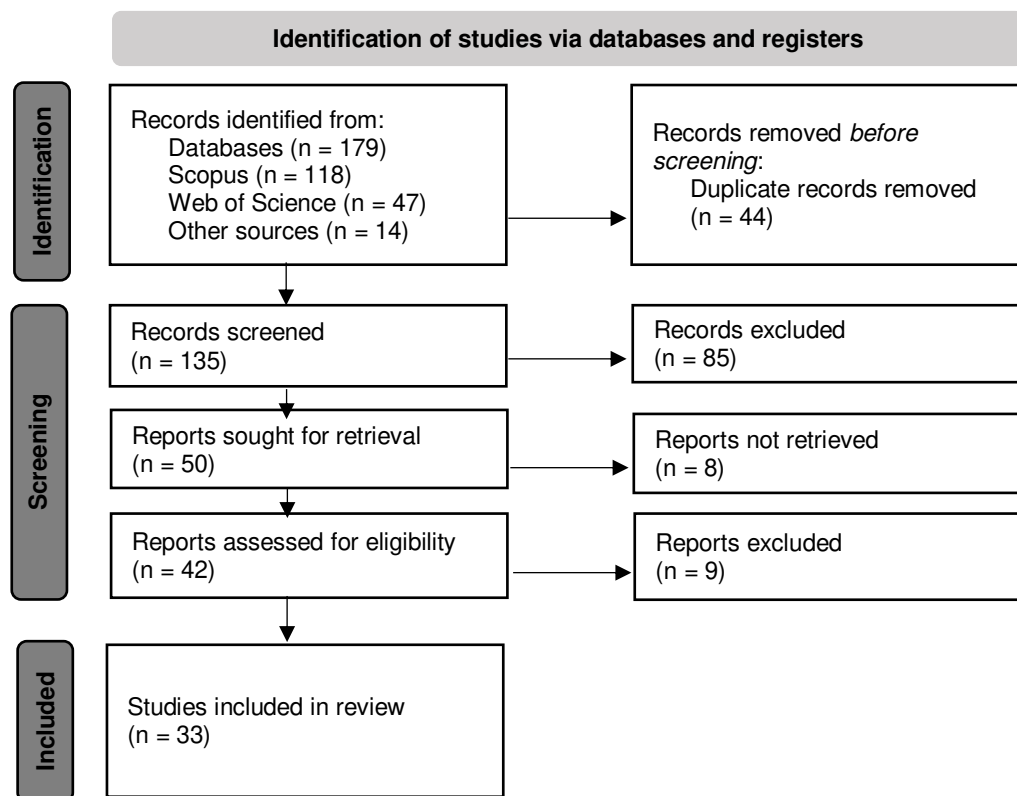


Figure 1. PRISMA flow diagram chart for search for academic articles on smart city maturity models.

Source: own elaboration based on PRISMA.

Searches were conducted in the Scopus and Web of Science databases, which contain scientific studies published in reputable, high-impact journals and maintain robust indexing standards and advanced bibliometric tools. Due to the need to exclude numerous publications that did not meet the eligibility criteria, the search was extended to Google Scholar and ResearchGate, with particular attention given to source credibility. Peer-reviewed publications in English from the years 2013–2025 were included.

In each database, search strings were formulated in a comparable manner, adjusted to reflect platform-specific constraints. In Scopus, searches were carried out by identifying occurrences of selected terms in titles, abstracts, and keywords using the string: TITLE-ABS-KEY ("smart cit*" OR "intelligent cit*" OR "digital cit*" AND "maturity model" OR "maturity level") AND PUBYEAR < 2026. The Web of Science string was adapted to the platform's syntax as TS=("smart cit*" OR "digital cit*" OR "intelligent cit*" AND "maturity"), supplemented with the keywords "maturity model" and "smart cities" or "smart city". In ResearchGate and Google Scholar, keyword searches such as "smart city maturity model" resulted in excessively large numbers of publications that precluded a rigorous screening process. Therefore, only the first ten pages of results ranked as most relevant were reviewed.

Following the searches, the selection process proceeded in three stages: (1) removal of duplicates, (2) analysis of titles and abstracts, and (3) full-text evaluation against inclusion criteria. The screening was performed independently by two reviewers, and discrepancies were resolved through consensus. The selection process was summarized and visually structured using a PRISMA flow diagram (Figure 1). Microsoft Excel was used to manage and analyze the data. From the included studies, key information was extracted regarding authorship, year of publication, purpose, methodology, practical implementation, and conclusions. The risk of bias in the selected studies was assessed by carefully examining methodological rigor, transparency of results, and potential conflicts of interest. Ultimately, 33 publications were qualified for qualitative analysis.

3. Research results

3.1. Keyword analysis

As part of the analysis and synthesis of the literature on smart city maturity models, a keyword analysis was conducted as an initial step. The technique of Visualisation of Similarities (VOS) was applied, enabling the visualization of relationships between concepts by showing networks of keyword co-occurrence in scientific publications. The connections among keywords were mapped using VOSviewer (Figure 2). The visualization reveals several distinct thematic clusters, differentiated by colour. The distances between nodes reflect the strength of semantic relationships: the closer two concepts are positioned, the more frequently they co-occur in the scholarly literature.

The keyword analysis conducted with VOSviewer 1.6.20 made it possible to identify ten thematic clusters covering issues related to smart cities and maturity models. The results highlight the main research areas and confirm the multidimensional nature of the discourse on smart city maturity models. The network consists of 1,254 links with a total link strength of

1,694, indicating a high degree of coherence and strong interdependencies among the examined topics. The concepts smart city and maturity model occupy a central position in the network, acting as nodes that integrate different research streams. Their proximal neighbourhood includes terms related to decision-making, sustainable development, and urban planning, confirming their significance as meta-frameworks for assessing and directing smart city development.

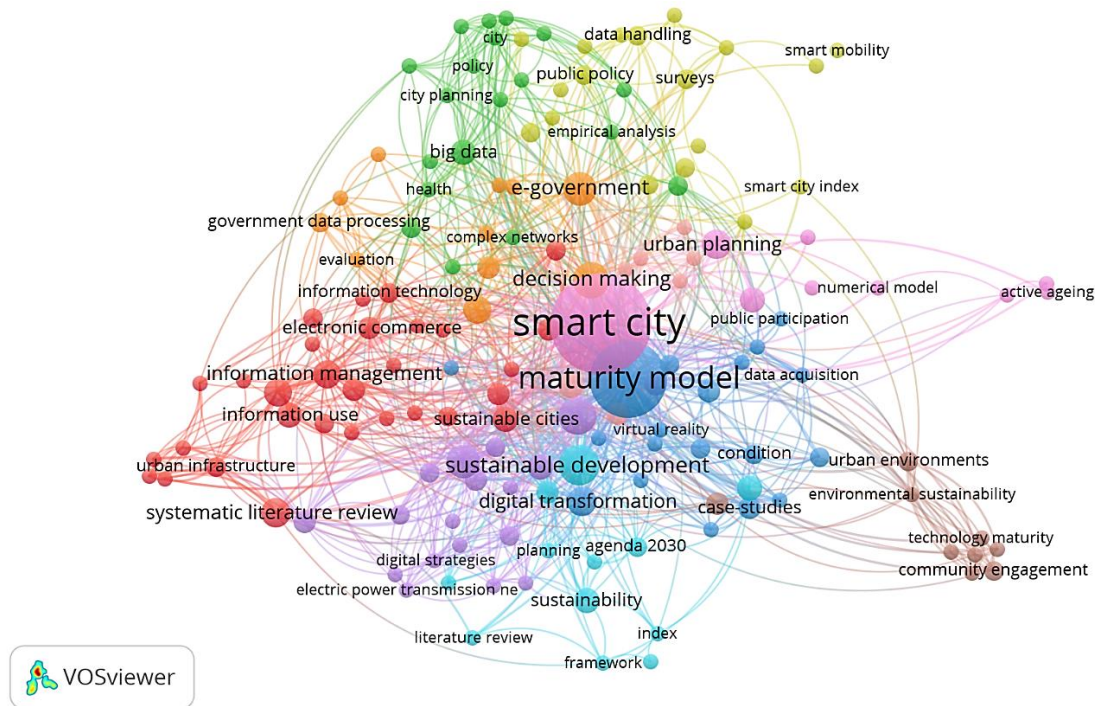


Figure 2. Results of keyword analysis using the VOSviewer tool.

Source: own elaboration.

Among the identified thematic clusters, four dominant areas stand out.

The red cluster – information and technology management (*information management, information technology, government data processing*) – relates to the management of information and the use of information and communication technologies in urban processes. It covers data collection, processing, and dissemination, as well as the use of data to support administrative decision-making and strategic planning. In the context of smart cities, the management of public sector data (*government data processing*) is of particular importance, as such data form the basis for open data services, urban analytics, and predictive infrastructure management. The guiding objective is to create an integrated information ecosystem in which data from various sectors (*transport, energy, environment, waste management, public safety*) can be combined and analysed in ways that support effective urban governance and enhance the transparency of public administration.

The second prominent area is the orange cluster – public policy and urban planning (*public policy, e-government, city planning*). This thematic area focuses on the institutional and regulatory dimensions of urban transformation towards smart cities. Public policy relates to the

development and implementation of strategies that facilitate sustainable urban development and the effective use of new technologies. E-government refers to the digitalization of public services and improvements in interactions between authorities and citizens through information technologies. Urban planning encompasses the use of digital tools in designing urban space, transport systems, environmental protection, and infrastructure development. The common objective of these activities is to build coherent public governance frameworks in which policy, law, and technology work together to support innovation, citizen participation, and urban resilience.

The third dominant cluster (blue) – digital transformation and sustainable development (*digital transformation, sustainable development, Agenda 2030*) – emphasizes the integration of digital technologies with sustainable development objectives. Digital transformation implies a profound shift in the functioning of urban institutions through technologies such as the Internet of Things, artificial intelligence, data analytics, and blockchain. Sustainable development refers to the need to balance environmental, social, and economic dimensions in urban growth. Agenda 2030 (*The United Nations 2030 Agenda for Sustainable Development*) provides a strategic framework, particularly through SDG 11 (*Sustainable Cities and Communities*) and SDG 9 (*Industry, Innovation, and Infrastructure*). In this perspective, the smart city becomes an instrument for implementing global development goals, where digitalization serves as a means to enhance quality of life, reduce emissions, and increase the resilience of urban systems.

The fourth cluster, the brown cluster – community engagement and technological maturity (*community engagement, technology maturity, environmental sustainability*) – refers to the social dimension of smart city transformation and the technological maturity of cities, understood as the ability of urban institutions to effectively use technology. Community engagement denotes the active involvement of residents in planning, co-decision-making, and monitoring urban initiatives. Such participation increases acceptance of innovation and improves the alignment of solutions with actual resident needs. Technological maturity refers to the level of development of digital infrastructure, organizational capabilities, and innovation culture that enable effective implementation of smart city solutions. Environmental sustainability signals the need to incorporate ecological considerations – such as energy efficiency, emissions reduction, and circular economy principles – into urban planning and technology projects. This cluster highlights that digital transformation must be accompanied by the development of social competencies and a culture of shared responsibility, which collectively contribute to more sustainable and resilient urban communities.

It should be emphasized that peripheral clusters identified through the VOSviewer analysis – such as *active ageing* or *virtual reality* – indicate emerging research directions that extend classical technological approaches to include social, demographic, and immersive dimensions.

3.2. Comparison of smart city maturity models

The analysis of the collected literature enabled the identification and characterization of a range of smart city maturity models developed between 2013 and 2025. This section presents the main assumptions of these models, the conceptualization of the smart city notion, the description of maturity levels, the domains of intelligent solution implementation, and the empirical applications of the models (Table 1). Based on a search conducted in academic databases (Scopus, Web of Science, ResearchGate, and Google Scholar), 33 maturity models were identified. It is noteworthy that the highest level of interest in the issue of city maturity was observed in 2018-2019, during which the largest number of proposals for assessing cities in terms of their advancement in implementing modern technologies across various domains was published. The development of new models was likely interrupted by the outbreak of the COVID-19 pandemic, which revealed the need to focus not only on ICT in cities but also on building urban resilience to unforeseen circumstances (including electricity supply disruptions, infrastructural inefficiencies, the physical lack of access to public services for stakeholders, or limited internet access).

Considering the countries of origin or employment of the researchers, the greatest number of maturity model proposals emerged in Brazil (4), Indonesia (3), India (3) and the United Kingdom (3). In addition, intensive work on smart city maturity was conducted by scholars from Germany, Greece, Turkey, Colombia, Canada, Poland, Morocco, Iran, Jordan, El Salvador, Bahrain, Australia, China, and Taiwan, often collaborating within international research teams.

The IDC Smart City Maturity Model (Clarke, 2013) should be considered a pioneering framework, introducing a five-stage concept of the evolution of cities toward intelligent solutions – from ad hoc activities to full optimization. A key assumption of the model is the view of the city as a “learning organization,” in which subsequent stages reflect increasing integration of information technologies, data management, and decision-making processes. This model established the foundations for numerous later proposals. In 2017, the model was structured into a set of stages, dimensions, and subdimensions (still across five levels), oriented toward benchmarking and “system-of-systems” planning (Yesner et al., 2017).

In 2014, the UK government published its own model – PAS 181 – which describes a strategy for building a city’s capability to become “smart” through the integration of people, processes, and technology (BSI, 2014). This model was created in response to the need for a framework to guide urban transformation in an integrated, data-driven manner. PAS 181 does not introduce formal levels; instead, it emphasizes the importance of political leadership and interoperability, becoming a basis for numerous self-assessment tools. PAS 181 has been applied in practice, including in Glasgow, Birmingham, and Bristol.

Table 1.*Comparison of city maturity models in terms of smart solution implementation*

No	Year	Model	Authors	Country	Maturity levels	Smart city domains	Practical verifiability
1	2013	IDC Smart City Maturity Model	Clarke (IDC Government Insights)	International	5: Ad-Hoc → Opportunistic → Repeatable → Managed → Optimized	Strategic Intent; Data; Technology; Governance and Service Delivery Models; Stakeholder Engagement	–
2	2014	PAS 181 Smart City Framework	British Standards Institution (BSI)	United Kingdom	–	Business management, Citizen-centric service management, Technology & digital asset management	–
3	2014	Smart Cities Maturity Model (SCMM)	Sustainability Outlook	India	4: 1 – Access → 2 – Efficiency → 3 – Behavior → 4 System Focus	Transport, Spatial Planning, Water Supply, Sewerage & Sanitation, Solid Waste, Storm Water Drainage, Energy & Electricity, Telecom & WiFi, Economy, Finance, Education & Health (Grouped), Environment	–
4	2014	Smart City Governance Maturity Framework (SCGMF)	Lee, Hancock, Hu	South Korea, USA, Taiwan	–	Urban openness, Service innovation, Partnership formation, urban proactiveness, Smart city infrastructure integration, smart city governance	San Francisco, Seoul
5	2015	Smart Cities Scotland Maturity Model	UrbanTide / Scottish Government	United Kingdom (Scotland)	5: Ad Hoc → Opportunistic → Purposeful & Repeatable → Operationalized → Optimized	Strategic Intent, Data, Technology, Governance & Service Delivery Models, Stakeholder Engagement	Aberdeen, Dundee, Edinburgh, Glasgow, Inverness, Perth, Stirling
6	2015	Smart City Maturity Model (SCMM)	Mani, Banerjee (ISB India)	India	5: Information Dissemination → Services Optimization → Services Replication → Services Integration → Connected Services	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
7	2015	Brazilian Smart City Maturity Model (Br-SCMM)	Afonso, Brito, Alvaro	Brazil	5: Simplified → Managed → Applied → Measured → Turned	Water, education, health, environment, energy, transport, housing, governance, security, technology	27 Brazilian cities
8	2017	CityDNA Dynamics – Smart City Maturity & Performance Benchmarking	Moustaka, Vakali, Anthopoulos	Greece	–	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
9	2018	Unified Smart City Model (USCM)	Anthopoulos, Marjin, Vishanth	Greece	–	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
10	2018	Maturity Model and Assessment for Indian Cities	Prasad	India	4: Basic → Improvised → Intermediate → Advance	Mobility, Water Management, Sewerage & Sanitation, Solid Waste, Storm Water, Energy, Healthcare, Environment, Security, Parking, ICT	20 Indian cities
11	2018	Garuda Smart City Model (GSCM)	Firmanyah, Supangkat, Arman, Adhitya	Indonesia	5: Ad hoc → Initiative → Scattered → Integrative → Smart	Economy; Society; Environment; ICT; Governance; People	Bandung, Palembang, Makasar and Surabaya, Magelang, Pontianak, Denpasar, Bontang
12	2018	Smart City Maturity Level Analysis Using ITIL Framework	Nur, Batmetan, Manggopa	Indonesia	–	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	Manado

Cont. table 1.

13	2018	Data-Quality Smart City Maturity Model (DQSC-MM)	Korachi, Boulmakoul	Morocco	5: Initial → Developing → Defined → Managed → Integrated	Data governance, data quality management, data integration and interoperability, data usage and analytics	–
14	2019	Smart City Evaluation Model	Nuraeni, Firmansyah, Pribadi, Munandar, Herdiani, Nurwathi	Indonesia	5: 0, 1, 2, 3, 4	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	Bandung
15	2019	ISO 37122 – Indicators for Smart Cities (basis for maturity assessment)	International Organization for Standardization (ISO)	International	–	Economy; Education; Energy; Environment & Climate Change; Finance; Governance; Health; Housing; Population & Social; Recreation, Culture & Sports; Safety; Solid Waste; Telecommunication & Innovation; Transportation; Urban Planning; Water & Sanitation; Wastewater; Innovation Ecosystem; Resilience	Dubai, Toronto, Buenos Aires, London, Växjö, Bogotá, Los Angeles
16	2019	ITU-T Y.4904	International Telecommunication Union	International	5: 1 – The overall strategy is developed → 2 – SSC initiatives are aligned with the strategy → 3 – Evaluation of SSC initiatives is carried out → 4 – Strategy is developed for improving integration and cooperation → 5 – Improvement and optimization potential is explored	3 dimensions: economic, environmental, social	Brazilian and Ecuadorian cities
17	2019	Smart City Maturity Assessment and Benchmarking (SCMAB)	Warnecke, Wittstocki Teuteberg	Germany	5: No smart urban mobility system is in place ($x \leq 10\%$) → Conceptualization of basic initiatives (10–40%) → Implementation of basic initiatives (40–70%) → Strategic planning and implementation of smart initiatives (70–90%) → Continuous smart initiatives planning ($\geq 90\%$)	Environmental impact; ICT integration; Intermodal integration; Policy and Planning; Public transport performance; Social impact	London, Vienna, Amsterdam, Stockholm, Berlin
18	2019	Smart City ICT Adoption Maturity Model (SCIAMM)	Maestre, Astudillo, Concha, Nieto	Colombia	5: 0 – initial city, 1 – intentional city, 2 – emerging city, 3 – adapter city, 4 – integrated city	E-Government strategy, Public innovation, IT services, Data management, IT infrastructure	Bogotá, Medellín, Cali, Bucaramanga, Manizales, Barrancabermeja, Popayán
19	2019	Sustainability Maturity Model (SMM)	Da Silva of Santana, de Oliveira Nunes, Passos, Santos	El Salvador	5: Initial → Managed → Defined → Quantitatively Managed → In Optimization	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
20	2019	Maturity-Based Scale for Smart Cities: A Conceptual Framework	Suliman, Rankin, Robak	Canada	5: Initial → Improved → Sustainable → Preventive → Proactive	Natural environment; Built infrastructure and ICT; Services including education and health; Mobility including transportation; Economy and Finance; Governance, policy, management and administration; People, living, and society; Quality of life.	–

Cont. table 1.

21	2020	Smart City Maturity Assessment Model of Turkey (SCMAM)	Bayraktar, Bayar, Kara, Bilgin	Turkey	–	Smart City Applications: Smart Environment, Smart Security, Smart Resident, Smart Building, Smart Economy, Smart Space Management, Smart Health, Geographic Information Systems, Information Technologies, Smart Transportation, Smart Energy, Communication Technologies, Information Security, Smart Infrastructure, Smart Governance, Natural Disaster and Emergency Management. Smart City Management: Governance, Strategy Management, Policy Management, Integrated Service Management, Business Management	4 Turkish cities
22	2021	Information Technology Maturity Model for Smart City Services	Bernal, Espitaleta	Colombia	3: Integrated [0...1] → Analytically Managed [1...2] → Optimized Automated [2...3]	Quality of Citizen Life; Sustainable Environment; Economics Opportunity; Infrastructure; Inclusive Government; IT Dimensions and Indicators	Cereté
23	2022	Maturity Model for Smart and Sustainable Brazilian Cities	Loureiro, Muniz, Pereira, Paseto, Martinez, Alves	Brazil	7: Accession → Commitment → Planning → Alignment → Development → Integration → Optimization	Economic, Socio-cultural, Environment and Institutional Capacity	Selected Brazilian cities
24	2022	Resilient Smart City Model (RSCM)	Baran, Kłos, Choderek, Marchlewska-Patyk	Poland	–	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
25	2022	Innovative Digital Maturity Assessment Model for Smart Cities	Topuz, Coskun, Tütek, Çakır, Temur, Sivri	Turkey	6: 0 – Outsider → 1 – Beginner → 2 – Intermediate → 3 Experienced → 4 – Expert → 5 – Top performer	Smart society; smart mobility; smart administration; smart resources; smart technology management	Istanbul
26	2022	Maturity Model-Based Service Evaluation (MMSE)	Sheng, Zhang, Wang, Shan, Fang, Lyu, Xiong	China	3: Performance, Process, Input & Output	Social benefiting; Accurate governance; Ecological livability; Intelligent facilities; Information Resources; System innovation; Life experience	10 Chinese cities
27	2023	Multicriteria Smart City Maturity Model (MSCMM)	Aragão, Chirolí, Zola, Araújo, Marinho, Correa, Colmenero	Brazil	5: Level 1 – No smartness infrastructure working; • Level 2 – Smartness working but not meeting future needs; • Level 3 – Smartness meets current needs; • Level 4 – Smartness partially initiated for future needs; • Level 5 – Smartness continuously improving to meet future needs	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	London
28	2023	Focus-Area Smart City Maturity Model	Aljowder, Ali, Kurnia	Bahrain, Australia	5: 0, 1, 2, 3, 4	ICT, Economy, Environment, Social, Resources, Services, Governance	–
29	2023	Smart Circular City Maturity Model	Damianou, Vayona, Demetriou, Katos	United Kingdom, France	4: Instrumented City → Connected City → Smart City → Responsive City	Citizen participation; ICT infrastructure; IoT devices	–

Cont. table 1.

30	2024	Maturity model for small and medium-sized cities (MMSMC)	Anschtütz, Ebner, Smolik	Germany	5: 0 – No smart city initiative is in place → 1 – Initial smart city initiatives have been conceptualized and started to be implemented → 2 – Initial smart city initiatives have been implemented → 3 – Strategic planning and implementation of smart city projects and documentation of all relevant data → 4 – Continuous smart city developing and implementing; focus on improvement of the existing smart city solutions	Smart governance, smart people. Smart economy, smart environment, smart living, smart mobility	–
31	2025	Process-aware Digital Transformation Capability Maturity Model for Smart Cities (PDTCCMMSC)	Ajoudanian, Aboutalebi	Iran	5: Incomplete → Performed → Managed → Established → Predictable → Innovating process	Strategic Governance, Information and Communication Technology, Digital Process Transformation, Citizen and Workforce Management	–
32	2025	Smart City Technology Maturity Model (SCTMM)	Jacques, Neuenfeldt Junior, De Paris, Gutierrez, Siluk	Brazil	5: Initial → In evolution → Intermediate → In improvement → Advanced	Living environmental and infrastructure; governance and engagement; entrepreneurship; health and assistance; education and training; energy; technology and innovation; economy and sustainable consumption; security and protection; coexistence and reciprocity; mobility	Santa Maria
33	2025	Dynamic quantitative model for measuring smart city maturity (DWMMSCM)	Kalaldehy, Tarawneh	Jordan	Quantitative model (continuous scale)	Connectivity; Mobility; Jobs and firms; Housing and built environment; Health and Safety; Education and skills; E-government; Energy, water, and waste	Amman

Source: own elaboration.

At the same time, the Indian government recommended the use of a set of benchmark indicators for key smart city parameters. Based on government recommendations and ISO 37120 standards, Sustainability Outlook developed a maturity model applicable to such areas as transport, spatial planning, water supply, sewerage and sanitation, solid waste management, stormwater drainage, electricity, telephone connectivity, and Wi-Fi access. The maturity of a smart city consists of four levels: availability of urban infrastructure and technology; efficiency in the use of resources and energy; behavioral change through interactions between people and physical assets that open new pathways for sustainable development; and a focus on systems of resource and energy exchange.

In 2014, Lee and his team published a study presenting the Smart City Governance Maturity Framework (SCGMF), which is not a formal maturity model in the sense of staged development, but rather a comprehensive assessment model of cities' smart activities, enabling comparative analyses of cities based on measurable dimensions and subdimensions. The overarching goal was to create a tool for assessing the maturity and effectiveness of smart city implementation across diverse cultural and organizational contexts. Six dimensions are evaluated: openness of urban systems, service innovation, partnership creation, municipal

proactiveness (in green smart solutions), infrastructure integration, and intelligent city management. The model was applied in studies conducted in Seoul (South Korea) and San Francisco (United States).

In 2015, the Scottish Cities Alliance developed the Smart Cities Scotland Maturity Model (SCSMM), which incorporated PAS 181 and IDS MaturityScape, combining a strategic management approach with a practical digital development pathway (UrbanTide, 2015). The key areas include strategic purpose, data and ICT, technology and innovation, service delivery, and stakeholder engagement. In this model, maturity is understood as a gradual transition from incidental implementations to systemic integration of smart city solutions and increased citizen participation. The model was applied to assess the seven largest Scottish cities (Aberdeen, Dundee, Edinburgh, Glasgow, Inverness, Perth, and Stirling) (Scottish Cities Alliance, n.d.). It was also used to evaluate the maturity level of Depok City (Indonesia) (Janiawan et al., 2017).

At that time, India saw the development of the Smart City Maturity Model (SCMM) by Mani and Banerjee (2015). Its structure reflects the characteristics of developing countries: the model accounts for infrastructural constraints and lack of resources, defining five levels from “basic” to “optimizing.” A similar approach was adopted in Brazil, where the Br-SCMM was created (Afonso et al., 2015). Unlike the Indian model, the Brazilian version places stronger emphasis on social issues and inequalities, arguing that intelligent transformation must be inseparable from improving quality of life and social inclusion. The authors assumed that a city’s maturity can be assessed through an analysis of its governance structures, technological infrastructure, level of data integration, citizen orientation, capacity for organizational learning, and innovation. Br-SCMM can be considered the first national Smart City maturity model developed for South America and represents an attempt to locally adapt Western concepts such as IDC or PAS 181 to the realities of territorial diversity, limited resources, and technological asymmetry in Brazilian cities. Its validation across 26 Brazilian cities makes it one of the most empirically verified models.

In 2017, Moustaka and her team began work on developing the CityDNA model, later expanded in 2020. The objective of CityDNA (similar to SCGMF) is to enable benchmarking of cities in terms of development, sustainability, and the level of “intelligence”, while considering their unique social and cultural characteristics. CityDNA focuses on three dimensions of city analysis – economy, environment, society and culture. The model assumes that each domain (e.g., transport, energy, health, data management) has its own “gene” – an indicator or a set of KPI metrics – describing the level of development and condition of that area. The model does not define classical maturity levels, but it indicates that a city with high integration, efficiency, and civic engagement exhibits a “stable” DNA structure, whereas imbalances between domains appear as “mutations” or breaks in the helix. In parallel, Anthopoulos, Marjin and Vishanth (2018) developed the Unified Smart City Model (USCM). USCM is based on an analysis of eight classes of conceptual models and six classes of

benchmarking tools, integrating them into a coherent framework. It includes dimensions such as technical architecture and infrastructure, urban governance and policy, planning and development, data and knowledge, sectoral infrastructures (energy, transport, health, environment), and human and social factors (people, living, governance, economy, mobility, environment).

Prasad (2018) proposed a four-level model for assessing Indian cities, aligned with the Smart Cities Mission program. Its purpose was the practical diagnosis of infrastructural and technological gaps and the definition of development pathways within the Indian context. The levels – basic, improvised, intermediate, and advanced – cover 11 functional domains (Mobility, Water Management, Sewerage & Sanitation, Solid Waste, Storm Water, Energy, Healthcare, Environment, Security, Parking, ICT). The model was applied to assess 20 Indian cities, most of which were found to be at the basic maturity level at the time of the study.

Another Asian maturity model is the one developed by Firmanayah and his team (2018). To assess the maturity level of cities regarding the implementation of smart solutions, they proposed the use of organizational maturity model concepts (CMMI, OPM3, PMBOK) adapted to the urban context. Five maturity levels were identified: (1) the ad-hoc level, indicating the absence of ICT infrastructure, management, and human resources; (2) the initiation level, where fragmented and uncoordinated ICT initiatives appear; (3) a level characterized by dispersed but better-planned smart projects; (4) the level of integrated actions for ICT services and stakeholder collaboration; and (5) the intelligent level, where full technological integration, high quality of life, and effective management are present. The assessed city areas include the economy, society, and environment. The model was empirically tested through interviews with urban stakeholders in 10 Indonesian cities: five large cities with over 1 million inhabitants (Bandung, Palembang, Makasar, and Surabaya), three medium-sized cities (Magelang, Pontianak, and Denpasar), and one small city (Bontang). At nearly the same time, another research team (Nuraeni et al., 2019) assessed Bandung's maturity level based on the Giffinger model, using a continuous scale from 0 to 4. According to the researchers, the city was positioned at level 3. Owing to its flexible structure and adaptability of indicators, this model was recognized as a practical tool for local monitoring of smart city digital transformation progress.

A distinct approach was presented by Nur, Batmetan and Manggopa (2018), who based their maturity assessment on the ITIL framework, which describes the lifecycle of IT services: Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement. The authors argued that smart city maturity can be measured as the readiness level of the organization managing municipal services and ICT – hence the adoption of ITIL as the analytical basis. The model assumes that smart city maturity is a function of three main resources: technology (ICT and smart city applications), organization (management, human resources), and use (citizens' awareness and adoption). Empirical verification was conducted in Manado (Indonesia) using a survey questionnaire containing items evaluating maturity levels

in the “Service Design” and “Service Transition” domains on a scale of 1-9. The study found that although technology and command centers were present in Manado, users and human resources were insufficiently prepared. Respondents often did not perceive the benefits of smart city applications, and their knowledge and usage levels were low.

Korachi and Boulmakoul (2018) observed that existing maturity models focus primarily on technological, strategic, or organizational aspects, while neglecting data quality, which is a crucial element enabling smart cities to function effectively. Considering that inadequate data and information management is the main barrier to smart city development, the researchers presented the Data-Quality Smart City Maturity Model (DQSC-MM). This model evaluates city maturity in four dimensions (data governance, data quality management, data integration and interoperability, data usage and analytics), each assessed on a five-level scale (initial, managed, defined, quantitatively managed, and optimizing).

In 2019, the International Organization for Standardization (ISO) developed ISO 37122:2019, which includes 80 indicators across 19 areas of city functioning. The objective of ISO 37122 is to provide an international set of measurable indicators that enable cities to assess their level of intelligent development (smartness) and functional maturity in technology use, data management, and citizen participation. The standard was prepared after several years of consultations with pilot cities from the World Council on City Data (WCCD) initiative, including Toronto, Dubai, London, Buenos Aires, Los Angeles, Boston, Bristol, and Amsterdam. Although it is not formally a maturity model, the standard has been widely used as a basis for assessment tools. For example, Kutami et al. (2018) applied the ISO 37153:2017 model to evaluate transportation infrastructure in one of the cities associated with the Association of Southeast Asian Nations.

The International Telecommunication Union (ITU, 2019) proposed its own model aimed at enabling cities to evaluate their progress toward becoming a smart sustainable city – that is, a city using ICT to improve quality of life, service efficiency, and competitiveness while ensuring economic, social, and environmental sustainability. This model constitutes a global UN standard and is used to diagnose the current state, define target development levels, plan actions, and monitor progress by linking maturity with measurable KPIs. The model includes three maturity dimensions – economic, environmental, and social – which reflect the three pillars of sustainable development. Notably, each dimension may include various thematic areas listed in the document, although the list is not exhaustive. The maturity levels were not assigned specific names, but five levels were defined, each describing concrete achievements in strategy, infrastructure deployment, service activation, data and system integration, and continuous improvement. In the ITU-T Y.4904 model, achievements may extend beyond those specified, depending on the city’s characteristics. The model has been applied in assessments of Brazilian and Ecuadorian cities.

Warnecke, Wittstock and Teuteberg (2019) proposed a design science research-based model for self-assessing city maturity in the smart city domain and comparing results across European cities. The model consists of 36 indicators divided into six thematic groups: policy and planning, ICT integration, intermodal integration, public transport efficiency, environmental impact, and social impact. In their article, the authors focused on smart mobility and distinguished five levels of smart city maturity in this domain – from the absence of smart mobility systems, through sustainable approaches, basic initiatives, strategic planning and implementation of projects, to continuous planning of intelligent mobility based on real-time data, artificial intelligence, and integration of all stakeholders through knowledge exchange. The maturity model was used to evaluate five European cities: London (United Kingdom), Vienna (Austria), Amsterdam (Netherlands), Stockholm (Sweden), and Berlin (Germany).

In Colombia, Maestre et al. (2019) developed the Smart City ICT Adoption Maturity Model (SCIAMM), which analyzes ICT adoption maturity – that is, the ability of cities to progressively integrate information and communication technologies into public services. The model responds to the problem of fragmented ICT implementation in Latin American countries, where tools for comparing digital maturity across cities are lacking. SCIAMM is based on the assumption that smart city development requires sequential ICT adoption across five maturity levels (initial city, intentional city, emerging city, adopter city, integrated city), which reflect increasing organizational and technological complexity. The maturity level is measured across five main dimensions: e-government strategy, public innovation, IT services, data management, and IT infrastructure. The model was applied to assess maturity levels in seven Colombian cities (Bogotá, Medellín, Cali, Bucaramanga, Manizales, Barrancabermeja, and Popayán). The study was conducted through surveys completed by municipal officials responsible for ICT and strategic planning.

Brazilian researchers da Silva of Santana, Nunes, Passos and Brito Santos (2019) presented another model designed to assess the sustainable development of Brazilian cities. The Sustainability Maturity Model (SMM) was developed on the basis of ISO 37122 (smart city) indicators and the logic of the Capability Maturity Model for Software (Paulk et al., 1993) for maturity levels, supplemented with project management elements from Control Objectives for Information and Related Technology (COBIT) related to planning and performance monitoring. The purpose of the model is to enable the classification of a city's maturity level using harmonized, comparable indicators and to derive a synthetic "General Compliance Index". Five maturity levels were proposed: 1 – initial, 2 – manager, 3 – defined, 4 – quantitatively managed, 5 – in optimization, along with assessment across six typical smart city domains according to Giffinger (2010), namely smart economy, smart governance, smart people, smart mobility, smart living, and smart environment.

Suliman and his team (2019) argued that models proposed in the academic literature focus primarily on infrastructural or technological aspects, while lacking a tool that integrates organizational, social, and environmental components of smart city development into one

structured assessment framework. Their response to this gap was the development of a meta-model combining the theoretical foundations of PAS 181:2014, ISO 37120/37122, and the Capability Maturity Model Integration. The model is built on three pillars – intelligent connectivity, sustainability, and resiliency – and includes five maturity levels: initial, improved, sustainable, preventive, and proactive.

The Turkish approach to smart city maturity assessment is based on government guidelines, specifically the National Smart City Strategy and Action Plan of Turkey (NSCSAP 2020-2023). Bayraktar and colleagues (2020) introduced the Smart City Maturity Assessment Model (SCMAM), designed to support effective investment planning and avoid resource waste through the selection of appropriate technological solutions for each city. The model consists of two main competency areas: Smart City Management – strategic management, service integration, policy, and business; and Smart City Applications – functional domains of the city. Each area is divided into competencies, components, and capabilities. Instead of fixed maturity levels, the model uses a continuous scale (0-1), where values closer to 1 indicate higher integration, maturity, and impact. Pilot testing, based on stakeholder surveys, was conducted in four Turkish cities located in different regions.

In 2021, another framework was developed in Colombia: the Framework for Developing an Information Technology Maturity Model for Smart City Services in Emerging Economies (FSCE) (Bernal, Espitaleta, 2021). Its goal is to create a practical tool for assessing the technological maturity of cities in developing economies, particularly in the context of implementing smart city services. The model consists of four IT dimensions: (1) IT management and governance, (2) IT services, (3) data management, and (4) technological infrastructure. Each dimension is assessed using a set of indicators derived from ITIL, COBIT, and TOGAF. The model structure is based on three maturity levels: 1) Integrated – data are integrated and available for smart services; 2) Analytically Managed – the city uses descriptive, predictive, and prescriptive analytics to support decision-making; and 3) Optimized Automated – systems are automated and supported by artificial intelligence in decision processes. The model encompasses five functional smart city areas: quality of life, sustainable environment, economic opportunities, infrastructure, and inclusive governance. The FSCE framework was validated empirically in a case study of the city of Cereté (Colombia), where it was used to assess IT maturity in six public service sectors (including health, education, security, and culture). The results indicated a varied maturity level – from Integrated to Analytically Managed – confirming the model's practical utility for planning investments in digital urban services.

Another Brazilian maturity model for smart cities is the Maturity Model for Smart and Sustainable Brazilian Cities (MMSSCB), developed by Loureiro and colleagues (2022). The model is based on three pillars: ITU-T Y.4904 and Y.4906 – international standards for assessing maturity and digital transformation of cities; the 2030 Agenda and the Sustainable Development Goals (SDGs); and the Carta Brasileira para Cidades Inteligentes (Brazilian

Charter for Smart Cities) with ISO 37120, 37122, and 37123 standards. MMSSCB evaluates smart city development across economic, socio-cultural, environmental, and institutional dimensions. The model uses 114 indicators, of which 80 relate to sustainable development and 34 to institutional capacity. Maturity levels are structured into seven stages: accession, commitment, planning, alignment, development, integration, and optimization. The model has been validated by the ITU and piloted in several Brazilian cities, with plans for deployment across all 5,570 municipalities as part of the national “Brazilian Program for Sustainable Smart Cities,” coordinated by the Ministry of Science, Technology and Innovation (MCTI) and the RNP research network (Rede Nacional de Ensino e Pesquisa).

In 2022, the Resilient Smart City Model (RSCM) was proposed by Polish researchers (Baran et al., 2022). The authors do not build a classic maturity model with sequential development stages, but rather a systemic model of interdependencies between key dimensions of urban resilience and smartness. RSCM is used to identify determinants of resilience, analyze relationships between components of the smart city system, and design an integrated approach to urban policies. The model relies on the six typical smart city dimensions according to Giffinger. It emphasizes citizen engagement in urban governance, creating conditions for local communities to participate in co-creating smart solutions and shaping the urban environment.

The Digital Maturity Assessment Model for Smart Cities (DMAM-SC), developed by Topuz et al. (2022), was created as an innovative tool for assessing the digital maturity of cities using the multicriteria decision-making method Best-Worst Method (BWM). The authors aimed to develop a measurable and adaptable evaluation system that enables cities to identify their strengths and weaknesses in deploying digital technologies and to plan strategic actions toward smart development. The model includes five main dimensions: society, mobility, administration, resources, and technology management. Each dimension is evaluated through weighted criteria derived using BWM, which helps objectify the assessment process and reduce expert subjectivity. The model defines six levels of digital maturity: Outsider, Beginner, Intermediate, Experienced, Expert, and Top Performer, which describe the degree of integration of digital solutions in urban management. Empirical validation was conducted through a case study of Istanbul (Turkey). The results indicated that the city is at an advanced level, with the highest scores in technology and management, and the lowest in the social dimension. The study confirmed the model’s practical usefulness for strategic analysis and its flexibility for adaptation to local conditions.

The Maturity Model-Based Service Evaluation (MMSE) developed by Sheng et al. (2022) is the first Chinese maturity model appearing in the literature that was designed to establish a standardized system for assessing and comparing the development level of smart city services. MMSE is intended to enable municipal authorities and researchers to conduct an integrated assessment of the quality, efficiency, and effectiveness of public services while accounting for social and technological factors. The structure of the MMSE is based on a three-level evaluation system: the Performance Layer, which measures the efficiency of municipal services

(e.g., transportation, healthcare, education, emergency management); the Process Layer, which assesses management processes, data openness, innovation, and cross-sector collaboration; and the Input-Output Layer, which focuses on resources, technological infrastructure, and implementation outcomes. The model defines five evaluation principles (data consistency, integration of subjective and objective indicators, dynamic development, regional flexibility, and empirical verifiability) and a hierarchical set of indicators comprising more than 100 variables describing the efficiency of municipal services. The model was applied in a study of 10 Chinese cities, for which a comparative evaluation was conducted for the years 2016-2018 using objective and subjective data.

In 2023, Aragão and his team aimed to create a model that would allow a quantitative measurement of a city's "smartness" level and enable comparison and development planning in accordance with ISO standards. Nineteen dimensions and 111 indicators were extracted from ISO standards and assigned to six smart axes according to the classical Giffinger model, forming the Multicriteria Smart City Maturity Model (MSCMM). The model uses a five-level maturity scale, evaluating indicators within ranges from "poor" to "great". The model was empirically tested using London (United Kingdom) as a case study.

Ajowder, Alego and Kurnia (2023) proposed the Focus Area Smart City Maturity Model (FAMM), which can be applied globally regardless of regional context. The model consists of seven domain groups (ICT, economy, environment, society, resources, services, governance) and 18 focus areas within these groups. Five maturity levels were identified, including level 0, representing the absence of actions or initiatives. The model was empirically validated using the Delphi method with 60 experts from 12 countries, representing stakeholders from public administration, academia, international organizations (including UN Agencies), and the private sector.

The Smart Circular City Maturity Model, developed by Damianou et al. (2023), extends smart city maturity concepts by incorporating the circular economy dimension. The purpose of the model is to support city decision-makers in planning and assessing the transition toward a data-driven circular economy by identifying the balance between technological investments, citizen participation, and resource efficiency. The model describes four maturity levels: (1) Instrumented City – infrastructure equipped with basic sensors and measurement devices; (2) Connected City – limited data exchange among entities; (3) Smart City – full integration of data and digital infrastructure; and (4) Responsive City – the highest level, in which the city operates adaptively, automatically reconfiguring resources in real time. The model encompasses areas such as technological infrastructure (IoT, 5G, data centers), data and service management, citizen participation (prosumers), governance and security (including cybersecurity), as well as environmental and economic dimensions related to circularity. Empirical validation was conducted using a cybersecurity use case concerning the application of crowdsourcing in incident response. The study confirmed that introducing crowdsourcing

mechanisms increases a city's maturity in data management and security, providing proof of concept for the model's practical effectiveness.

The Smart City Maturity Model for Small and Medium-Sized Cities (SMC-MM), developed by Anschütz, Ebner and Smolnik (2024), is one of the latest and most context-sensitive tools for assessing smart city maturity. It was designed with the needs and capabilities (financial, human, and infrastructural) of small and medium-sized cities in mind, which had been previously overlooked in maturity models. The SMC-MM aims to enable diagnosis of a city's digital advancement level, identification of development priorities, comparison with peer cities, and planning of further transformation stages toward a smart city. The model incorporates five maturity levels—from the absence of smart city initiatives through the initial phase, early implementation, strategic planning, and up to full maturity. The model analyzes city development across the six Giffinger (2010) domains with weighted importance: smart governance and smart people at 26% each, and smart economy, environment, living, and mobility at 12% each. The model was empirically tested using expert interviews in two small cities (approx. 30,000-40,000 inhabitants) – Bad Hersfeld and Lemgo (Germany) – and two medium-sized cities (approx. 100,000-150,000 inhabitants) – Guimarães (Portugal) and Tartu (Estonia).

Ajoudanian and Aboutalebi (2025) proposed a maturity model combining multicriteria decision-making (MCDM) methods with classical concepts of organizational and urban maturity. The goal is to develop a hybrid evaluation system that integrates technological, social, economic, and environmental aspects, enables quantitative classification of city maturity levels, and provides a tool supporting strategic decision-making in public administration. The model focuses on analyzing city functioning across five domains with differentiated weights: governance – 0.27, economy – 0.21, environment – 0.20, mobility – 0.18, and living and people – 0.14. The maturity levels range from the initiation of smart solutions, through fragmented ICT implementation, establishment of integrated urban projects, advanced data-driven strategic management, and innovation and full data integration, to adaptive management and sustainable decision-making. The model was tested on four medium-sized Iranian cities (including Mashhad, Isfahan, Yazd, and Shiraz), using data from public documents, municipal portals, and expert interviews.

Jacques et al. (2025) highlighted the need to develop an assessment of cities' technological readiness for implementing smart city solutions using a quantitative method tailored to the context of developing countries. The Smart City Technology Maturity Model (SCTMM) includes five maturity levels: at the Initial level, there is a lack of strategic smart city actions; the second level (In Evolution) introduces basic ideas and actions toward smart solutions; the third level (Intermediate) involves the preliminary identification of technologies used in the urban environment; the fourth level (In Improvement) reflects technological development, where mature implementations of smart city initiatives are verified; and the fifth level (Advanced) encompasses near-complete data integration, automation, and decision-making

based on predictive analysis. SCTMM evaluates 11 assessment areas, and for the first time compared to previously described models, includes entrepreneurship as a separate element, as well as economy and sustainable consumption, coexistence, and reciprocity, indicating a shift toward sustainable urban development. The authors developed a set of quantitative indicators for each area and applied factor analysis to validate the model's structure. Empirical validation was conducted in Santa Maria, Brazil, where the city's smart city maturity was identified at an intermediate level.

Finally, Kalaldeh and Tarawneh (2025) presented a quantitative dynamic model, empirically applied in Amman, Jordan, which enables real-time monitoring of progress and calibration of urban policies. The core of the model is the Holistic Key Performance Indicator (H-KPI), which integrates indicators from multiple areas of urban management, including infrastructure and spatial planning, environment and energy, economy and investment, mobility and transport, quality of life and citizen engagement, and governance and participation. The model does not classify cities into predefined stages; instead, maturity is treated as a continuous variable that can increase over time as indicators improve. The researchers propose creating a digital twin of Amman based on real-time data.

Among the common features of the analyzed models, most incorporate elements of Giffinger's concept for organizing indicators and capabilities. A similar trajectory of smart city development is also observable – regardless of terminology – progressing from fragmented initiatives through data-driven management to continuous improvement.

It can be concluded that in the analyzed set of 33 smart city maturity models, three main streams are clearly visible: progressive models, indicator-normative models, and framework models. Progressive models are based on five-level or similar maturity scales (e.g., IDC 2013, national variants such as Br-SCMM, FAMM, SMC-MM), mapping development from initiation/fragmentation to optimization and continuous improvement. Indicator-normative models are based on ISO/ITU standards (e.g., ISO 37122/37123, national solutions such as MMSSCB in Brazil, or continuous 0-1 models like SCMAM in Turkey), where maturity is perceived as a numerical result or standard compliance rather than a named rank. Framework (diagnostic) models, which do not contain rigid levels and are used for mapping capabilities and gaps, include SCGMF and CityDNA/USCM.

The analysis of national and regional contexts in which smart city maturity models emerge indicates that their structure, measurement logic, and thematic scope are neither random nor neutral. Instead, they reflect the level of institutional development of states, the dominant culture of public administration, and the actual administrative capacities of cities. Consequently, maturity models not only measure the degree of advancement of smart city development but also constitute a projection of the systemic conditions within which they are created and implemented.

In countries characterized by high institutional capacity, stable legal frameworks, and advanced systems of public data collection and integration, normative and continuous models grounded in indicators and international standards prevail. This is exemplified by approaches inspired by ISO and ITU standards, as well as by models developed in Western European countries such as Germany and the United Kingdom. In these contexts, urban maturity is perceived as a measurable level of compliance with established standards, where data interoperability, international benchmarking, and long-term coherence of public policies play a central role. Such models presuppose the existence of competent public administrations capable of conducting advanced monitoring, reporting, and organizational learning processes.

A different logic underlies models developed in developing countries or in states undergoing intensive institutional transformation, such as India, Brazil, and Indonesia. In these cases, stage-based models, often of a compensatory nature, dominate. Their objective is not precise measurement of compliance with predefined standards, but rather the identification of a realistic development pathway—from fragmented and pilot initiatives toward more integrated forms of urban governance. Staged progression thus serves a pedagogical and strategic function, enabling cities with limited resources to gradually build technological, organizational, and social capacities. In such models, particular emphasis is placed on social inequalities, accessibility of public services, and the provision of basic digital infrastructure.

Another important differentiating factor in the construction of maturity models is the degree of centralization of the public governance system. In highly centralized contexts, the state plays a prominent role in defining the smart city maturity framework, resulting in models that function as national standards or official public policy instruments. These models are often linked to national digitalization strategies and serve to coordinate public investment. In contrast, decentralized systems tend to produce framework-based and diagnostic models that do not impose rigid maturity levels but instead allow cities to independently identify competency gaps, development priorities, and areas requiring intervention.

These observations demonstrate that smart city maturity models are inherently context-embedded instruments, and that their design reflects not only developmental ambitions but also real institutional and cultural constraints. The transition from simple stage-based models to more complex, adaptive, and data-driven maturity assessment frameworks becomes possible only when cities possess adequate organizational, competency, and informational foundations. Accordingly, smart city maturity should not be interpreted solely as a function of implemented technologies, but rather as the outcome of the co-evolution of technology, institutions, and public governance culture.

The conducted systematic literature review makes it possible to identify a common conceptual architecture underlying existing smart city maturity models. This architecture does not constitute a new measurement model; rather, it synthesizes the key components and analytical logics recurring across the reviewed approaches, regardless of their geographical and institutional contexts.

From a synthetic perspective, this architecture consists of three interrelated analytical domains and differentiated conceptualization logics of maturity that determine how smart city development trajectories are interpreted (Table 2).

Table 2.

Preliminary conceptual architecture of smart city maturity models (result of literature review synthesis)

Architecture component	Role in smart city maturity models	Dominant logics of maturity
Structural layer (governance, data, institutional capacity)	They create boundary conditions for the development of smart cities; determine the ability to integrate technology, the scalability of solutions and the ability to learn organizationally.	Stage-based Continuous
Operational layer (urban services, technologies, interoperability)	It is the area of implementation of intelligent solutions and the main subject of maturity measurement in most empirical models.	Continuous
Result layer (sustainability, resilience, inclusiveness)	It defines the meaning and goals of smart city development; shifts the focus from technology to social, environmental and institutional effects.	Adaptive

The identified maturity logics – stage-based, continuous, and adaptive – do not represent separate dimensions of the architecture, but rather alternative interpretative lenses for understanding the smart city development process. Their application depends on the level of institutional maturity, data availability, and the analytical and decision-making objectives assigned to maturity models within a given context.

4. Discussion

A systematic review of smart city maturity models reveals a clear evolution in the paradigm for assessing urban development – from simple, stage-based structures describing the levels of technological implementation to complex, multidimensional and integrated assessment systems based on data management, sustainability and resilience.

In the first generation of models, the perspective of linear technological and institutional progress predominated – from the initial phase to full optimization. These models had high educational and communicative value, facilitating strategic planning and progress comparison for cities. However, their limitations include low measurement precision and limited flexibility in the context of dynamic technological changes.

The next generation of models, based on ISO standards (37120, 37122, 37123) and ITU-T guidelines, introduced the dimension of normative comparability and continuous scales. This allowed for more precise monitoring of progress over time and linking maturity assessment with sustainable development goals. The advantage of this approach is alignment with

international reporting systems, while its drawback is the risk of excessive standardization, which may hinder consideration of local socio-economic conditions.

In recent years, framework (diagnostic) models have also emerged. These models are characterized by the absence of formal maturity levels and a focus on management quality, data interoperability, institutional openness, and service co-creation. They provide in-depth functional diagnostics, serving as valuable strategic tools for policymakers, but they make direct quantitative comparisons between cities more difficult.

It can be observed that all identified models share a common structural core: governance, technology and data (ICT/data governance), and social participation. These three dimensions appear to be the key determinants of smart city maturity development. However, we agree with Torrinha and Machado (2017) and Mohsin et al. (2020) that existing models focus primarily on measuring the current state of smart cities but do not provide guidance on transitioning between maturity levels, nor do they include indicators covering all activities across the value chain of impact (Santosa et al., 2024).

The findings of this review demonstrate that smart city maturity models are inherently context-dependent instruments rather than neutral or universally applicable frameworks. Their design consistently reflects the institutional maturity, governance culture, and development priorities of the environments in which they are produced. Variations among models therefore arise not merely from academic traditions but from adaptive responses to concrete systemic constraints, including data fragmentation, limited interoperability, social trust deficits, regulatory pressures, and administrative capacity. Models developed in data-rich, institutionally mature settings tend to adopt continuous, indicator-based and normative structures aligned with international standards, while models originating in resource-constrained contexts more frequently employ stage-based architectures that simplify transformation through discrete development levels. Consequently, maturity models function as translational mechanisms that operationalize abstract smart city objectives into governance tools calibrated to local institutional and socio-organizational conditions. This perspective enables a shift from descriptive model cataloguing toward an explanatory understanding of the structural forces shaping the evolution and differentiation of smart city maturity frameworks.

We also believe that smart city development is not based solely on advanced technologies. Implemented solutions must benefit residents, enable barrier removal, prevent emerging problems, and eliminate bottlenecks (Tundys et al., 2022). The differences we identified between models mainly concern the representation of maturity (stage-based vs. continuous), the scope of standardization (normative vs. adaptive), and the functional orientation (technological, organizational, or environmental).

Ghazinoory et al. (2024), based on a systematic analysis and synthesis of smart city maturity models, suggest giving greater consideration during the assessment of a city's maturity to the local context, adaptability, and modularity. We also agree with Hajduk (2020) that there is no single exemplary or ideal model of urban development leading to a smart city, given the

individuality of each city in terms of economic, social, and environmental conditions. Nevertheless, we believe it is possible to develop a universal maturity model that would allow for comparative analysis and provide guidance on further steps toward smart city development.

5. Conclusions

Smart city maturity models today constitute an important tool for both researchers and practitioners, allowing the diagnosis of a city's current state, identification of development pathways, and support for strategic decision-making and resource allocation. Based on the conducted literature review, it can be concluded that the evolution of smart city maturity models reflects a paradigm shift – from a technological perspective, viewing the smart city as a set of ICT solutions, toward an integrated, systemic approach in which governance, data, participation, and resilience are mutually interlinked pillars.

In light of the analysis, several scientific and practical recommendations appear warranted. First, harmonization of terminology and measurement methodology is necessary to enable comparison of results across different models and countries. Second, further research should focus on integrating the data perspective (data quality, interoperability) with governance and social dimensions, as this represents a current key knowledge gap. Third, future models should incorporate resilience and social inclusivity as integral components of maturity, in line with the direction indicated by ISO 37123 standards.

Finally, empirical and longitudinal validation is recommended, allowing not only the assessment of a static maturity level but also the tracking of urban development dynamics over time. Additionally, research indicates that following the conceptual phase (earlier years), there is currently an intensification of constructive and validation studies of maturity models, yet a greater unification of language and research tools is still needed.

There is a need for further development of maturity models that holistically integrate digital, social, environmental, and institutional components. In practice, this implies a transition from the “smart = technology” model toward the “smart = sustainable + resilient + inclusive” model. Standardization of comparability between cities should be promoted, potentially supported by common indicators, frameworks, and databases. Models must possess flexibility and adaptability, as cities differ in terms of size, resources, organizational culture, and local policy; hence, a universal model requires a modular structure and the capacity to adapt to local contexts.

Empirical validation of models should be expanded, including more case studies in countries and cities at varying levels of development and across different geographic regions, as well as longitudinal studies showing how cities transition between maturity levels. New research directions should include, among others: integration of urban digital twins, continual learning in city AI systems, cybersecurity issues, digital equity, and the relationship

between maturity models and sustainable development outcomes (e.g., alignment with the SDGs).

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ASSESSING LOCATIONS FOR LOGISTICS SERVICES IN POLAND: A HELLWIG INDEX RANKING

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Purpose: To evaluate the investment attractiveness of selected Polish provincial capitals for logistics outsourcing and offshoring, and to build a transparent ranking that supports firms' location decisions and public policy.

Design/methodology/approach: Using 2021 data from the Polish Central Statistical Office's Regional Data Bank, we construct an Investment Attractiveness Model (IAM) comprising 18 indicators spanning labour market, local economy, and transport/real-estate infrastructure. Variables are screened via coefficient of variation and Pearson correlations to limit collinearity, then standardised and aggregated with the Hellwig development pattern. Cities are ranked by distance to the synthetic pattern and classified into four groups.

Findings: Most capitals exhibit medium or low attractiveness. Lodz attains the highest synthetic score, while Gorzow Wielkopolski records the lowest. Katowice and Lodz form the top group; Warsaw, Gdansk, Krakow, Lublin, Szczecin, and Rzeszow follow with high attractiveness. Spatial concentration of logistics employment and firms is stronger near Poland's western border. Key stimulants include expressway/rail density, cargo airport utilisation, warehouse supply, innovation intensity, and specialised human capital; higher labour costs act as destimulants. An outlier is Wroclaw, where firm counts exceed what the synthetic score would predict.

Research limitations/implications: Results rely on one country's official statistics and city coverage; international generalisation is limited. Future research should test the IAM with Eurostat data across European countries and examine sector-specific weights and temporal dynamics.

Practical implications: The IAM offers a reproducible screen for site selection, enabling firms to balance cost, access, and time-to-market, and helps city authorities prioritise transport and warehouse infrastructure and talent pipelines to raise attractiveness.

Social implications: Better-informed location choices can support regional cohesion, job creation, and quality of life through planned logistics development and reduced bottlenecks.

Originality/value: The research paper integrates a clearly specified, logistics-oriented IAM with the Hellwig index to deliver a ranked, policy-relevant picture of urban investment attractiveness in Poland; provides a replicable framework for managers and policymakers.

Keywords: investment attractiveness; location determinants; Hellwig index; logistics outsourcing; Poland.

Category of the paper: Research paper.

1. Introduction

Dynamic changes in the economic environment contribute to increased competition between companies in the fight for customers. One of the effects of globalisation is the increasing diversity of product ranges and lower prices. This phenomenon forces companies to adapt to changing operating conditions. As a result, managers should focus on seeking sources of competitive advantage that will improve the company's profitability, strengthen its market position, and ensure an adequate level of dividends for shareholders.

The specialisation of companies, resulting from a focus on their core business, is becoming increasingly important. To properly define this area, managers should analyse which areas generate value and should be carried out within the organisation, and which can be transferred in whole or in part to external entities (Srbotic, Ruzzier, 2012). One of the key areas is supply chain management, which is responsible for the efficient flow of materials, products, and information at every stage of its operation (Aktas, Agaran, Ulengin, Onsel, 2011). There is also a growing trend of outsourcing tasks to foreign entities, often located in regions that are culturally and geographically close (e.g., the transfer of services from Western Europe to Central and Eastern Europe), referred to as offshoring.

Companies that want to remain competitive in the market should seek solutions that enable them to adapt to a changing environment. One of the tools for increasing competitiveness is the effective use of both internal and external resources. Outsourcing is an increasingly common practice, the aim of which is to use cheaper or more technologically advanced resources. This strategy promotes flexibility and improves efficiency, which translates into increased competitiveness for the company. The topic of outsourcing is gaining increasing importance in the literature, which results from growing interest from both business practitioners and researchers (Merino, 2017; Paek, Kim, Park, Lee, 2019). This is influenced, among other things, by new concepts of supply chain management, advances in information and communication technologies, a decline in transport costs, and the development of the logistics industry.

The main reason for outsourcing addressed in the research is cost reduction (Quélin, Duhamel, 2003; Roza et al., 2011; Stringfellow et al., 2008). However, the following are also important: the ability to focus on the company's core business, market expansion, and innovation potential (García-Vega, Huergo, 2019; Görg, Hanley, 2009; Mazzola et al., 2019), increased operational flexibility (Merino, 2017; Paek et al., 2019), and gaining a competitive advantage (Quélin, Duhamel, 2003; Solakivi et al., 2013).

According to Bunyaratavej et al. (2007), companies that decide to outsource are looking for savings related to lower wages and other costs of doing business outside their country. The researchers point out that low labour costs in the host country are a positive or at least neutral factor when choosing an investment location.

Research by Bengtsson and Dabhilkar (2009) shows that, in addition to cost reduction, the main motives include the ability to focus on core activities and increased operational flexibility. An important factor in manufacturing companies is also the use of outsourcing for innovative activities: using the expertise of external entities can shorten the time it takes to bring new products to market and enable the adoption of innovative solutions from suppliers.

From the perspective of resource-based theory (RBV) and the competency-based concept, outsourcing provides an opportunity to acquire specialised external knowledge and can promote inter-organisational learning processes. Many studies have analysed the impact of outsourcing on the innovativeness of companies. Arvanitis and Loukis (2013) found that labour costs were not a key factor in the choice of outsourcing strategy, but in their models, they took into account the positive relationship between outsourcing and the propensity of companies to implement product and process innovations.

Hwang and Kim (2019), on the other hand, point to the flexibility that outsourcing offers in logistics. In addition to transport, it also includes activities related to management, control, and other logistics functions. Logistics outsourcing allows companies to provide customers with the resources they need, strengthens their strategic capabilities to adapt to changing market conditions, and enables them to respond to unforeseen market needs. Researchers also emphasise its role in dealing with business risks and taking advantage of market changes as opportunities. This approach gives companies a competitive advantage in a dynamic environment.

Research shows that separating specific processes and focusing on core activities enables companies to achieve numerous benefits and strengthen their competitive position. However, it is crucial not only to identify the processes that can be outsourced, but also to select the right partners and locations where the services will be provided.

City-level decision support for logistics in Poland is scarce. This article provides, to our knowledge, the first logistics-oriented, city-level Investment Attractiveness Model (IAM) for Poland. Methodologically, we assemble 18 indicators across labour, local economy, and transport/real-estate infrastructure and aggregate them using the Hellwig method after formal screening. Empirically, we juxtapose the synthetic Hellwig score (d_i) with per-capita firm intensity, revealing corridor/port deviations (western/coastal cities with high firm intensity despite moderate/low d_i) that national or regional composites do not detect. Substantively, we translate these findings into city-specific recommendations for infrastructure, real estate, and skills.

The aim of this article is to identify the factors determining the attractiveness of selected Polish cities, to rank their investment potential using the Hellwig method, and to answer questions about the spatial diversity of Poland's investment attractiveness and its impact on the location of logistics companies.

The following sections present the theoretical basis for outsourcing logistics services, the research methodology together with the characteristics of the Hellwig index, and then present an analysis of the investment attractiveness of provincial capitals in Poland, indicating their distance from the development model. The study concludes with conclusions and recommendations regarding the outsourcing of logistics services and the choice of location.

2. Literature Review

Outsourcing and offshoring are becoming increasingly common management tools that play an important role in the activities of modern enterprises. Their use promotes the growth of productivity, efficiency, and competitiveness of organisations (Bozarth, Handfield, 2008; Cheung, Rossiter, Zheng, 2008; King, Malhotra, 2000; Schniederjans, Schniederjans, Schniederjans, 2005). Thanks to offshoring, companies can target their investments more precisely, especially in areas that strengthen their competitive advantage in the market.

The use of this strategy enables companies to reduce operating costs, simplify organisational structures, improve the quality of services provided, focus on key competencies, and accelerate innovation processes. At the same time, outsourcing and offshoring also involve certain risks. The most frequently mentioned ones include: the risk of losing control over processes, reduced operational flexibility, and the possibility of transferring strategic information to suppliers who may become potential competitors in the future (Aktas et al., 2011). In the manufacturing sector, one of the most frequently delegated areas is logistics (Srabotic, Ruzzier, 2012). In this context, three models stand out: external logistics, Third Party Logistics (3PL) and Fourth Party Logistics (4PL).

The 3PL model is based on the provision of comprehensive logistics services by a logistics operator. On the other hand, 4PL means full integration of services – the operator becomes the main contractor and coordinator of all logistics activities in the company. Typical outsourced logistics services include warehousing, packaging, order picking, and transport to the recipient. They operate within the framework of so-called contract logistics, a term often used interchangeably with the concept of logistics outsourcing. In this arrangement, the logistics operator becomes the link responsible for ensuring the continuity of supplies for production, as well as for the further distribution of finished products.

The development of international trade, increased competition, and growing customer demands are driving the dynamic growth of the logistics outsourcing market. This phenomenon is particularly significant in the context of globalisation and advances in information technology. More and more often, companies decide to cooperate with specialised logistics operators, which allows them to focus on their core business and contributes to the growing popularity of outsourcing in this sector (Yeung, Zhou, Yeung, Cheng, 2012) (Table 1).

Table 1.*Advantages and disadvantages of long-term cooperation in logistics outsourcing*

Advantages	Disadvantages
• improvement of efficiency, • the possibility of using the resources and information of the service provider, • reduction of warehouse costs, • the possibility of using knowledge related to the functioning of legal regulations, e.g. regarding customs clearance, • reduction of possible delays in delivery, • creating a competitive advantage, • the possibility of expansion into new markets, • change of fixed costs into variable costs.	• the risk of losing confidential information, • failure to achieve the expected reduction in warehouse costs, • no possibility to use the expanded scope of logistics services, • lack of use of advanced information technologies by the suppliers, • impaired communication between the company and the service provider, • no control over the distribution system.

Source: Own study based on Yeung, Zhou, Yeung, Cheng, 2012, pp. 741-753.

Both the benefits and limitations of outsourcing apply to companies that outsource their processes to external suppliers. At the same time, service providers themselves strive to reduce costs and seek optimisation by expanding their activities outside their home country. In this context, it is particularly important to analyse the attractiveness of cities as locations for establishing foreign branches and hiring highly qualified personnel. This is especially important when a company uses knowledge of the legal regulations in force in the country from which it imports or to which it exports its products and services.

Poland belongs to a group of countries where numerous service centres are located, or to which selected processes are outsourced. The outsourcing services provided here primarily serve customers from Western Europe. This is facilitated by, among other things, the adequate supply and quality of labour resources, i.e., the level of education of the workforce, wage relations, and the relatively low costs of doing business.

Maintaining a high level of expertise and operational excellence in every field generates significant costs, which is why companies that are aware of the value of advanced skills and modern technologies are willing to outsource such tasks to external entities. In this sense, outsourcing becomes a fundamental component of a company's operating strategy (Greer, Youngblood, Gray, 1999). The economic and organisational benefits of this model of cooperation are recognised not only by large corporations but also by smaller entities. As a result, more and more companies are establishing relationships with service centres located in various regions of the world (Budzyńska, 2017). The most recognisable outsourcing locations include India, China, Malaysia, Indonesia, Vietnam, and the United States. In the Top Countries for Outsourcing 2019 ranking compiled by A.T. Kearney, Poland was ranked 24th among the most attractive destinations for outsourcing services (Kearney, 2019).

According to the Deloitte Global Shared Services Survey Report 2019, companies are increasingly implementing onshore and offshore location strategies. The most frequently mentioned destinations include India, the United States, Poland, Costa Rica, and Mexico. Poland is among the top five most popular locations considered for service relocation (Deloitte, 2019). A similar assessment of Poland's position is presented in the Executive Brief – Outsourcing 2019 report prepared by 7N (7N, 2019).

The 7N report indicates the leading destinations for outsourcing companies, i.e., the Philippines, India, the Czech Republic, Hungary, and Poland. In the case of the Philippines, the report highlights the very high level of English language proficiency and the good cultural fit of employees with the expectations of companies. India has had a developed business services sector for years; its attractiveness is determined, among other things, by the large number of technical specialists, infrastructure facilities, and relatively convenient air connections compared to other Asian locations. The next positions are occupied by Central and Eastern European countries, the Czech Republic, Hungary, and Poland, where nearshoring is particularly strong, reinforced by geographical proximity and a maximum of two time zones difference from parent companies. The Czech Republic has been a leader in nearshoring services for years, thanks to the availability of skilled personnel and short flight connections to Scandinavia. Hungary, in addition to its relatively broad base of specialists, is experiencing rapid GDP growth in the ITO segment. Poland, in turn, has one of the largest groups of highly qualified IT specialists in Europe (7N, 2019).

Poland has a set of factors conducive to its leading position in the business services segment, especially in advanced forms of outsourcing and offshoring. According to a McKinsey analysis (McKinsey & Company, 2015), the country has significant potential for employment growth in this sector, and the more advanced services provided here further stimulate the economy. An additional advantage is the geographical proximity of suppliers to customers, which reduces operational risk. In recent years, there has been a relocation of some services from India to other countries, including Poland. Initially, investors located mainly basic processes in Poland, taking advantage of lower costs. (McKinsey & Company, 2015). However, city-level, logistics-oriented composite assessments for Central and Eastern Europe remain scarce; to address this gap, the next section operationalises a city-level Investment Attractiveness Model (IAM) and applies the Hellwig development pattern to evaluate Polish provincial capitals.

3. Methods

The aim of this study is to analyse the investment attractiveness of selected Polish provincial capitals using a method based on the Hellwig index. Based on data from the Regional Data Bank of the Central Statistical Office, the authors constructed an investment attractiveness model (IAM) that allows them to answer research questions related to the assessment of the investment potential of provincial capital.

3.1. The research questions

A review of the literature and identification of the motives for outsourcing made it possible to formulate the following research questions:

- Q1: What conditions favour or limit the choice of location for relocated logistics services?
- Q2: How does the spatial diversity of the investment attractiveness of Polish provincial capitals look in the context of the logistics outsourcing sector?
- Q3: Do outsourcing entities from the logistics industry tend to locate their operations in regions closer to the western border of the country?
- Q4: Does the level of investment attractiveness of a particular city influence the location decisions of companies in the sector in question?

To answer the above questions, a six-step research procedure was applied, on the basis of which an investment attractiveness model (IAM) was constructed.

3.2. The research procedure

The research process was organised in six consecutive stages: from a review of the literature, through statistical data analysis, to the formulation of conclusions and recommendations addressed to business owners and municipal authorities (Figure 1).

The indicators used reflected the investment attractiveness of the logistics outsourcing sector and described both the situation of individual cities and their regional hinterland. The regional approach was deliberate, as investors' decisions are shaped not only by strictly urban factors, but also by environmental conditions, for example, access to national roads, motorways or railway infrastructure at the provincial level, which is crucial for the location of entities from the analysed sector.

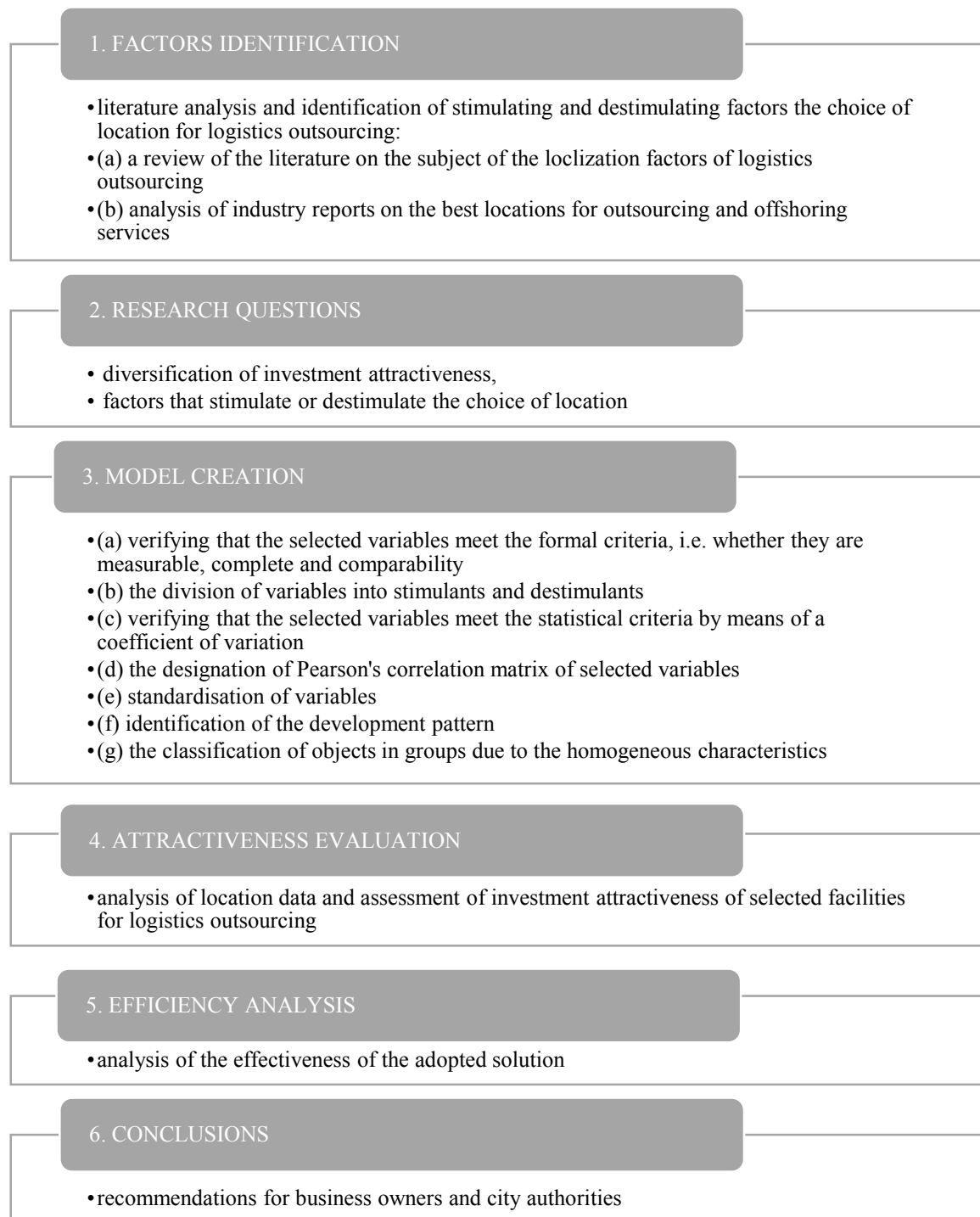


Figure 1. The research procedure.

Source: own study.

The conclusions from the literature review were supplemented with data from various industry analyses and reports. This allowed for a broader consideration of the degree of warehouse space development and the associated costs. Due to the lack of available statistical data for some provincial capitals (including Kielce, Opole and Olsztyn), they were excluded from the investment attractiveness assessment.

3.3. Hellwig's Index

The main element of the analysis was the use of the Hellwig method to determine the level of investment attractiveness of selected provincial capitals in Poland. This is a taxonomic measure of development proposed by Z. Hellwig in 1968, originally used for international comparisons of economic development levels. This technique allows for the measurement of sustainable development and the ranking of the objects under study (e.g. cities) from the least to the most developed, according to the level of the analysed phenomenon. The procedure involves constructing a matrix of diagnostic variables (indicators) selected on the basis of substantive and statistical premises, and then standardising them to obtain comparable values (Roszkowska, Filipowicz-Chomko, 2021). The schedule for applying the method is as follows:

- a) A set of statistical variables to be evaluated is determined and divided into stimulants and destimulants: $\{X_1, X_2, \dots, X_m\}$;
- b) For each object, the values of X_j variables are standardised (according to formula (1) in the text), using the arithmetic mean and standard deviation of a given feature to bring the indicators to a comparable scale:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j} \quad (1)$$

where:

$\bar{x}_j$ – the arithmetic mean of the j th feature,

S_j – the standard deviation of the j th feature.

- c) Next, a development pattern P_0 with coordinates $(z_{01}, z_{02}, \dots, z_{0m})$, defined by relations (2) is determined, maximum values are taken for stimulants and minimum values for destimulants after standardisation:

$$\begin{cases} z_{0j} = \max_i z_{ij}, & \text{when } X_j \text{ is a stimulant} \\ z_{0j} = \min_i z_{ij}, & \text{or when } X_j \text{ is a destimulant} \end{cases} \quad j = 1, 2, \dots, m, \quad (2)$$

In this step, the set of variables is divided into stimulating (S) and destimulating (D) factors (Table 2).

Table 2.

Grouping by different ranges of synthetic variability of the development measure

Group	Development rate	Value
****	Very high development rate	$d_i \geq \bar{d}_i + S_{d_i}$
***	High development rate	$d_i + S_{d_i} > d_i \geq \bar{d}_i$
**	Low development rate	$\bar{d}_i > d_i \geq \bar{d}_i - S_{d_i}$
*	Very low development rate	$d_i < \bar{d}_i - S_{d_i}$

Note. † d_i – general expression for the values of the synthetic method indicator of Z. Hellwig's development pattern; $\bar{d}_i$ – the arithmetic mean of the synthetic indicator; S_{d_i} – standard deviation of the synthetic indicator.

Source: Own study based on Malinowski, 2017, pp. 178-197.

Stimulants, i.e. supporting factors and destimulants, i.e. barriers, are diverse and depend on industry, scale, country or region of investment. The concept of stimulants and destimulants was introduced by Z. Hellwig in 1968, and their definition is as follows: are two objects ω_1 and $\omega_2 \in \Omega$ and the attribute $\varphi_1 \in \Phi$. It is said that the object ω_1 is dominated by the object ω_2 (or the object ω_2 dominates the object ω_1) and is written symbolically as $\omega_1 \succ \omega_2$ if $x_{2j} \geq x_{1j}$. A feature φ_1 is a stimulant, when: $\wedge_{x_{rj}, x_{sj}} (x_{sj} \geq x_{rj}) \Rightarrow \omega_s \succ \omega_r$. A feature φ_1 is a destimulant, when: $\wedge_{x_{rj}, x_{sj}} (x_{sj} \geq x_{rj}) \Rightarrow \omega_s \prec \omega_r$ (Hellwig, 1981). An example of the attracting factors (stimulant) of foreign companies may be the quality and availability of technical or transport infrastructure. The availability of workforce in a given location, which attracts new businesses, is also an important element. The availability of the workforce can be measured by the number of students at universities, which should be directly proportional to the attractiveness of the region concerned. A very important factor is the availability of roads, which increases the level of investment in a given region, regardless of the sector. The density of roads is linked to the cost of doing business and the availability of the region (Popescua, 2013). On the other hand, the destimulant, which is a characteristic for which lower values are desirable, i.e. costs associated with doing business. Examples include labour costs, maintenance costs of technical (warehouse) or transport infrastructure. Companies will seek to reduce business costs (Graf, Mudambi, 2005).

The destimulant collection includes variables with the symbols: X_1 and X_2 . Other variables were considered stimulants. Stimulants are those whose high values are desirable from a certain point of view, while low ones are undesirable. Destimulants are, however, features whose low values are a desirable phenomenon from a certain point of view, and high values are undesirable.

- d) The next stage of the calculations was the calculation of the Euclidean distance of the distinguished objects from the standard established in the above manner, in accordance with the formula:

$$D_{io} = \sqrt{\sum_{j=1}^m (z_{ij} - z_{oj})^2}, i = 1, \dots, n \quad (3)$$

On the basis of the obtained distance sequence $D_{10}, D_{20}, \dots, D_{n0}$ – we determine:

$$\overline{D_o} = n^{-1} \sum_{i=1}^n D_{io}, \quad (4)$$

$$S_o = \sqrt{n^{-1} \sum_{i=1}^n (D_{io} - \overline{D_o})^2}, \quad (5)$$

$$D_0 = \bar{D}_0 + 2S_0, \quad (6)$$

$$d_i = 1 - \frac{D_{io}}{D_0}, i = 1, \dots, n, \quad (7)$$

Values $d_1, d_2, \dots, d_n$ are ordered from the highest to the smallest value. The object is more developed, if the value of the development measure d_i approaches one (Fura, Wang, 2017; Maráková, Dyr, Wolak-Tuzimek, 2016; Reiff, Surmanová, Balcerzak, Pietrzak, 2016; Stec, 2008). The method of Z. Hellwig's development pattern allows determining the ranking of the examined objects according to the level of their development on the basis of calculated taxonomic development indicators. Synthetic values of development indicators (d_i) are in the range of 0-1.

- e) The obtained values of indicators allow for the classification of objects, due to homogeneous groups, from the point of view of the achieved level of the studied phenomenon. The total range of variability of the synthetic measure of development was divided into four groups, to which individual examined objects were assigned according to the formula (Table 2).

3.4. Investment Attractiveness Model (IAM)

Investment attractiveness is multidimensional and consists of many partial variables, which makes it impossible to measure directly. Therefore, multidimensional statistical tools are used to assess it, which enable the construction of a synthetic measure. Such a measure replaces a set of features describing a given object with a single aggregate variable. This makes it possible to compare locations using a single indicator and to rank the cities.

To construct a synthetic measure, the Investment Attractiveness Model (IAM), a set of 18 ariables was proposed (Table 2). These covered various dimensions of regional development related to its attractiveness to investors: the labour market, the local economy and transport infrastructure. The key stages of model construction are presented in Figure 2.



Figure 2. Investment attractiveness model (IAM) development stages.

Source: own study.

In the first step, a review of the literature on logistics outsourcing and location conditions was conducted, identifying factors influencing the choice of service location. Next, the variables were grouped into areas reflecting different aspects of the region's level of development (Table 3) and identified as stimulants or deterrents to location choice (Q1).

Table 3.

Potential variables that characterize the investment attractiveness for the logistics outsourcing sector

The symbol of variable	The group of the variable	The name of the variable	stimulants (S) / destimulants (D)	Average	Coefficient of variation %
X ₁	The cost of doing business	Share of the average gross wage in section H in Voivodeship in the average monthly gross wage in section H in Poland	D	0.93	13%
X ₂		Rent rate	D	2.61	7%
X ₃	Transport infrastructure	Roads with hard surface at 100 km ²	S	301.44	18%
X ₄		Expressways and highways per 1000 km ²	S	16.26	41%
X ₅		Total railway lines per 100 km ²	S	6.66	45%
X ₆		Loading of cargo and mail at airports per 1000 companies in total	S	0.05	179%
X ₇		Landing of cargo and mail at airports per 1000 companies in total	S	0.04	163%
X ₈	The real estate	The area of industrial buildings in m ² calculated per 1 company from section H	S	2.65	124%
X ₉		Supply of warehouse space per 1 company from section H	S	274.88	149%
X ₁₀		Empty buildings	S	4.38	77%
X ₁₁	The labour market	Share of the economically active unemployed with higher education in the total population in %	S	0.73	45%
X ₁₂		Population density per 1 km ²	S	2001.64	30%
X ₁₃		University students transport services majors per 10,000 total students	S	119.18	67%
X ₁₄		University graduates of transport services majors per 10,000 total students	S	133	67%
X ₁₅		Balance of internal and foreign migration per 1 thousand population	S	-0.129	-2661%
X ₁₆	The location market	Entities from section C for 10,000 residents	S	105.31	18%
X ₁₇		The average share of innovative enterprises in the total number of enterprises in %	S	25.43	15%
X ₁₈		The number of entities from section H per 1000 entities in total	S	59.44	12%

Source: own calculations based on Regional Data Bank of the Polish Central Statistical Office (2021).

The coefficient of variation was used to check whether the data met the formal requirements (measurability, completeness, comparability). The next step was to assess the strength of the linear relationship between the variables using Pearson's correlation; strongly correlated variables ($r > 0.7$) were eliminated to reduce collinearity.

The variables were then standardised and transformed to a comparable scale, which allowed the Euclidean distances from the development pattern to be calculated (Hellwig method). Finally, the values of the synthetic development pattern index were grouped using the arithmetic mean and standard deviation (Table 4), classifying the objects into four homogeneous groups.

Table 4.
Pearson correlation coefficient

	X_1	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
X_1	1																
X_3	0.638**	1															
X_4	0.419	0.275	1														
X_5	0.462	0.399	0.799**	1													
X_6	0.235	0.352	0.625**	0.814**	1												
X_7	0.300	0.400	0.457	0.739**	0.951**	1											
X_8	0.274	0.214	0.285	0.274	0.283	0.248	1										
X_9	0.231	0.339	0.750**	0.877**	0.952**	0.843**	0.337	1									
X_{10}	0.314	0.444	0.689**	0.655**	0.571*	0.510*	0.518*	0.650**	1								
X_{11}	0.292	0.497*	0.060	0.206	0.213	0.236	0.190	0.183	-0.162	1							
X_{12}	0.546*	0.952**	0.269	0.333	0.373	0.404	0.242	0.329	0.427	0.510*	1						
X_{13}	0.402	0.261	0.121	0.353	0.355	0.413	0.327	0.335	-0.037	0.352	0.158	1					
X_{14}	0.320	0.261	0.127	0.330	0.332	0.373	0.191	0.328	-0.089	0.406	0.142	0.965**	1				
X_{15}	0.015	0.203	0.107	0.301	0.375	0.461	0.172	0.313	0.064	0.576*	0.288	0.291	0.292	1			
X_{16}	0.614**	0.608**	0.375	0.363	0.281	0.302	0.488*	0.334	0.364	0.330	0.553*	0.446	0.400	0.391	1		
X_{17}	0.211	0.256	0.391	0.459	0.401	0.375	0.231	0.366	0.327	0.270	0.313	0.338	0.309	0.168	-0.166	1	
X_{18}	0.669**	0.370	0.320	0.258	-0.005	-0.023	0.135	-0.020	-0.062	0.417	0.331	0.370	0.333	-0.088	0.264	0.465	1

Note. * Correlation significant at the level of 0.05 (two-sided). ** Correlation significant at the level of 0.01 (two-sided).

Source: own calculations based on Regional Data Bank of the Polish Central Statistical Office (2021).

Based on the coefficient of variation:

$$V = \frac{S(x)}{\bar{x}} \cdot 100, \text{ where} \quad (8)$$

$$S(x) = \sqrt{\frac{\sum_{i=1}^m (x_i - \bar{x})^2}{m}} \text{ means standard deviation,} \quad (9)$$

$$\bar{x} = \frac{\sum_{i=1}^m x_i}{m} \text{ means the arithmetic mean} \quad (10)$$

for $i = 1, \dots, m$ (m – number of cities), it was found for all indicators describing cities that the variable Rent rate (X_2) does not meet the differentiation threshold, its V did not exceed the assumed 10%. As a result, it was considered quasi-constant, with low variability and poor diagnostic properties, and was eliminated from further calculations. Next, Pearson's correlation matrix was determined within individual areas (Table 4).

Variables with high correlation coefficients (marked in grey) indicated excessive interaction; as a result, those for which $r > 0.7$: X_5 , X_7 , X_9 , X_{12} and X_{13} . In accordance with the adopted procedure, the variables used in the model should be characterised by weak mutual correlation; in the case of significant interdependence, such a variable is eliminated, as high correlation suggests similar behaviour of the indicators and reduces the diagnostic value of the model.

4. Results

The regional aspect, including the availability of skilled personnel, is reflected in employment intensity. Figure 3 shows the number of employees in the section ‘transport and storage’ (H) per 1,000 total employees by voivodeship in 2021. The highest band is observed in Mazowieckie, with elevated levels also along the western border, including Lubuskie, Wielkopolskie, Pomorskie and Zachodniopomorskie.

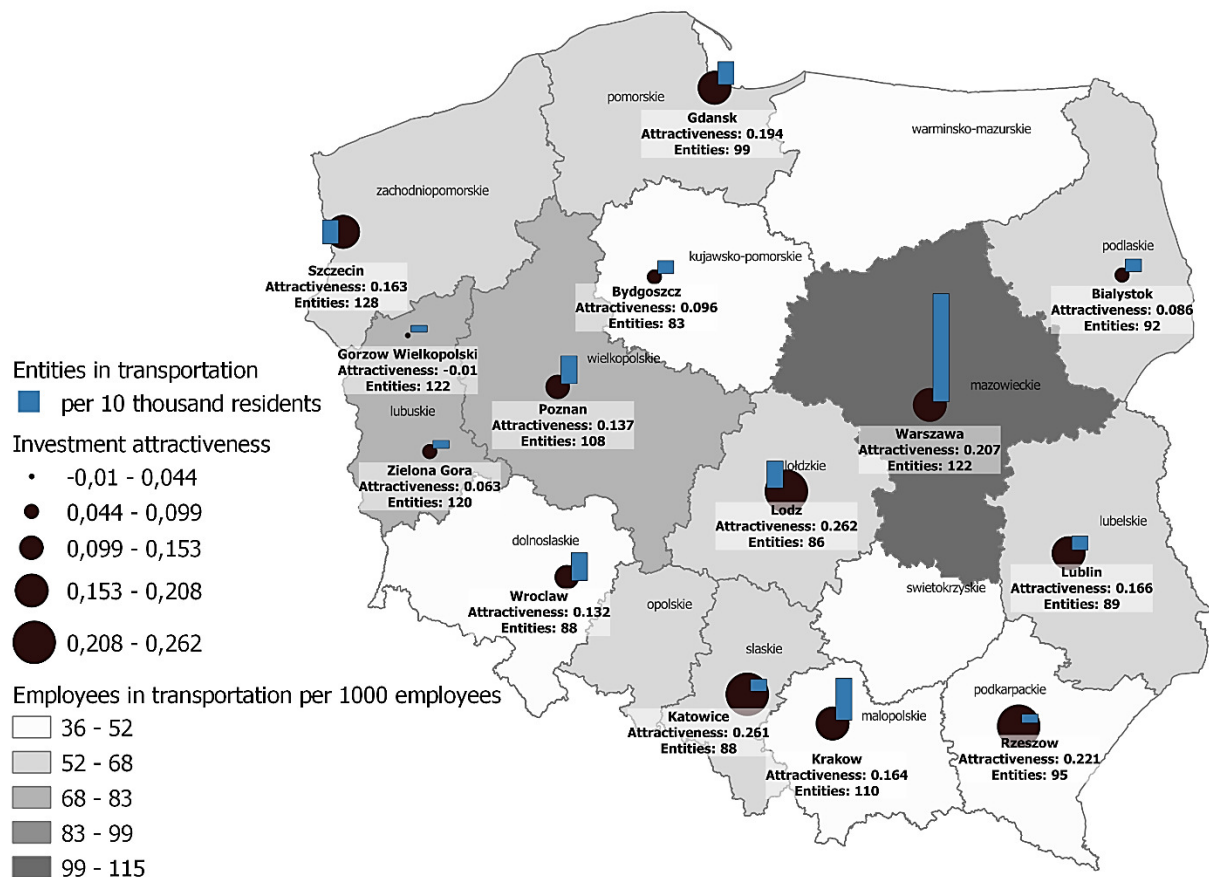


Figure 3. The number of employees in section transportation and storage per 1000 employees in total in 2021.

Source: own calculations based on Regional Data Bank of the Polish Central Statistical Office (2021). Visualised in QGIS.

For the 14 voivodeship cities, the per-capita density of section-H entities ranges from 83 to 128 per 10,000 residents in 2021. The highest values occur in Szczecin (128), Warsaw (122), Gorzow Wielkopolski (122) and Zielona Gora (120). Elevated levels are noted in Krakow (110) and Poznan (108). Mid-range outcomes cluster around 95-99 (e.g., Rzeszow 95, Gdansk 99), with several cities between 88-92 (Lublin 89, Katowice 88, Wroclaw 88, Bialystok 92). The lowest recorded value is in Bydgoszcz (83); Lodz reports 86.

For the 14 cities analysed, the synthetic investment attractiveness index (d_i) ranges from 0.262 to -0.010. As per formula (7), higher values of d_i index indicate greater investment attractiveness. The city-level calculated using the Hellwig method are presented in Table 5.

Table 5.
Value of the indicator of the synthetic level of investment attractiveness of voivodeship cities in Poland

City	Variables												d _i	Ranking	Group [^]
	X ₁	X ₃	X ₄	X ₆	X ₈	X ₁₀	X ₁₁	X ₁₄	X ₁₅	X ₁₆	X ₁₇	X ₁₈			
Lodz	-0.17	-0.28	1.78	0.37	1.64	1.12	-0.09	-1.19	-0.53	0.81	-2.44	-0.19	0.262	1	****
Katowice	0.36	0.16	1.90	3.20	-0.77	1.30	-0.71	0.43	-0.05	0.01	-2.34	-1.15	0.261	2	****
Rzeszow	-1.00	-0.50	-0.52	-0.37	-0.27	-0.94	2.41	0.12	2.01	-0.31	-2.32	-0.21	0.221	3	***
Warszawa	1.93	1.79	-0.38	0.82	-0.74	0.27	-0.09	-0.18	0.61	0.76	-2.27	-0.19	0.207	4	***
Gdansk	2.11	0.02	-1.06	0.01	2.23	0.55	-0.09	0.43	0.67	0.98	-2.30	-0.40	0.194	5	***
Lublin	-0.88	0.68	-1.21	-0.48	-0.61	-1.26	1.47	1.78	-0.29	-0.37	-2.41	-0.04	0.166	6	***
Krakow	-0.63	0.27	-0.63	-0.43	-0.65	-0.14	-0.09	-0.59	1.23	0.28	-2.33	-0.42	0.164	7	***
Szczecin	0.52	-0.73	-0.27	-0.48	0.43	-1.20	-0.40	1.89	-0.53	01.10	-2.62	01.06	0.163	8	***
Poznan	0.52	0.58	0.05	-0.32	-0.28	0.46	-0.71	0.60	-0.62	0.72	-2.45	-1.20	0.137	9	**
Wroclaw	0.03	0.37	0.94	-0.37	-0.22	1.01	-0.40	-1.09	0.46	-0.07	-2.32	-1.58	0.132	10	**
Bydgoszcz	-0.67	0.16	-0.12	-0.48	1.27	1.15	-1.03	-1.03	-1.72	-0.09	-2.51	0.16	0.096	11	**
Bialystok	-0.78	0.92	-1.24	-0.48	-0.67	-1.26	1.16	-1.21	-0.56	-0.84	-2.31	01.05	0.086	12	**
Zielona Gora	-0.67	-2.48	0.39	-0.48	-0.68	-1.26	-0.40	0.02	0.64	-0.14	-2.58	1.20	0.063	13	*
Gorzow Wielkopolski	-0.67	-0.94	0.39	-0.48	-0.69	0.18	-1.03	0.02	-1.31	-2.83	-2.58	1.91	-0.010	14	*

Note. ^ - level of attractiveness **** - high * - small

Source: own calculations based on Regional Data Bank of the Polish Central Statistical Office (2021).

In the group under study, Lodz is characterised by the highest attractiveness, while Gorzow Wielkopolski, which achieved the lowest synthetic measure value, is characterised by the lowest attractiveness (see Figure 4).

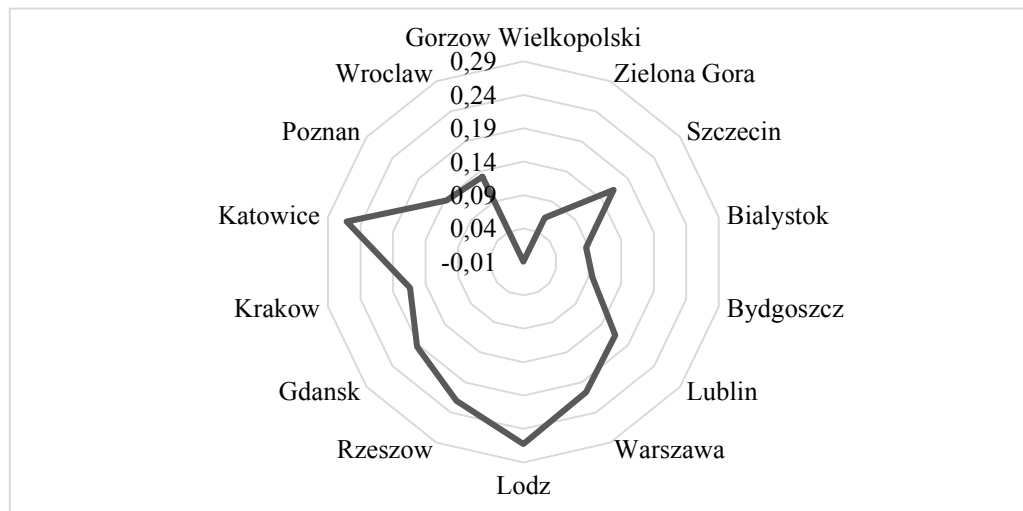


Figure 4. The distance (d_i) of provincial cities from the development pattern according to Hellwig in 2021.

Source: own calculations based on Regional Data Bank of the Polish Central Statistical Office (2021).

Based on the taxonomic measure of development d_i , provincial cities were divided into four groups (Table 5). The analysis shows that Katowice and Lodz achieve a very high level of investment attractiveness (group I). Six centres, Rzeszow, Warsaw, Gdansk, Krakow, Lublin and Szczecin, were classified in group II, characterised by high attractiveness. Most of the cities surveyed were classified in group III (low level of attractiveness). Zielona Gora and Gorzow Wielkopolski were classified in group IV, which means a very low level of attractiveness for logistics services compared to other units (Q2).

For individual indicators, the lowest value of X_1 (labour costs) occurs in Rzeszow, with Lublin, Bialystok, Bydgoszcz, Gorzow Wielkopolski, Zielona Gora, Krakow and Lodz are also below the sample average (4326 PLN/month), whereas the highest X_1 values are observed in Gdansk and Warsaw. In transport infrastructure, Warsaw records the highest X_3 (roads with hard surface at 100 km²), while Katowice records the highest X_4 (expressways and highways per 1000 km²), and the lowest X_4 values are in Bialystok and Lublin.

For air-cargo intensity (X_6), the highest level is in Katowice and the lowest values appear in Gorzow Wielkopolski, Zielona Gora, Bydgoszcz, Szczecin, Lublin and Bialystok. Regarding real-estate/warehouse metrics, Gdansk has the highest X_8 (industrial building area per firm in section H) and Katowice the lowest, while Katowice posts the highest X_{10} (vacant space), with the lowest X_{10} in Lublin, Bialystok and Zielona Gora.

In labour market availability, Rzeszow has the highest X_{11} (share of unemployed with higher education) and Gorzow Wielkopolski the lowest. For specialised human capital, Szczecin records the highest X_{14} (graduates in transport services per 10,000 students), with the lowest values in Lodz and Bialystok. Net migration (X_{15}) is highest in Rzeszow and lowest in

Bydgoszcz. Measures of economic activity show the highest X_{16} (number of manufacturing enterprises per 10,000 inhabitants) in Szczecin and the lowest in Gorzow Wielkopolski. The highest X_{17} (share of innovation enterprises) is in Warsaw, and the lowest is in Szczecin. The highest X_{18} (share of section H in the total number of companies) is in Gorzow Wielkopolski, and the lowest is in Wroclaw.

5. Discussion

This study introduces a city-level, logistics-oriented Investment Attractiveness Model (IAM) for Poland and explicitly juxtaposes the Hellwig score with per-capita firm intensity. In contrast with national-scale composites, we uncover corridor/port deviations – western/coastal cities with high firm intensity despite moderate/low d_i (Q1–Q3). Prior work emphasises costs, connectivity and talent as location determinants (Aktas et al., 2011; Graf, Mudambi, 2005; Hwang, Kim, 2019). National indices (Kearney, 2019; Deloitte, 2019) rank countries or broad regions. We confirm these drivers at city scale and show that cross-border corridors, port access and labour-market pooling can amplify siting beyond average attractiveness captured by d_i .

Similar to the literature, our high-ranked cities combine expressway/rail density and warehouse capacity. Unlike national-scale assessments, Szczecin, Zielona Gora and Gorzow Wielkopolski exhibit high firm intensity with only moderate/low d_i , signalling corridor/port and legacy-specialisation effects that attenuate the d_i -presence link. The IAM captures the baseline attractiveness channel, while infrastructure corridors and ports act as multipliers. This explains the weak, non-monotonic associations reported in the Results and guides place-specific policy (see Conclusions). Next steps include: (i) rank-based association tests (Spearman) with bootstrapped confidence intervals, (ii) sector-specific weights for IAM domains, and (iii) a multi-year panel (e.g., 2016-2023) using Eurostat to test rank stability and dynamics across European cities.

Our IAM operationalises location determinants for logistics outsourcing into a transparent set of stimulants (infrastructure, warehouse/real-estate stock, labour supply, local economy/innovation) and destimulants (business costs), consistent with prior work on cost, connectivity and talent (e.g., Aktas et al., 2011; Graf, Mudambi, 2005; Hwang, Kim, 2019) (Q1). The Hellwig index indicates marked spatial differentiation, two cities at very high levels, six high, most low, and two very low, underscoring uneven endowments in connectivity, warehouse stock and specialised human capital (Q2). While the Results section reports distributions only, their geography aligns with corridor and port adjacency: western and coastal regions display stronger logistics presence and labour pooling that can amplify attractiveness beyond cost fundamentals (Q3).

The association between the synthetic score and firm location is positive but non-monotonic. High-ranked centres (e.g., Warsaw) also show high firm intensity, yet several western-border cities (e.g., Szczecin, Zielona Gora, Gorzow Wielkopolski) record high per-capita firm counts despite moderate or low synthetic scores. This indicates that investment attractiveness matters, but corridor/port access, legacy specialisation and labour-market pooling also shape siting decisions (Q4).

Indicator patterns are consistent with these mechanisms. High road density (X_3) in Warsaw and expressway density (X_4) in Katowice and Lodz support market access and distribution. Airport cargo intensity (X_6) peaks in Katowice, echoing logistics-capability evidence (Hwang, Kim, 2019). On the warehouse market, Gdansk's high X_8 suggests abundant space relative to section-H firms, while Katowice's high vacancy (X_{10}) implies immediate availability that may compress onboarding times. Human-capital signals are mixed: Rzeszow shows high X_{11} (university-educated unemployed), Szczecin leads in transport-graduate output (X_{14}), and net migration (X_{15}) is positive in Rzeszow but low in Bydgoszcz. Broader economic activity ($X_{16} - X_{18}$) further highlights heterogeneity: manufacturing density (X_{16}) is highest in Szczecin, the innovation share (X_{17}) in Warsaw, and section-H specialisation (X_{18}) in Gorzow Wielkopolski.

Situating these findings in the literature, our city-level results nuance national indices (e.g., Kearney, 2019; Deloitte, 2019) by showing that medium or even low synthetic scores can coexist with high firm intensity along western corridors, an effect not visible in country-level composites. Consistent with location-determinant studies (Aktas et al., 2011; Graf, Mudambi, 2005), transport connectivity and labour-market depth act as strong stimulants in the IAM. Future work will (i) assess rank-based association (Spearman) between d_i and firm intensity, (ii) explore sector-specific weights, and (iii) extend the IAM with Eurostat time series to analyse dynamics across European cities.

6. Conclusion

This study identifies the determinants of location choice for logistics outsourcing (Q1) and develops a transparent Investment Attractiveness Model (IAM). Factors were grouped into stimulants (e.g., labour supply, population density, road/rail density, cargo-airport use, sectoral specialisation, innovation) and destimulants (wages in section H, warehouse rent). Using the Hellwig method, we ranked Polish provincial capitals and classified them into four groups (Q2). Most centres display medium or low attractiveness; Lodz attains the highest score, while Gorzow Wielkopolski records the lowest. These findings indicate where targeted improvements in transport and storage infrastructure, as well as talent pipelines, could raise attractiveness.

A key original contribution is a city-level, logistics-oriented composite that reveals patterns not visible in national indices: notably, corridor/port effects in western and coastal cities (Q3). We also juxtapose the synthetic score with per-capita firm intensity and find a positive but non-monotonic association; for Q4 we observe only partial alignment, investment attractiveness matters, yet proximity to west–east corridors and ports, legacy specialisation and labour pooling also shape siting.

Practical implications follow for both managers and city authorities. The IAM provides a reproducible screening tool to shortlist cities by cost–access and time-to-market; policymakers can prioritise expressway/rail density, cargo-airport capability, warehouse stock and targeted skills (transport/logistics graduates). Theoretically, the results support location-determinant perspectives that emphasise connectivity and human capital, while qualifying them with corridor/port adjacency effects.

Lodz should take advantage of its location on transport corridors by increasing intermodal capacity (rail and road terminals) and improving last-mile access to expressways in order to translate its high synthetic attractiveness into additional demand for warehouse space. Katowice can build on its advantages of a dense network of expressways and high cargo traffic at the airport by improving first and last-mile access to logistics parks; at the same time, it is worth monitoring vacancy rates (X_{10}) to maintain a competitive but not excessive supply of space.

In Warsaw, it is advisable to alleviate cost pressures through a spatial development policy that favours urban consolidation centres and night delivery windows; this will maintain accessibility advantages without escalating operating costs. In Gdansk and Szczecin, as port centres, the priority should be the throughput capacity of the port hinterland railway and the automation of gates, which will consolidate corridor effects and reduce dwell times. It is also worth reserving land for cross-docking and value-added services. Wroclaw should combine its strong exposure to transport corridors with increased innovation (X_{17}) and the development of staff training paths in order to reduce the gap between the intensity of companies and the synthetic attractiveness score.

Lublin can capitalise on its proximity to Warsaw by accelerating the expansion of expressways and ring roads, which will shorten transit times to the capital and major east-west routes. Zielona Gora and Gorzow Wielkopolski should strengthen north-south connectivity and develop modern, modular warehouse space to maintain a high number of companies per capita, while improving the quality of available infrastructure.

Limitations include reliance on official statistics for a single year and a reduced city set; unobserved factors (e.g., firm age, contract structures, cross-border demand) were not captured, which may attenuate the link between d_i and firm siting. Using a single cross-section (2021) also introduces temporal limitations: the IAM may be sensitive to short-run shocks (e.g., infrastructure openings, port disruptions) and cyclical labour-market conditions. A multi-year panel (e.g., 2016–2023) would allow us to test rank stability, re-estimate weights, and assess whether city positions converge or diverge over time. Consequently, the results

should not be generalised directly to other countries, though they complement existing research on urban logistics attractiveness.

Future work will extend the IAM with Eurostat data to test robustness across countries and time, explore sector-specific weights, and assess rank-based associations between d_i and firm intensity. Overall, we provide a logistics-specific, city-level composite for Poland and show where the synthetic score aligns and misaligns, with actual firm intensity, highlighting the distinct role of western transport corridors and port adjacencies.

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FORMS OF PROJECT ORGANIZATION AND SUPPORT USING A MULTI-PROJECT APPROACH TO STRATEGY IMPLEMENTATION

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Purpose: The paper aims to highlight the necessity of a systemic approach to organizing multi-project initiatives for effective organizational strategy implementation. By investigating various forms of project organization and the role of Project Management Offices (PMOs) it addresses the growing complexity of organizational environments and the need for structured project organization and support mechanisms to achieve strategic goals.

Design/methodology/approach: The paper adopts a theoretical and descriptive approach, drawing from existing literature and established methodologies in project, program, and portfolio management. It defines concepts like organizational ambidexterity, elaborates on multi-project implementation forms (programs and portfolios) and – on the basis of comparative analysis – presents various typologies of project organization forms. The authors also detail different PMO models and provide a decision scheme for their selection in supporting strategy implementation.

Findings: The study finds that the choice of project organization forms and PMO types significantly affects the effectiveness of strategy implementation. It also emphasizes the importance of effective management of projects, programs, and portfolios for achieving organizational development goals and successful strategy implementation. Key success factors include a.o. aligning project structures with organizational goals, balancing operational and project work (ambidexterity), and integrating portfolio and program management into governance processes for better resource allocation efficiency and control over the implementation of strategic priorities.

Research limitations/implications: The study is primarily theoretical and does not include empirical data, which limits its generalizability. Future research should empirically test the effectiveness of proposed models across different industries and organizational sizes.

Practical implications: Organizations should adopt a multi-project approach for resource allocation and strategic monitoring. The findings offer guidance on choosing suitable project organizational structures based on project scope and complexity. Businesses can leverage PMOs to standardize processes and develop project competencies, selecting the most appropriate PMO model for their needs.

Originality/value: The paper's value lies in its comprehensive synthesis of multi-project approaches, project organization forms, and PMO models from diverse sources. It is valuable

for academics, project managers, and organizational leaders aiming to optimize project-based strategy execution.

Keywords: Project management, strategy implementation, portfolio and programme management, forms of project organization, PMO.

Category of the paper: Research paper.

1. Introduction

Modern organizations operate under conditions of increasing complexity and dynamic environmental changes, necessitating the balancing of operational efficiency with flexibility and the ability to undertake transformational and developmental activities. In such conditions, the importance of projects, programs, and portfolios, which increasingly become not only a means of implementing specific development initiatives but also the primary mechanism for implementing organizational strategy, is growing. The ability to effectively combine operational and project activities, referred to in the literature as organizational ambidexterity, is a key factor in achieving strategic goals and maintaining competitive advantages in the long term. In this context, it becomes essential to develop appropriate forms of project work organization, taking into account the specificity of projects, the project maturity of the organization, and the quality and availability of resources. Project Management Offices (PMOs) also play a significant role, which, depending on the adopted implementation model, support the planning, execution, and supervision of projects, programs, and project portfolios. Proper organization of the project environment, encompassing both structural and process aspects, thus becomes a key condition for the effective implementation of strategy and the achievement of organizational development goals.

2. The Role of Projects in Implementing Organizational Strategy. Forms of Multi-Project Implementation

Considering the main activities of the organization, its activity can be divided into two categories: operational (process, routine) and project (innovation, change, transformation). The phenomenon of the organization's ability to find a balance between repetitive and project activities has been termed ambidexterity in the literature (see more: Zakrzewska-Bielawska, 2016, pp. 435-449; O'Reilly, Tushman, 2004, pp. 74-81; Bukłaha, 2022, pp. 62-63; Camine, Smith, 2022). The financial result, value growth, and the degree of achievement of the organization's strategic goals depend on the efficiency of processes and the effectiveness of project implementation. While repetitive activities ensure the continuity of its operations, the implementation of initiatives allows for its transformation, especially concerning strategic

activities. Operations include repetitive tasks (run-the-business), such as manufacturing, service, and production, while projects involve unique, single initiatives (change-the-business), such as the development and implementation of new products, improvement of existing services, or investment in company infrastructure, examples of which are projects.

Proposals for improvements, technology changes, and new product development may result from observations of operational activities or from defining the company's development strategy in specific areas of its activities. Transformational activities, in turn, aim to change the way the organization operates to increase the efficiency of processes and operations. Therefore, the effectiveness in achieving the organization's strategic goals and the ability to operate in the long term are conditioned by the efficiency of both operational and increasingly transformational activities (Juchniewicz, 2017, p. 7; Ika, Munro, 2022, pp. 601-607).

Project management as an area of knowledge primarily emerged in response to the needs of economic practice when traditional management methods and tools proved insufficient for the effective implementation of large, complex, and unique initiatives. Over several decades, it has evolved from a set of simple principles and tools to a comprehensive and multifaceted sub-discipline in the field of management and quality sciences, with its own research object, terminology, and theoretical and methodological foundations (Lichtarski, Wąsowicz, 2017, p. 124; Geraldi et al., 2022, pp. 439-453). This has its roots, among others, in the changing project environment, particularly considering changes in the functioning of enterprises and the development of new products (Spalek, 2017, p. 106; Crawford, Pollack, England, 2006, p. 176; Sońta-Drączkowska, Krogulec, 2024, pp. 360-384). Today, projects are present in virtually all areas of human activity, from public administration and commercial activities of all kinds to culture and sports.

Projects are considered one of the most important tools for organizational development, introducing changes, optimizing processes, and implementing strategic plans. The appropriate form of project implementation should depend on the goal for which they are established – if it cannot be achieved through the implementation of individual projects, the most effective form of organization and control of planned initiatives from the perspective of key decision-makers in this regard is determined.

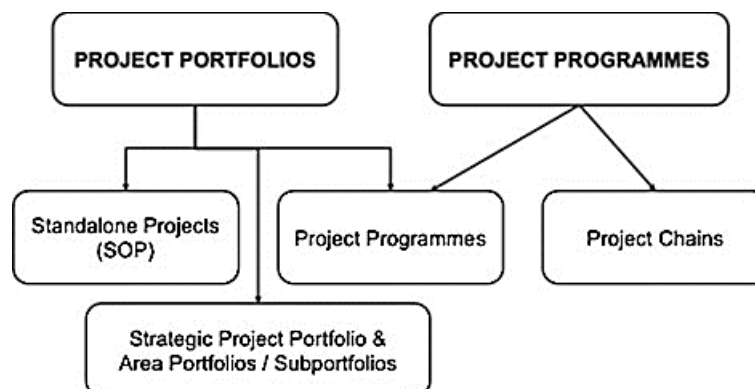


Figure 1. Forms of Multi-Project Implementation.

Source: own elaboration.

As shown in Figure 1, the achievement of identified development goals of varying significance for the enterprise can occur through the implementation of individual significant initiatives (standalone project, SOP), unrelated to other projects in the organization, or in the form of multiple projects carried out sequentially or simultaneously in relation to each other (multiple project management). This group includes project programmes, chains and project portfolios. The former have a finite implementation time, a business justification, and allow for the achievement of business goals and non-financial benefits that cannot be achieved through the implementation of individual projects. Projects within a program can be carried out in parallel or sequentially, creating so-called project chains. In this latter form, the possibility of starting the next project in the chain depends on achieving the expected results (outcomes, final products) of the previous project or projects. A project portfolio, on the other hand, means either (in the case of companies implementing few projects simultaneously) all projects at various stages of work progress carried out throughout the organization or (in the case of companies with a larger number of simultaneous initiatives) a group of centrally monitored/controlled projects selected according to a specific key in the organization (product, area, geographic, or functional), e.g., a portfolio of strategic projects and area portfolios (subportfolios) of projects f.e. carried out in Europe, in consulting services, within the IT Department, R&D, etc.

3. Programs and Project Portfolios and Organizational Development Goals

As mentioned earlier, organizational goals can be achieved operationally and process-wise (evolutionary) and project-wise (changes and transformations). In the latter case, strategic programs and project portfolios are utilized. They should be closely linked to the organization's vision, mission, and strategy. In this context, they should be treated as tools for implementing the most significant changes resulting from strategic goals within the strategy adopted for implementation in the organization's immediate future. The procedure for creating a program or project portfolio involves first identifying projects currently being executed in the organization and initiatives awaiting initiation (not yet initiated due to a lack of appropriate or sufficient resources). The next step is to verify their significance in relation to the organization's leading developmental goals, the availability of key resources necessary for their execution, and to consider the pace of necessary investments in each of the organization's business areas, i.e., perform so-called investment balancing. After obtaining answers to the above questions, projects should be prioritized and a list of initiatives most fitting the organization's important development criteria, significant during the strategy implementation period, and feasible considering the organization's resources, including synergistic connections between them, should be created. This list illustrates the significance of projects from the perspective of developmental goals and should be handed over for planning and execution, as well as

periodically monitored and adjusted to the changing situation of the company in each area of its operations.

Knowledge of multi-project management has evolved into specialized sets of best practices and methodologies, primarily serving two purposes. First, they enabled the standardization of procedures and terminology used in executed initiatives. Second, they equipped project managers, program managers, and portfolio managers with logically thought-out and organized sets of steps to make the most effective management decisions. While there are at least several dozen widely used standards for executing individual projects (See f.e.: Trocki, 2017), the choice is much smaller when it comes to managing multiple projects. Directors of program and portfolio management offices, as well as those managing strategic project management offices, have at their disposal primarily multi-project methodologies and standards, which are summarized in Table 1.

Table 1.
Selected Methodologies for Multi-Project Management

Name of the methodology	Abbreviation	Concerning	Organization / Owner
Management of Portfolios	MoP	Project portfolio	Axelos
P5.express	n/a		OMIMO
PM ² Portfolio Management	PM ² -PfM		The European Commission
Project Portfolio Management	PPM/PPfM		PMI
Scrum of Scrums	SoS		Scrum Inc.
Managing Successful Programmes	MSP	Project Programme	Axelos
PM ² Programme Management	PM ² -PgM		The European Commission
Project Programme Management	PPgM		PMI

Source: own elaboration.

By utilizing comprehensive methodological approaches, the certainty increases that no essential steps or stages will be missed at the initial planning stage of a program or project portfolio, which is particularly important for implementing strategic goals and executing strategies.

To effectively execute SOP-type projects as well as programs and portfolios, special organizational forms are often created to enable the efficient functioning of project teams within the structures of a given organization. There are several types of these forms, as there is no single form of project work organization that best fits all types of organizations and the specific projects executed within their structures. Regardless of the chosen organizational structure, the work of project teams can be supported by activities undertaken within Project Management Offices (PMOs). These can be single- or multi-level and offer various support to decision-makers responsible for achieving the goals of the program or project portfolio. These issues are addressed in the further part of the article.

4. Typical Forms of (Multi)Project Organization in Enterprises

Developmental activities of an organization described in the main strategy and functional strategies should be reflected in the real actions of the teams established to develop them. Traditionally, project management activities are presented from the perspective of their execution processes, distinguishing between execution processes (designing the final result and its execution), management processes (setting goals, planning, organizing, controlling, and coordinating), and project support and service processes (ISO 21500:2012; Trocki, 2013).

This approach, developed in many standards and knowledge compendiums on project management, focuses on individual initiatives and identifies problems and solutions related to their execution—answering the question ‘how to do the project well?’ Meanwhile, the observed increase in the importance of projects in organizations is also accompanied by an increase in their number. It is rare to find organizations characterized by the sporadic execution of single, structurally distinct projects. In the vast majority of cases, managers deal with multiple parallel project initiatives executed in the environment of one organization, at the same time, based on the same limited resources, and additionally interdependent with the development directions adopted in the strategy, changes introduced in processes, products, or the impact on the company's stakeholders. The multitude of projects poses problems for the enterprise in properly combining execution and management tasks resulting from both ongoing activities (business as usual, BAU) and time-limited and unique projects and programs (Barbosa, Carvalho, 2024; Butler, 2022).). The answer to these problems is organizational solutions (Crawford, 2004).

Organizational problems mainly concern issues such as:

- the method and scope of integrating project activities into the organizational structures of the enterprise (in the form of individual projects, programs, and portfolios),
- relationships between the static, permanent structure of the organization and the dynamic, temporary structure of projects,
- adoption of appropriate, flexible organizational structures enabling the efficient execution of cross-functional projects of various specificities,
- effective information flow within executed projects (as well as programs and portfolios) and within the organization's information system,
- the method of executing portfolio and program management processes in a multi-project environment,
- permanent and comprehensive integration of solutions used in project management into the organization's management system.

The way of solving the above problems, established by practice or described in organizational documentation, will define the project environment in the organization. Various typologies and models describing such solutions – so-called types/forms of project organization – can be found in the literature. Their summary is presented in Table 2.

Table 2.*Forms of Project Organization found in the literature*

Author	Forms of Project Organization						
	functional	weak matrix	balanced matrix	strong matrix	projectized		
B. Lent	independent project organizational structure	project management organization from a staff position	project organization with units simultaneously subordinate in the linear structure of the enterprise				
H. Kerzner	traditional hierarchical structure	linear structure with a collaboration department	project staff structure	projectized	weak matrix	balanced matrix	strong matrix
E.W. Larson, C.F. Grey	functional organization	dedicated project team reporting to top management	project hierarchy	weak matrix	balanced matrix	strong matrix	
J.R. Turner	functional line structure	coordinated matrix	balanced matrix	secondment matrix	project hierarchy		
J.M. Nickolas, H. Steyn	single functional team	single cross-functional team	temporary matrix	permanent matrix	pure project structure	partial project or Project Office	

Source: PMI, 2013a; Lent, 2005; Kerzner, 2003; Larson, Grey, 2011; Turner, 2009; Nicholas, Steyn, 2008.

Among the factors mentioned as decisive in the process of selecting and designing organizational structures are aspects such as the frequency of project execution, their duration, size, complexity (Nicolas, 2003), as well as the project maturity of the organization, the level of top management involvement, project location, available resources, or unique project characteristics (Kerzner, 2003).

In Polish literature on organizational problems of project management, the categorization proposed by Trocki is distinguished. He presents a set of nine so-called forms of project organization (Figure 2).



Figure 2. Forms of Project Organization according to Trocki.

Source: Trocki, 2014.

The above models enable the selection and organization of a project within the parent company's structure to ensure the effective execution of both execution and management/coordination tasks in undertaken developmental works (projects, portfolios, and programs).

If the planned initiative has a relatively limited scope, within the responsibility of one division/department in the organization and will be executed mainly by resources from this part of the organization, the recommended form of organizing such a project will be the so-called **project organization in a linear structure**. In this case, it is best to appoint the project manager as the head of the organizational unit, who, by virtue of already holding a managerial position (e.g., division director), will have full managerial tools in relation to the subordinate employees forming the project team. This solution does not require significant changes to the management system and relies largely on existing solutions.

For initiatives of a more complex nature, where a wide range of work involves various parts of the organization (large projects and programs), it is necessary to transfer coordination activities from the division management level to the top management level and apply the so-called **project organization in a line-and-staff structure**. The entire initiative is then divided into sub-projects, projects within the program, or so-called streams and assigned to designated organizational units for delivery. To manage the entire project or program, a special organizational unit is created, consisting of the project (or program) manager along with the management team and necessary administrative support. The unit, being located directly under top management, ensures the efficient execution of the initiative by reporting its progress directly to the Board or selected Board Members. The advantage of this solution is the ability

to execute the largest projects and programs in a way that ensures cooperation between all involved parts of the organization.

If the organization executes a larger number of projects (e.g., in project portfolios), matrix solutions are usually applied. The introduction of the so-called **project matrix organization** allows adding a second dimension to the existing organizational structure, in this case, the project dimension.

The matrix enables the introduction of many simultaneously executed projects into the organization, managed by specially appointed project managers who will engage resources from various organizational units according to the established scope of work. Depending on the significance and rank of developmental activities relative to the ongoing operations of the organization, three variants of the discussed structure are possible:

- **strong matrix** structure: priority in resource access is given to projects, and project managers have the decisive voice in case of conflicts,
- **weak matrix** structure: projects must yield to ongoing operations, which are usually the primary source of revenue,
- **balanced matrix** structure: rarely encountered, where both dimensions have equal importance from the perspective of achieving organizational goals.

Another way of organizing project activities in enterprises is the so-called '**clean**' **project organization**. This solution is applied when the project can proceed independently of the parent organization's primary activities. Top management may decide to 'cleanse' the organizational structure and separate the project team into a new, newly created organizational unit. In this case, employees involved in project work are transferred to the new department/division, and any gaps are filled through external recruitment. Responsibility for managing the initiative rests with the head of this unit, who effectively acts as the project manager or program director. The 'pure' project organization can be particularly used when the organization undertakes diversification initiatives involving the development of new areas of activity.

For initiatives with a broad scope and high level of risk, the recommended form of project/program organization is the so-called **project subsidiary** or **project-based subsidiary company**. This model assumes the separation of the project into a newly created entity dependent on one 'parent company' or multiple shareholders. Adopting this model brings several benefits: limiting the investor's risk to the level of the contributed capital, the possibility of involving more partners, financing the investment with debt (project finance formula), and greater freedom for the new company in shaping the management system and configuring resources for efficient project execution. The costs of establishing and maintaining a new company, which previously posed a barrier, are gradually decreasing, making this form increasingly accessible.

A significant and frequently used form of project organization is the so-called **external project organization**. It involves outsourcing the entire project or a significant part of it to an external contractor. The scope of outsourced project work, time, cost, and quality constraints,

and the method of cooperation between the parties in project execution will typically be described in a contract between the commissioning organization and the (general) contractor. The external project organization allows for relatively quick identification of a contractor and, by utilizing specialized resources on their side, achieving results that would require long-term capacity building within the organization if executed internally. Often, due to the unique nature of the initiative, the investment is obviously unprofitable. However, it should be remembered that transferring technical and managerial work to an external contractor does not relieve the client of the need to establish effective oversight. Additionally, the client should organize a team on their side to handle tasks such as requirement identification, user collaboration, and implementation and maintenance activities. In this case, it is possible to designate two project managers: the 'technical' manager from the contractor's side and the 'business' manager from the client's side. Their mutual relations, scope of authority, and responsibilities should be described in the project execution contract.

When the scope of the initiative exceeds the capabilities of a single external contractor, the recommended formula for project execution is the so-called **consortium-based project organization**. This formula assumes that a group of organizations, led by a consortium leader, commits to jointly executing the project commissioned by the investor. Existing organizations retain their independence and legal personality, continuing to operate on their own account. The consortium agreement will describe the mode of operation, duration, division of work and budget among the consortium members, decision-making and management methods, and the consortium's representation rights. Consortia are usually formed to execute the largest-scale initiatives (mega-projects) such as building power plants, roads and highways, airports, and large R&D projects.

One of the newer and more interesting forms of project organization is the so-called **network-based project organization**. This form is, in fact, a 'project organization without an organization'. Project execution in this formula is based on cooperation within so-called 'contract networks', i.e., 'groups of independent entities in terms of formal-legal aspects, cooperating in project execution based on contractual relationships and mutual trust' (Trocki, 2014, p. 167). The network project organization is initiated by the parent organization, which defines the needs and outlines the principles accompanying cooperation between the involved partners, acting as an integrator. The way of solving the posed problems, organizing the work of teams, and the scope of tasks performed are planned and coordinated independently by the individual project participants, giving them high autonomy and freedom in their actions.

The comparative analysis of project organization forms reveals that each structure offers distinct benefits while also generating specific limitations. The linear structure ensures familiarity of roles and stable oversight but restricts the involvement of external expertise and constrains flexibility. The line-and-staff structure strengthens managerial supervision and professional support, yet increases top management's burden and limits staff autonomy. The matrix structure promotes resource efficiency, professional development, and cross-unit

cooperation, though it often leads to competence conflicts, ambiguous reporting lines, and stress among employees. In contrast, the clean project structure guarantees full dedication of resources, independence from ongoing operations, and high professionalism, but may result in instability of employment and difficulties in team integration. Establishing a project subsidiary provides legal and financial separation and strong managerial autonomy; however, it raises operational costs, complicates oversight, and can create conflicts among shareholders. Network-based project organizations and consortia enable access to specialized expertise and reduce client-side risk, but simultaneously increase costs, reduce direct control, and pose coordination challenges in multi-partner settings.

An important dimension in assessing the suitability of different forms of project organization is their alignment with the organization's culture and maturity level. Functional, line, or weak-matrix structures tend to correspond with more hierarchical, process-oriented cultures and with organizations at an early stage of project maturity, where formalized project management practices are limited. Conversely, strong-matrix, pure project, or subsidiary-based forms require more flexible, collaborative cultures and higher maturity levels, as they presuppose advanced competencies, effective conflict resolution mechanisms, and trust in cross-functional cooperation. External and consortium-based organizations, in turn, demand an openness to interorganizational collaboration and mature governance frameworks to balance autonomy with accountability. Considering organizational culture and maturity thus provides a more holistic perspective, allowing decision-makers to better align structural choices with the behavioral norms, values, and capabilities that ultimately determine project success.

In sum, the choice of a project organization form should be aligned with the scope, complexity, and strategic significance of the undertaken initiatives, as each structure offers unique advantages but also imposes specific constraints. To mitigate these limitations and ensure consistency in governance, organizations increasingly rely on Project Management Offices (PMOs), which provide structural support, methodological guidance, and integration across diverse project environments.

5. Organizational Support for Project, Program, and Portfolio Management (PMO)

The progressing projectification¹ of organizations (Wald et al., 2025; Jałocha, 2019 and 2023; Jacobsson, Jałocha, 2021), and consequently the growing need to ensure the execution of new, specialized project tasks within the organization, and the difficulty in delegating them to competent executors, have led to the creation of new organizational structures composed of

¹ Projectification denotes the growing tendency to carry out tasks in the form of projects, rather than fixed processes or routine-like, repetitive activities. It can refer to individual organizations, sectors or entire industries.

individuals specialized in overcoming specific project management problems and capable of providing comprehensive assistance and support to all stakeholders involved in projects within organizations. In such cases, this responsibility is placed on Project Management Offices (PMOs) (Tsaturyan, Müller, 2015).

The most frequently indicated model of PMO operation is the Enterprise-wide PMO (EPMO). This office is positioned at the level of central functional units of the organization and reports to its top management. Thanks to this location, it can: perform overall governance over project management and the participation of individual functions in their execution as well as coordinate undertaken activities and build a unified, coherent pro-project organizational culture (Kendall, Rollins, 2003). Moreover, EPMO is also often responsible for (PMI, 2013b):

- ensuring compliance of projects and programs with the organization's development strategy,
- resolving conflicts considering strategic priorities,
- executing project portfolio management processes, i.e., collecting initiatives, evaluating and selecting them for the portfolio, planning and monitoring portfolio execution, and evaluating realized benefits.

If the organization wants to support project management but does not see the need to give it a special, strategic character, it can opt for the classic solution in the form of a Project Management Office (PMO), also known as a Project Support Office (PSO) or Project Control Office (PCO). This unit will be responsible for developing and implementing a common set of tools, practices, and processes within the organization, sometimes taking the form of a methodology or internal project management standard (Alexandrova, Stankova, Gelemenov, 2015). In this case, it may act as a 'guardian' of procedures, providing support and training to project managers in using the tools, overseeing their work, and requiring information confirming compliance with the company's standards.

Another frequently appearing PMO model is the **Project Management Center of Excellence (PMCoE)**, also known as the *Competency Center* (O'Leary, Williams, 2008). This unit, as its name suggests, will focus on improving the methods and tools of project personnel within its scope of influence. It will conduct its activities through various types of training activities, managerial development programs, coaching and mentoring, consulting, management reviews of completed projects, and promoting professional project management in internal communication channels (conferences, newsletters, etc.). This office may also initiate and participate in knowledge management programs, particularly interested in collecting and distributing so-called project knowledge or knowledge related to project execution (Wyrozębski, 2014).

Another type of PMO is the **Departmental PMO**, also known as the 'tactical' PMO. The main distinguishing feature of this type of PMO is its location within the organizational structure of the enterprise. The departmental PMO is located at the middle level of the

organizational hierarchy, fulfilling the mission of improving project management practices in a selected part/segment of the organization as determined by the management.

The fifth model of the PMO is the **Project Office**. This model can be encountered under various names, emphasizing the singular rather than the plural – not ‘projects’ but ‘project’. In this case, the project office aims to support and relieve the project/program manager from routine and time-consuming activities, allowing them to fully focus on tasks related to actual project management. The project office will also provide the necessary information and ensure the implementation of decisions and resolutions made by the project manager. It will primarily handle activities such as ensuring the correctness of project execution in accordance with organizational standards and procedures; overseeing and tracking project progress (in terms of scope, time, and budget), including internal and external project reporting; managing project databases and documentation; ensuring managerial communication within the project; collecting best practices and project experiences; managing project risks (analyzing and reporting risks); and providing general administrative support for the project.

When choosing the appropriate PMO model, which can serve as a reference point for adaptation activities, it is necessary to first analyze the goals set for it (at what scope will it be able to effectively achieve them?), the current project management practices used in the organization (what is the level of project maturity of the company?), and its strategic goals (e.g., the need for project support for one of the businesses) (Wyrozębski, 2019).

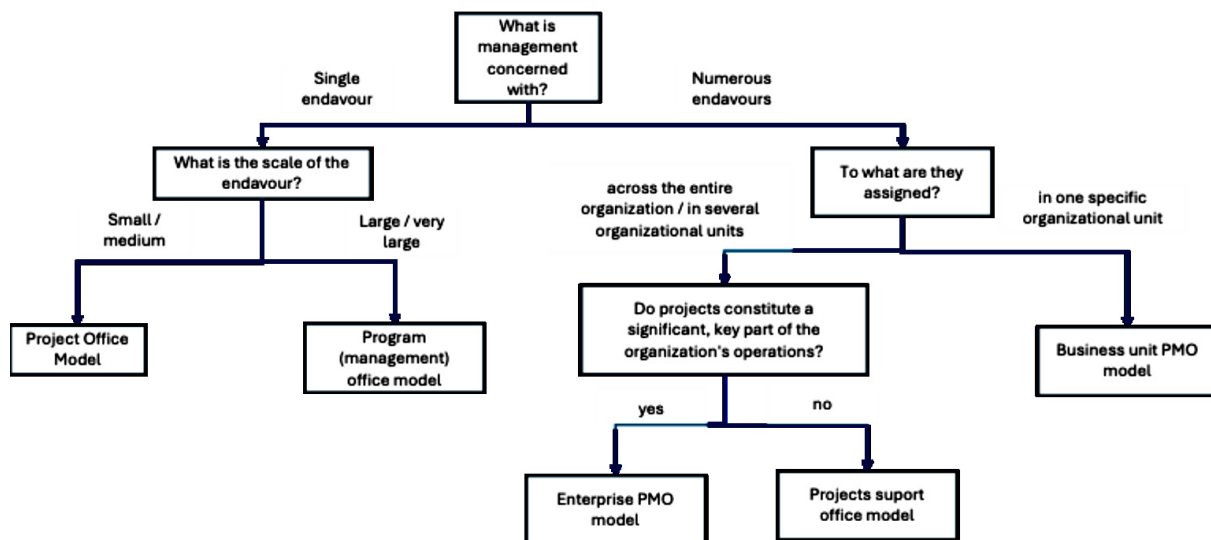


Figure 3. Decision Scheme for Selecting the Model PMO Type.

Source: Wyrozębski, 2019.

The decision scheme above (Figure 3) can assist in making a decision regarding the selection of the base model of the PMO.

6. Conclusion

To sum up, effective implementation of organizational strategy in the face of increasing environmental complexity and progressing projectification of activities requires a systemic approach to organizing developmental initiatives. The application of a multi-project approach enables the rationalization of resource allocation and increases the effectiveness of controlling the execution of developmental priorities. Proper management of project portfolios and programs requires not only the identification and prioritization of initiatives but also their ongoing monitoring in the context of long-term strategic goals. PMOs play a special role in this process, supporting the standardization of processes, the development of project competencies, and the institutionalization of project knowledge management mechanisms at various levels of the organizational structure. The success of complex and strategic developmental initiatives (projects, programs, portfolios) will therefore depend on the proper alignment of strategic project management mechanisms, appropriate forms of project organization, and support structures that enable effective oversight of their progress and execution.

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Footnotes

1. Projectification denotes the growing tendency to carry out tasks in the form of projects, rather than fixed processes or routine-like, repetitive activities. It can refer to individual organizations, sectors or entire industries.

POLISH AUTOMOTIVE INDUSTRY DURING THE COVID-19 PANDEMIC. EVALUATION OF THE WIG AUTOMOTIVE INDEX

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Purpose: The article aims to analyse and evaluate the financial standing of WIG Automotive companies listed on the Warsaw Stock Exchange between 2019 and 2023 using selected discriminant analysis models. We also examined the relationship between liquidity and profitability. The selected time interval supports conclusions about the effects of the COVID-19 pandemic.

Design/methodology/approach: The research process is threefold. It involves a literature review, analysis of 2019-2023 financial data from financial statements of the investigated companies, and selected statistical methods, such as discriminant analysis.

Findings: All the automotive companies were in a good or very good financial standing during the period of interest. We confirmed the practicality of discriminant analysis models for forecasting insolvency risk and evaluating corporate financial standing in stable and unstable business environments. No clear association was identified between liquidity and profitability for the investigated companies.

Practical implications: The presented research can be used to draw the attention of enterprises operating in the automotive industry to methods of assessing their financial condition and verifying the relationships between selected financial indicators.

Originality/value: This article presents an analysis and assessment of the financial condition of selected companies from the WIG Automotive index. Pearson linear correlation analysis was used to identify the underlying causes of these financial results.

Keywords: financial standing, discriminant analysis, WIG Automotive index, Warsaw Stock Exchange, COVID-19 pandemic.

Category of the paper: research paper.

1. Introduction

Enterprise operations, also of listed companies, are under constant dynamic pressure from internal and external constraints. Black swans, which are surprising events of significant uncertainty and low frequency, crises, and catastrophes of substantial impact, are particularly important (Kisielnicki, 2021, p. 23). They are inherent to economic activity. Black swans can substantially affect the financial health and operational stability of an enterprise. The COVID-19 pandemic was a black swan event.

With 8% of the GDP, the automotive industry is counted among the primary sectors of the global economy (Stawiarska et al., 2021, p. 1; Podgórska et al., 2022, p. 93). The Polish automotive industry has transitioned from simple, low-cost, and labour-intensive production of the communist era (Domański et al., 2008, p. 85) to a strong CEE player, critical for the production of vehicles and automotive parts and assemblies, which was possible thanks to international investments (Stojczew, 2021, p. 69; Domański et al., 2008, p. 89). High quality and innovations elevate the competitiveness and advantage of the Polish automotive industry (Misztalewski, Daniluk, 2018, p. 68).

Today, national markets are very interconnected through economic relations. Disruption of a single link in the supply chain can have serious repercussions for many countries (Łuka, Woźniak, 2012, pp. 33-34). The recent COVID-19 pandemic can be considered a major supply chain shock. It shook the global market, individual national economies, and many organisations (Ivanov, 2020, pp. 141-165). The pandemic has substantially affected the automotive industry as well. Its—mostly adverse—impacts were reported by numerous authors (Stojczew, 2021, p. 67; Musa et al., 2023, p. 727; Jureczka, 2022, p. 9), also in the context of corporate financial standing (Hyży, 2023, p. 51).

Given the dynamic growth of the Polish automotive industry in recent years, it is crucial to monitor factors that may impact it. It is also crucial to verify the financial standing of automotive companies and their risk of insolvency (Boratyńska, Yafremava, 2023, p. 276; Antczak, 2015, p. 279). Discriminant analysis is a method for detecting threats and evaluating organisations' financial standing (Pilch, 2021, p. 78; Wojnar, 2014, p. 220; Antczak, 2015, pp. 279-280). It has been applied to the automotive industry, among other domains (Boratyńska, Yafremava, 2023, p. 276). The advantages of discriminative models include specific outcomes that are easy to interpret unambiguously (Pitera, 2019, pp. 193-204).

The period between 2019 and 2023 was a time of substantial changes in the Polish automotive industry: from dynamic growth to challenges brought on by global crises. Table 1 is an overview of registration and production of passenger cars in Poland in that period (Polski Związek Przemysłu Motoryzacyjnego, 2019-2023).

Table 1.*Passenger cars registered and produced in Poland between 2019 and 2023 (thousand)*

Year	Passenger cars registered in Poland	Passenger cars produced in Poland
2019	555.6	434.7
2020	428.3	428
2021	446.6	383.2
2022	419.7	420.1
2023	475	574.6

Source: original work based on PZPM reports.

The automotive industry reached an activity peak in 2019. There were 555.6 thousand new cars registered that year. It was thanks to favourable economic conditions and high demand. The passenger car output reached 434.7 thousand units. Despite a slight momentum loss compared to the previous years, it was still a meaningful result for the Polish industry (Polski Związek Przemysłu Motoryzacyjnego, 2020). The market slumped in 2020 due to the COVID-19 pandemic. The registration volume fell to 428.3 thousand, which was about 22% YoY. On the other hand, car production increased to 428 thousand (Polski Związek Przemysłu Motoryzacyjnego, 2021). The recovery began in 2021, slowly at first. Registrations reached 446.6 thousand, and production, 383.2 thousand. It was 10.5% below the 2020 levels (Polski Związek Przemysłu Motoryzacyjnego, 2022). In 2022, the registration volume declined once more to 419.7 thousand. This time, it was because of component shortages and overall economic uncertainty. Still, output grew to 420.1 thousand cars, which was indicative of the rising exports and greater non-domestic demand (Polski Związek Przemysłu Motoryzacyjnego, 2023). Both values improved significantly in 2023. Registrations grew to 475 thousand, which was 13.2% YoY, with car output reaching its long-time high of 574.6 cars (Polski Związek Przemysłu Motoryzacyjnego, 2024).

The **primary goal** of the article is to analyse and evaluate the financial standing of WIG Automotive companies listed on the Warsaw Stock Exchange between 2019 and 2023 using selected discriminant analysis models. We analysed data for years that facilitate conclusions concerning the COVID-19 pandemic. The secondary objective is to verify the association between liquidity and profitability and identify its direction, if any. It was pursued with a ratio analysis of liquidity and profitability metrics. We also employed the Pearson correlation coefficient. The proposed research hypothesis (**H1**) is that discriminant analysis models adequately reflect corporate financial standing under stable and unstable economic conditions. The second hypothesis (**H2**) proposes an association between liquidity and profitability of the investigated companies over the period of interest.

The originality of this study lies in its analysis and assessment of the financial condition of selected companies from the WIG Automotive index (2019-2023) using five discriminant analysis models. Furthermore, the scope of the study was expanded to include a ratio analysis of the financial liquidity and profitability of the analyzed companies, attempting to determine whether there is a statistically significant relationship between these indicators. Pearson linear correlation analysis was used for this purpose.

2. Literature review

The literature is replete with analyses of the COVID-19 pandemic's implications, undertaken by experts in various fields and disciplines. Such a multidimensional black swan could disrupt multiple sectors and pose a threat to enterprises. On the other hand, the pandemic could be a turning point for various companies and improve their financial standing, depending on their scope of business and characteristics. Regular monitoring and evaluation of the current financial standing are important in this context, as is forecasting its growth (Meluzin et al., 2017, pp. 171-187; Meluzin et al., 2018, pp. 148-169). A flexible approach and adaptability to fluctuating constraints may be considered critical at times like this. The COVID-19 pandemic's impact on the automotive industry has also been investigated (Stojczew, 2021, pp. 64-84; Hyży, 2023, pp. 39-54). Researchers analysed corporate financial standing using diverse discriminant analysis models to determine their risk of insolvency (Peres, Antao, 2017, p. 114; Klietk et al., 2018, p. 570). The 1990s witnessed the emergence of insolvency forecasting models in Poland, marked by the development of the first national discriminant functions based on linear discriminant analysis (Urban, 2024, p. 43). After a decade, there were over a dozen discriminative models dedicated to the Polish macroeconomic constraints (Tomczak, 2019, p. 98). Table 2 summarises studies that analysed the financial standing of automotive companies using discriminative models among other techniques.

Table 2.

Studies on the financial standing of Polish automotive companies that employed discriminant analysis

Author	Year	Investigated companies	Period	Employed discriminant analysis models
Kitowski	2018	WIG Automotive production and trade companies: - Auto Gaz, - Auto Partner, - Dębica, - Fota, - Groclin, - Inter Cars, - Sanok.	2015	- Hadasik's model 4, - Wierzba's model, - Hołda's model, - Hamrol's model, - Mączyńska's model, - Mączyńska & Zawadzki's model (IE PAS G), - Mączyńska & Zawadzki's model (IE PAS F), - Gajdka & Stos's model 4, - Prusak's model 1, - Prusak's model 2.
Boratyńska, Yafremava	2023	Automotive limited liability companies: - Volkswagen Group Polska, - Hyundai Motor Poland, - Kia Polska, - BMW Vertriebs GmbH, - Ford Polska, - Toyota Central Europe, - Volvo Polska, - Porsche Inter Auto Polska, - Mercedes-Benz Polska, - Renault Polska.	2018-2021	- Hadasik's model, - Wierzba's model, - Hołda's model, - Mączyńska & Zawadzki's model (IE PAS F), - Poznań model, - Prusak's model (P1), - Mączyńska & Zawadzki's model (IE PAS G).

Cont. table 2.

Pitera	2024	Seventy-five enterprises in the Euro-Park Mielec and Euro-Park Wisłosan Tarnobrzeg Special Economic Zones, including automotive companies	2015-2021	- Mączyńska's model, - Jagiełło's model, - Maślanka's model, - Prusak's model (P1), - Herman's model.

Source: original work based on the literature review.

Kitowski (2018) attempted to verify the diagnostic reliability of discriminative models using WIG Automotive companies. He focused on the situations of seven enterprises in 2015. His analysis results demonstrated that two of the seven WIG Automotive companies were at risk of insolvency in 2015. The models (Table 1) evaluated the other five as safe. His conclusions emphasise the importance of considering industry-specific criteria and a volatile economic environment when evaluating a company's financial standing. He also suggested that the mere popularity of a model among researchers should not be identified with its reliability.

Boratyńska and Yafremava (2023) analysed ten automotive companies between 2018 and 2021. Their study aimed to verify the performance of discriminative models in evaluating insolvency risk during the COVID-19 pandemic. They employed selected insolvency prediction models designed in Poland (Table 1). The results were somewhat divergent. Wierzbza's model and IE PAS's (Institute of Economics, Polish Academy of Sciences) model F did not identify any risk of insolvency for the companies. On the other hand, the other five models suggested a risk of insolvency from 2018 to 2021. The discrepancy was reflected in the conclusions, where the authors suggested the necessity to apply multiple discriminant analysis models to improve diagnostic reliability. Furthermore, they considered the models to be well-aligned with the dynamic business conditions brought about by the COVID-19 pandemic.

In his study of the financial standing of enterprises in special economic zones in Poland, Pitera (2024) employed discriminative models, logistic regression models, and a creditworthiness assessment model (Table 1). The study period was from 2015 to 2021. None of the investigated companies exhibited poor financial standing between 2015 and 2019. A potential business risk was found only in 2020–2021. Additionally, outcomes of the ratio analysis and modified bank risk scoring were consistent over the investigated periods. The author summarised the overall financial standing of the enterprises as good but clearly affected by the COVID-19 pandemic in 2020 and 2021.

In summary, studies often offer divergent results depending on the discriminant analysis model employed. Therefore, multiple models should be used for improved diagnostic reliability. In general, the financial standing of automotive companies during the period of interest (2015-2021) was good, with a downturn and increased insolvency risk between 2020 and 2021, which could be attributed to the COVID-19 pandemic.

The literature review has identified a research gap in the design and application of models specifically tailored to the automotive industry. According to what was established by conducting a literature review, there are no clear studies relating to the analysis and assessment of the financial condition of companies making up the WIG Automotive index to the extent proposed in this study. This could be a path worth following in future research.

3. Methods

The present study employs such research methods and tools as literature review, analysis of financial data from 2019–2023 financial statements of the companies, and selected statistical methods. We selected four automotive companies listed on the Warsaw Stock Exchange that conduct operations in Poland: AC SA, Auto Partner SA, Inter Cars SA, and Sanok Rubber Company SA. The selection was guided by the following inclusion criteria:

- companies listed on the Warsaw Stock Exchange,
- 2019-2023 financial statement available,
- automotive companies.

The sample consisted of automotive industry enterprises with an established market position in Poland, allowing for the reduction of external influences unrelated to the COVID-19 pandemic and thus enabling a more precise assessment of its impact on corporate performance.

We juxtaposed the financial data to conduct a comparative analysis of the selected automotive companies.

Discriminant analysis can be used to evaluate the risk of insolvency. It involves a proper selection and analysis of a set of financial ratios (such as liquidity, profitability, and debt). This way, a model can be designed for forecasting company insolvency (Boratyńska, Yafremava, 2023, p. 277). E.I. Altman is the pioneer of discriminant analysis research and its application in economics and finance (Altman, 1968, pp. 589-609). The primary role of discriminant analysis is to evaluate the economic and financial standing of companies and identify signs of an increasing risk of insolvency (and financial deterioration) (Wysocki, Kozera, 2012, pp. 167-182). Discriminant analysis is particularly useful in the context of the automotive industry. It can help enterprises that operate in difficult market conditions through early detection of threats, facilitating timely response (Boratyńska, Yafremava, 2023, p. 276).

The study employs five models of multivariate discriminant analysis that are the most common in the literature: the model by D. Hadasik, the IE PAS Z6 and Z7 models by E. Mączyńska and M. Zawadzki, D. Wierzba's model, and the Poznań model by Mirosław Hamrol, Bartłomiej Czajka, and Maciej Piechocki. Each model was verified in terms of its accuracy in the economic and financial evaluation of enterprises. We measured the models' performance with percentages: Hadasik 95.08%, IE PAS Z6 94.2%, IE PAS Z7 93.78%,

Wierzba 94%, and ‘Poznań’ 93.78% (Żurakowska-Sawa, Hodun, 2012, pp. 165-170). Each model is assigned a value for assessing the financial standing of the enterprise. The value, referred to as the threshold, was defined by the authors of each model. In the case of the selected discriminant analysis models, it is (Hadasik, 1998; Mączyńska, 2004). Table 3 summarises the equations of the discriminant analysis models selected for the analysis.

Table 3.
Polish discriminant analysis models used in the study

Models	Equation	Indicators
Hadasik (1998)	$Z_H = 2.36261 + 0.365425A_1 - 0.765526A_2 - 2.40435A_3 + 1.59079A_4 + 0.00230258A_5 - 0.0127826A_6$	A_1 = current assets / current liabilities, A_2 = (current assets – inventories) / current liabilities, A_3 = total liabilities / total assets, A_4 = (current assets – short-term liabilities) / total liabilities, A_5 = receivables / sales revenues, A_6 = inventory / sales revenue
Poznań (Hamrol, Czajka, Piechocki, 2004)	$Z_{POZ} = 3.562A_1 + 1.588A_2 + 4.288A_3 + 6.719A_4 - 2.368$	A_1 = net financial income or loss / total assets, A_2 = (current assets – inventories) / short-term liabilities, A_3 = capital employed / total assets, A_4 = sales results / sales revenue
Wierzba (2000)	$Z_W = 3.26A_1 + 2.16A_2 + 0.3A_3 + 0.69A_4$	A_1 = (operating profit – depreciation) / total assets, A_2 = (operating profit – depreciation) / product sales, A_3 = current assets / total liabilities, A_4 = working capital / total assets
IE PAS Z6 (Mączyńska, Zawadzki, 2004) (Żurakowska-Sawa, Hodun, 2012)	$Z_{(6\ IE\ PAS)} = 9.478A_1 + 3.613A_2 + 3.246A_3 + 0.455A_4 + 0.802A_5 - 2.478$	A_1 = EBIT / assets, A_2 = equity / assets, A_3 = (net result + depreciation) / total liabilities, A_4 = current assets / short-term liabilities, A_5 = sales income / total assets
IE PAS Z7 (Mączyńska, Zawadzki, 2004) (Żurakowska-Sawa, Hodun, 2012)	$Z_{(7\ IE\ PAS)} = 9.498A_1 + 3.566A_2 + 2.903A_3 + 0.452A_4 - 1.4987$	A_1 = EBIT / assets, A_2 = equity / assets, A_3 = (net result + depreciation) / total liabilities, A_4 = current assets / short-term liabilities

Source: original work based on the literature review.

The selection of models was based on their well-documented high predictive reliability in the literature and their consistency with the operating conditions of Polish enterprises, which was particularly important given that the study focused on firms operating in Poland.

The study additionally analyses the three liquidity ratios and three profitability ratios. The period of interest spans 2019–2023, reflecting the situation of the selected companies during the COVID-19 pandemic and the war in Ukraine.

There are three primary profitability ratios that are central to correct financial analysis. They can evaluate the enterprise's performance in various domains. These are return on assets (ROA), which reflects the enterprise's capacity to generate profits with its resources; return on equity (ROE), which reflects how well owners' contributions are multiplied; and return on sales (ROS), which specifies what part of sales profits are converted into net profit. These indicators

help evaluate whether the operations are profitable and verify the financial performance of the company (Rutkowska-Ziarko, 2015).

The primary liquidity ratios include cash ratio (CR), quick ratio (QR), and current ratio (CR). The literature does not provide explicit values of liquidity ratios. Therefore, it is not possible to determine their universal level (Stickney, 2009; Bragg, 2012). Table 4 summarises the equations for the selected ratios with proposed optimum values (liquidity ratios).

Table 4.
Selected profitability and liquidity ratios

Ratio	Formula	Interpretation
Return on equity (ROE)	$\frac{\text{zysk netto}}{\text{kapitał własny}}$	The rate of return on the company's employed equity.
Return on assets (ROA)	$\frac{\text{zysk netto}}{\text{aktywa ogółem}}$	The efficiency of a company's use of assets to generate earnings.
Return on sales (ROS)	$\frac{\text{zysk netto}}{\text{sprzedaż netto}}$	Profit derived from sales.
Cash ratio (C _{SHR})	$\frac{\text{aktywa obrotowe} - \text{zapasy} - \text{krótkoterminowe rozliczenia międzyokresowe} - \text{należności krótkoterminowe}}{\text{zobowiązania krótkoterminowe}}$	Optimum value: 0.2 (Soliwoda, 2011)
Quick ratio (QR)	$\frac{\text{aktywa obrotowe} - \text{zapasy} - \text{krótkoterminowe rozliczenia międzyokresowe}}{\text{zobowiązania krótkoterminowe}}$	Optimum value: 1.0-1.2 (Dresler, Czekaj, 2008)
Current ratio (CR)	$\frac{\text{aktywa obrotowe}}{\text{zobowiązania krótkoterminowe}}$	Optimum value: 1.5-2.0 (Soliwoda, 2011)

Source: original work based on: Bragg, 2012; Kuciński, 2023; Subramanyam, 2014; Mao, 2023; Akyüz, Bilgiç, 2016; Higgins, 2012; Golas, Witczyk, 2010; Tokarski, Tokarski, 2001; Śpiewak, 2014.

A proper liquidity level is essential for business continuity (and constant growth). Profits are the main source of asset and capital growth. High profitability and adequate liquidity are among the primary objectives of corporate finance management. Any associations between liquidity and profitability can only be analysed if a suitable approach is employed. The challenge is to try to reconcile two opposing objectives: to maximise value for owners and minimise the risk of liquidity crisis (Kuciński, 2018).

We investigated the associations between profitability and liquidity ratios using the Pearson correlation coefficient.

4. Results

Table 5 summarises the values of the results of the selected discriminant analysis models for the companies of interest from 2019 to 2021. Values below the model's threshold are displayed against a grey background.

Table 5.*Results of selected discriminant analysis models for the companies in 2019–2023*

Items	H 2019	H 2020	H 2021	H 2022	H 2023
ACAUTOGAZ	2.326	2.332	2.393	2.687	2.341
AUTOPARTN	2.595	2.799	2.552	2.556	2.654
INTERCARS	1.713	2.180	2.053	2.032	1.982
SANOK	1.392	1.239	1.456	1.680	1.656
	Z6_2019	Z6_2020	Z6_2021	Z6_2022	Z6_2023
ACAUTOGAZ	1.382	6.122	5.168	8.195	5.269
AUTOPARTN	0.157	6.005	5.391	4.956	5.439
INTERCARS	-0.757	3.868	4.172	3.775	3.555
SANOK	-1.765	1.802	2.210	2.999	3.477
	Z7_2019	Z7_2020	Z7_2021	Z7_2022	Z7_2023
ACAUTOGAZ	7.691	6.017	5.075	7.706	5.051
AUTOPARTN	3.367	5.105	4.700	4.345	4.630
INTERCARS	2.377	3.178	3.472	3.123	2.885
SANOK	2.073	1.909	2.088	2.766	3.191
	POZ_2019	POZ_2020	POZ_2021	POZ_2022	POZ_2023
ACAUTOGAZ	3.426	3.153	2.664	3.933	2.952
AUTOPARTN	1.555	2.551	2.414	2.221	2.569
INTERCARS	1.436	2.019	2.143	1.908	1.921
SANOK	1.735	1.502	1.490	2.463	2.540
	W_2019	W_2020	W_2021	W_2022	W_2023
ACAUTOGAZ	1.056	0.704	0.556	0.631	0.283
AUTOPARTN	0.536	0.802	0.788	0.669	0.471
INTERCARS	-0.006	0.241	0.624	0.530	0.193
SANOK	-0.128	-0.093	-0.083	0.021	0.074

* Column titles consist of abbreviated model name (H – Hadasik, Z6 – IE PAS Z6, Z7 – IE PAS Z7, POZ – Poznań, W – Wierzbą) and the reference year.

Source: original work based on the financial statements of the companies

All companies exceeded the thresholds for three models (Hadasik, IE PAS Z7, and Poznań). These models established that the companies were in good financial standing.

Note two models that identified financial issues in two cases (Inter Cars SA and Sanok Rubber Company SA). IE PAS Z6's result for Inter Cars SA was -0.757 in 2019. Still, the next year saw a substantial improvement with 3.868. The company managed to preserve financial stability in consecutive years of the period, with results above the threshold from 2020 to 2023. These results clearly exceeded the threshold, and the company was in a safe zone despite the difficulties. Sanok Rubber Company SA went through some financial troubles in 2019, as evidenced by the result below the threshold (-1.765). Its situation improved in 2020 with 1.802 and high results in consecutive years. Later, both firms continued to reach model indicator values above the threshold, with much improved financial standings.

Inter Cars SA reached -0.006 in 2019, failing to achieve the threshold value, which indicates a risk of insolvency. It improved to 0.241 in 2020, reflecting a retreat from the risk zone. In 2021, it grew to 0.624. The result of 0.530 in 2022 indicates a secure position above the threshold; however, the decline to 0.193 in 2023 means the standing deteriorated and requires monitoring. Sanok Rubber Company SA was also below the threshold in 2019 (-0.128), risking insolvency (degrading financial standing). Poor results in 2020 and 2021

(−0.093 and −0.083, respectively) demonstrate a persistent risk of insolvency. In 2022, the situation improved to 0.021. Continued growth to 0.074 in 2023 confirms improving standing.

Both companies singled out by the models (Inter Cars SA and Sanok Rubber Company SA) were listed on the Warsaw Stock Exchange between 2019 and 2023 and were not excluded from the WIG Automotive index. The negative results of the discriminant analysis can be interpreted as indicating a deteriorating financial standing in the period of interest; however, the other models did not identify the companies' conditions as poor.

Table 6 summarises the association between values of the liquidity ratios and profitability ratios for the selected companies. The statistical technique is the Pearson correlation coefficient.

Table 6.
Pearson correlation coefficient

Company/indicator	ROE	ROA	ROS	CR	QR
ACAUTOGAZ					
ROA	0.990**				
ROS	0.807	0.811			
C _{SHR}	0.391	0.372	0.413		
QR	−0.544	−0.485	−0.678	−0.868	
CR	−0.196	−0.078	−0.400	−0.367	0.725
AUTOPARTN					
ROA	0.956**				
ROS	0.995***	0.962**			
C _{SHR}	−0.930*	−0.866	−0.922*		
QR	0.103	0.261	0.145	−0.339	
CR	−0.584	−0.369	−0.543	0.420	0.705
INTERCARS					
ROA	0.994***				
ROS	0.995***	0.999**			
C _{SHR}	−0.258	−0.169	−0.163		
QR	0.107	0.179	0.167	0.456	
CR	−0.302	−0.197	−0.207	0.917*	0.566
SANOK					
ROA	0.979**				
ROS	0.506	0.630			
C _{SHR}	0.901*	0.946*	0.824		
QR	0.846	0.832	0.591	0.881*	
CR	0.778	0.781	0.477	0.787	0.952*

Statistical significance levels: *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001.

Source: original work based on the financial statements of the companies.

AC SA (ACAUTOGAZ) exhibits a very strong positive correlation between return on assets and return on equity of 0.990. This correlation indicates effective use of assets, leading to a high return on equity. The correlation between quick ratio and return on equity is −0.544. Although not statistically significant, the association may suggest that AC SA achieves lower liquidity at a higher return on equity. It may be due to more asset investments or higher short-term liabilities, which may curb liquidity.

Auto Partner SA shows a very strong positive correlation between return on assets and return on equity of 0.956. This means that effective use of assets contributes to a better return on equity, reflecting proper asset management towards greater value for owners and investors. The correlation between return on sales and return on equity is 0.995, which is a high value. This shows that return on sales directly affects return on equity. The correlation between cash ratio and return on equity is -0.930 , which is a strong negative relationship. An increased return on assets suggests lower liquidity, indicating that Auto Partner SA tends to invest in assets rather than hold cash.

The correlation between return on assets and return on equity for Inter Cars SA is 0.994, revealing a strong positive association. Hence, an increase in return on assets is conducive to better return on equity. This could suggest that the company effectively utilises its assets to boost profits at the equity level. The correlation between return on sales and return on equity is 0.995. This value also indicates a very strong positive link. This means that a higher return on sales is associated with a better return on equity, suggesting that the company achieves higher sales profits, leading to a more effective use of equity.

Sanok Rubber Company SA reached a correlation between return on assets and return on equity of 0.979, which is a strong positive value. This demonstrates that the company effectively manages its assets, driving a higher return on equity. The high correlation suggests that the company effectively puts its assets to work, generating profits at the level of equity. The correlation between cash ratio and return on equity is 0.901, which is a strong positive vector. High liquidity can enable the company to manage its capital more effectively and generate higher profits by utilising its resources.

The correlations between return on assets and return on equity are very strong for all companies, which may indicate that return on assets has a significant impact on return on equity. Therefore, companies that utilise their assets effectively tend to generate higher profits. In most examples, return on sales tends to be strongly positively correlated with return on equity, emphasising the role of operational efficiency in pursuing high return on equity. High return on sales may indicate a good organisation and competitive position. Liquidity metrics (cash ratio and quick ratio) exhibit inconsistent relationships with return on equity.

5. Discussion

The present results on the impact of the COVID-19 pandemic on the automotive industry display certain similarities and differences when compared to reports by other researchers. It is safe to say that the present study is more optimistic, as the general standings were good and there were no significant negative signs from the companies during the pandemic. According to the results from Hadasik's model, IE PAS's Z7 model, and the Poznań model,

not a single company reached a result below the threshold during the COVID-19 pandemic. The IE PAS's Z6 and Wierzba's models warned of poor standings for two companies.

Referring to the studies conducted by Pitera R., as cited in the literature review, it is evident that in 2015-2019 of the analyzed enterprises, including those operating in the automotive industry, exhibited poor financial condition. According to Pitera R., a potential threat to business continuity emerged in the years 2020-2021, which, in the author's view, confirms the observable impact of the COVID-19 pandemic, whose adverse effects materialized during that period. The findings obtained by the authors of the present study likewise indicate the emergence of early warning signals during the COVID-19 pandemic, as evidenced by the outcomes produced by certain predictive models.

Referring to the findings reported by Boratyńska K. and Yafremava K., as cited in the literature review, their results reveal notable discrepancies, as some of the applied models did not indicate bankruptcy risk among the analyzed entities, whereas other models employed in the study suggested that the enterprises were exposed to insolvency risk in 2018-2021. In light of these inconsistencies, the authors emphasized the necessity of applying multiple models in order to enhance the reliability of the diagnostic assessment. This conclusion is consistent with the findings obtained by the authors of the present study.

Boratyńska, Yafremava, and Pitera identified a deteriorated standing or threats to the financial standings of their analysed companies in 2020-2021.

The present study confirms hypothesis H1 that discriminant analysis models can effectively support the evaluation of financial standing and forecast insolvency risk in stable and unstable circumstances.

The conclusions from the present study align with the findings of other researchers regarding the general performance of discriminant analysis models in evaluating financial standing. Another common observation is that different models can yield divergent results. It is evident in the present study as IE PAS's Z6 and Wierzba's models warned of the risk of insolvency, while other models did not. This directly corroborates Boratyńska and Yafremava's conclusion that diagnostic reliability is improved by using multiple models. Therefore, the models are not only useful but also distinct in their characteristics.

The original study presented a unique analysis of the associations between profitability and liquidity in the automotive industry, highlighting their complexity and ambiguity. Therefore, the second hypothesis, H2, that there is an association between liquidity and profitability of the investigated companies over the period of interest cannot be fully confirmed.

6. Conclusions

The financial analyses and application of predictive models have yielded several relevant conclusions regarding the financial standing of the four WIG Automotive companies between 2019 and 2023.

The study analysed the financial standing of four automotive companies in Poland using five Polish discriminant analysis models. The results must not be generalised for the entire industry due to purposive sampling.

According to Hadasik's model, IE PAS's Z7 model, and the Poznań model, not a single company reached a result below the threshold during the COVID-19 pandemic. The IE PAS's Z7 and Wierzba's models warned of poor standings in the case of two companies (Inter Cars SA and Sanok Rubber Company SA). Inter Cars SA scored slightly lower during COVID-19, but remained in the secure zone, and its situation was stable over time. Despite better results in the last years of the period, Sanok Rubber Company SA remained below the threshold for Wierzba's model most of the time, which suggests that its position has to be monitored. Being more conservative, Wierzba's model can demonstrate stronger responses to poorer results. No increase in the number of negative discriminative model values occurred during the COVID-19 pandemic.

All the companies were in good or very good standing in the period of analysis. AC SA and Auto Partner SA fared the best. Inter Cars SA managed to maintain a steady financial standing despite lower results in recent years, which may be due to cost pressures or market limitations. Although Sanok Rubber Company SA has to be monitored, its better results for 2022-2023 promise a positive change and potential for future improvement. The analysis shows that discriminant analysis models can effectively support the evaluation of financial standing and forecast insolvency risk, especially during market disruptions, such as the COVID-19 pandemic. Together with traditional profitability measures, liquidity metrics, and correlation analysis, the models can offer a comprehensive assessment of a company's financial standing and identify potential risk areas.

The analysis of associations using the Pearson correlation coefficient has confirmed very strong positive correlations between return on assets and return on equity in all the investigated companies, suggesting that return on assets is a critical factor for achieving a high return on equity. The relationships between return on sales and return on equity were equally strong. This confirms the impact of operational effectiveness on the financial result. The relationships between liquidity and profitability were less clear. In some cases, there were significant negative correlations (such as those for Auto Partner SA and Inter Cars SA), suggesting a preference for investments over maintaining high liquidity. However, the correlations were positive for Sanok Rubber Company SA, indicating a more balanced financial strategy where

high fluidity does not disturb profitability. AC SA had a negative correlation between liquidity and profitability, which may suggest a more risky approach to working capital management.

Most of the discriminant analyses unambiguously assess their diagnostic reliability for the models. The study has confirmed the first research hypothesis (H1), which posits that discriminant analysis models accurately reflect a company's financial standing under both stable and unstable economic conditions in the country. This conclusion may be regarded as a practical implication of the present research. The findings concerning the association between liquidity and profitability for the companies tested with the Pearson correlation coefficient failed to identify a single relationship between the two groups of metrics. Therefore, the other hypothesis (H2) regarding an association between liquidity and profitability for the companies in the period of interest cannot be confirmed. The observed negative correlations between liquidity and profitability may also be examined within the framework of working capital management theory. The relationship between financial liquidity and profitability may depend on a firm's adopted strategy and its market position, which provides a potential interpretative context for the negative correlations identified in the study.

Another worthwhile aspect would be to discuss and apply international automotive insolvency prediction models to compare their outputs with those of the Polish models. A further challenge could be to build models insensitive to volatile economic environments and black swans (such as the COVID-19 pandemic).

The proposed research has application in the area of analysis and evaluation of companies from the WIG Automotive index during the pandemic crisis (2019-2023). The financial condition assessment of selected companies provides insight into the automotive industry's response from a capital market perspective. The presented results can be used by investors who wish to invest in the indicated sector index and are interested in assessing the resilience of these companies to crisis shocks. Furthermore, the presented research can be used for further comparative sectoral analyses and can support the formulation of economic policy.

The conducted research and its conclusions provide new knowledge about the functioning of companies on the Warsaw Stock Exchange, with particular emphasis on their financial condition during the economic crisis caused by the COVID-19 pandemic. An additional element of the research is the verification of the suitability of selected discriminant analysis models for assessing the financial situation of selected entities. The conducted research allowed for the assessment and identification of companies in terms of their resilience to the emerging crisis. The research contributes knowledge about the financial indicators used and the analysis of companies in the automotive sector during the pandemic.

Like all studies, this one also has certain limitations. Due to limited data availability, the study only considered the period during and after the COVID-19 pandemic, when the Polish economy was grappling with the impact of the pandemic crisis. This implies the need for future research, supplemented by additional years. Furthermore, the study was limited to selected companies that make up a specific index on the Warsaw Stock Exchange, meaning the research

should not be generalized. It should be noted that the presented research is based on the analysis of secondary data (primarily financial data with a lack of a qualitative perspective), and its quality may depend on the accounting standards of individual companies. In addition, such a restricted temporal scope reduces the statistical power of the correlation analysis between financial liquidity and profitability, as well as the stability of the Pearson correlation coefficients. As a result, it is not possible to unequivocally confirm the second research hypothesis (H2) concerning the existence of a relationship between liquidity and profitability among the analyzed entities.

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**THE EFFECT OF IPO UNDERPRICING ON THE REACTIONS
OF CAPITAL MARKET INVESTORS:
A STUDY OF THE WARSAW STOCK EXCHANGE –
RESEARCH RESULTS FOR THE PERIOD 2013-2023**

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Purpose: The aim of the article is to investigate and disclose the presence of underpricing in the initial public offering (IPO) prices of companies listed on the Warsaw Stock Exchange over the period 2013-2023. Furthermore, the study aims to analyze the post-IPO stock price performance of these companies over three- and six-month periods following their initial listing.

Design/methodology/approach: The scientific objective of the article is pursued through a meticulous review of the existing literature. Furthermore, to examine the underpricing of initial public offerings (IPOs), the study employs the ordinary least squares (OLS) method and linear regression analysis, incorporating explanatory variables, such as the subscription reduction rate, offer value, changes in the WIG index, and the risk-free interest rate. Additionally, Parkinson's extreme value measure is applied to estimate the uncertainty risk on the IPO listing day.

Findings: The results of empirical analyses conducted in this study indicate that the most significant determinants of the examined phenomenon are factors related to information asymmetry, followed—though to a lesser extent—by behavioral factors and those associated with ownership and control structures.

Research limitations/implications: The analysis is based on a limited sample of companies conducting public offerings, which may introduce a degree of bias due to the deterministic approach employed in the sample selection process.

Practical implications: Knowledge about the stock price changes of companies following underpriced equity offerings is highly important for both investors and fund managers.

Social implications: Among the social implications of this article, the most significant appears to be a potential shift in investors' attitudes toward participation in public offerings, alongside an improved understanding of stock price behavior during the initial months of trading.

Originality/value: A novel contribution of this study is the analysis of stock price changes of companies conducting equity offerings at underpriced levels over three- and six-month periods following their initial listing. Moreover, the research incorporates a current timeframe, covering equity offerings from 2013 to 2023, including the period of heightened volatility caused by the global COVID-19 pandemic.

Keywords: initial public offering (IPO), investor, underpricing, investment portfolio.

Category of the paper: Research paper.

1. Introduction

Investors operating in the financial market most commonly include shares of domestic or foreign issuers among the components of their investment portfolios, aiming, on the one hand, to achieve high rates of return, and, on the other, to protect themselves against a real decline in the value of their accumulated capital. Investments in shares of issuers can be made both on the secondary market and at the time of the company's public offering, that is, on the primary market. The introduction of shares to trading is one of the common methods by which companies raise capital. However, observations indicate that instead of maximizing the raised capital by setting the issue price of shares at a level adequate to their true value—known by the management and owners of the company based on conducted valuations—shares are often issued at prices lower than those determined by the market. This phenomenon, known as underpricing of initial public offerings (IPOs), has been observed by many researchers across various markets. According to some scholars, this phenomenon is caused by information asymmetry among different parties interested in the offering (Rock, 1986, p. 206). Other authors, such as M.J. Brennan and J.R. Franks (Brennan, Franks, 1997, p. 412), argue that it may be driven by managers seeking to retain control over the company or intentionally ceding part of it to investors (Stoughton, Zechner, 1998, p. 74). Another potential cause of this phenomenon is the behavior of entrepreneurs who make investment decisions based on irrational premises (Kahneman, Tversky, 1979, pp. 274-280; Welch, 1992, p. 695; Ljungqvist, Nanda, Singh, 2004, p. 1669). In some cases, this issue can also be attributed to institutional conditions prevailing in a given country at the time of the debut (Tinic, 1988, p. 797; Rydqvist, 1997, p. 296). However, these theories can be considered inadequate for the studied market due to the absence of conditions which, according to these theories, could justify issuing shares at a price lower than the market value.

The aim of this article is to investigate the causes of the occurrence of this phenomenon on the Warsaw Stock Exchange during the period 2013–2023, to identify which group of theories explaining the phenomenon is most applicable to this market, and to reveal the impact of IPO underpricing on the stock price performance of these companies over three- and six-month periods following their share issuance.

The research scope covers companies that conducted their initial public offerings on the Warsaw Stock Exchange between 2013 and 2023, excluding those whose listings were transferred from the NewConnect Market. These were excluded because they were already present in the trading system, and therefore more information was available about them compared to other companies. Ultimately, the study considered a sample of 80 companies. The analysis was conducted using multiple regression. Following the approach of previous researchers (Sieradzki, 2019, pp. 148-163), various variables associated with different groups of theories explaining IPO underpricing were selected to investigate the causes of this

phenomenon. Additionally, to examine the impact of IPO underpricing on stock performance over three- and six-month periods, linear regression was employed with three control variables included to ensure model accuracy, although these variables were not subject to further interpretation.

It is worth noting that the examined phenomenon has already been analyzed by selected authors for the periods 2003-2013 (Sieradzki, 2019) and 2005-2016 (Pomykalski, Filipiak, 2020). However, these studies did not cover the period of heightened volatility in capital markets caused by the global COVID-19 pandemic, which in turn led to the emergence of another speculative bubble¹. Additionally, they did not consider the impact of IPO underpricing on the stock price performance of these companies over three- and six-month periods following their initial listing.

2. Literature review and research hypotheses development

Underpricing of initial public offerings (IPOs) is a phenomenon that has been extensively studied through various approaches. Within this body of research, four main groups of theories have emerged to explain the phenomenon (Ljungqvist, 2005, p. 378): information asymmetry, ownership and control, institutional settings, and behavioral theories, including aspects of investor psychology in capital markets (Ljungqvist, 2005; Plummer, 1995; Rock, 1986; Baron, 1982; Michaely, Shaw, 1994; Zaleśkiewicz, 2003; Zielonka, 2011), focusing on investors' behaviors and decisions, which are often irrational from the perspective of economic assumptions or stock market cycles (Kubiak, Skwarek 2021).

A rational investor primarily acts to maximize profits without succumbing to emotional influences or peer pressure, relying solely on information derived from rigorous financial analysis (so-called fundamental data) (Zaleśkiewicz, 2003, pp. 9-10). Moreover, research by Benartzi and Thaler (1995) indicates that investors frequently revise their portfolios excessively, thereby failing to treat investing as a long-term process. The authors emphasize that returns are a result of a combination of loss aversion and frequent performance evaluations, including portfolio rebalancing (Benartzi et al., 1995, pp. 73-92).

Such investor behavior, including loss aversion, manifests clearly in investments in companies conducting public offerings. Investors subscribing to a company's shares often sell them on the first trading day, aiming to profit from the period between subscription² and initial trading. The short-term investment horizon among shareholders is supported by studies

¹ As a result, the COVID-19-driven bull market led to an influx of individual investors into the stock market, who were focused on achieving above-average returns within a short time frame.

² Specifically, the date of allocation of shares to a given investor.

conducted by Thaler (1999), Nofsinger (2001), and Lea, Tarpy, and Webley (1987, cited in Zaleśkiewicz, 2003, p. 123), which show that most investors make financial decisions in an impatient and impulsive manner, disliking long waits for profits. Investors behave this way even when it results in lower returns than could be obtained with a longer-term perspective. Participation in new share offerings thus facilitates the realization of such investor traits and attitudes. This also applies to the demand generated by investors during an initial public offering (Gemra, Kwestarz, 2024). Additionally, it has been noted that investors are often impulsive, lack self-control, and struggle with delaying financial gratification. Meanwhile, investing – especially long-term – requires patience and often prolonged waiting for a suitable moment to sell shares (see also Zaleśkiewicz, 2003, pp. 123-125). Furthermore, Kahneman and Tversky (1979, pp. 263-291) demonstrate through their studies that investors are influenced by the certainty effect, whereby they prefer a guaranteed gain rather than risk, even when the risk is small (see also Zaleśkiewicz, 2003, pp. 167-168).

On the other hand, information asymmetry theories assume that one party involved in the offering has more information about the true value of shares than others, profiting from issuing shares at a price lower than market value. The most well-known among these theories is the winner's curse (Rock, 1986, p. 206), which posits two types of investors— informed and uninformed. This theory assumes that the presence of both groups is necessary for market functioning. Informed investors know which IPOs are profitable, while the uninformed invest “blindly” in hopes of gains. When an IPO yields profits, uninformed investors receive a smaller share due to the larger number of participants. However, when it results in losses, they bear the full cost, leading to their discouragement. To retain these investors, shares are offered at a discounted price. Another theory in this category is Baron's model (Baron, 1982, p. 957), which attributes the phenomenon to the underwriter's role in setting the offer price. The underwriter charges a form of fee for lending their expertise and reputation during the IPO process, reflected in the form of underpriced shares. According to this theory, the degree of underpricing should be proportional to the underwriter's reputation.

Ownership and control theories posit that the reasons for issuing shares at undervalued prices are related to the company's ownership structure and control over it. Some researchers argue that IPO underpricing is motivated by the desire to maintain control over the company (Brennan, Franks, 1997, p. 412), while others suggest that the motivation is to diversify the ownership structure and obtain external oversight over the company's operations (Stoughton, Zechner, 1998, p. 74). These two theories developed independently, and their differences are explained by the underlying assumptions. Brennan and Franks' theory assumes proportional allocation of shares to all subscribing investors, whereas Stoughton and Zechner's theory assumes that a predetermined portion of shares is assigned to a single institution, enabling organized supervision by the investor. Institutional setting theories are based on the assumption that, due to legal or regulatory conditions, it may be more advantageous for a company to issue shares at undervalued prices. This could be intended to avoid lawsuits (Tinic, 1988, p. 797) or

to reduce tax liabilities (Rydqvist, 1997, p. 296). However, the conditions described by these theories were not present during the period and market under study, and thus they will not be considered in the current research. Behavioral theories suggest that the observed phenomenon is driven by irrational decisions made by groups of investors. One of the earliest researchers of crowd behavior was Gustave Le Bon (Le Bon, 1986, cited in Plummer, 1995, p. 11). Subsequent studies by S. Freud, C. Jung, and A. Koestler confirmed Le Bon's conclusions. Le Bon viewed the crowd as a psychological rather than a physical phenomenon. Such investors base their decisions not only on available rational premises but also on their own intuitions and the actions of other investors, leading to investment decisions that are difficult to understand or justify. This group includes the information cascade theory (Welch, 1992, p. 695), which assumes that each subsequent investor relies on the transactions of all previous investors, increasing the amount of available information but decreasing its accuracy, thereby leading to irrational decisions. Another theory in this category is the sentimental investor theory (Ljungqvist, Nanda, Singh, 2004, p. 1669), which postulates that investors make decisions based on their belief in a company's success, even if this belief is not supported by empirical evidence.

Based on the literature review and the identified research gaps, the following research hypotheses have been formulated:

H₁: There is no evidence of IPO underpricing on the Warsaw Stock Exchange.

H₂: A higher level of IPO underpricing has a negative impact on stock performance over three- and six-month periods following the debut.

3. Sample selection and methodology

For the purposes of achieving the article's objective, the study covered all companies that conducted their initial public offerings on the Main Market of the Warsaw Stock Exchange between 2013 and 2023, excluding those whose listings had been transferred from the NewConnect Market. These companies were excluded due to their prior presence in the trading system, which meant that more information was publicly available about them than about other firms. Ultimately, the sample consisted of 80 companies, namely: AATHOLD, ALLEGRO, ALTUSTFI, ALUMETAL, ANSWEAR, ARCHICOM, ARTIFEX, ATAL, AUTOPARTN, BIGCHEESE, BIK, BOOMBIT, CAPTORTX, CAVATINA, CDRL, CLNPHARMA, CPGROUP, DADELO, DEKPOL, DINOPL, ENERGA, ENTER, FEERUM, GAMEOPS, GAMFACTOR, GETBACK, GPRE, GRUPRACUJ, HUUUGE, I2DEV, IDEABANK, INPOST, KRKGL, KRVITAMIN, LIVECHAT, LOKUM, MASTERPHA, MAXCOM, MERCATOR, MFO, MLPGROUP, MLSYSTEM, MURAPOL, NANOGROUP, NEWAG, NOVATURAS, OAT, ONDE, OTLOG, PBKM, PCCROKITA, PCFGROUP, PCM, PEIXIN, PEKABEX, PEMANAGER, PEPCO, PHN, PKPCARGO, PLAY, PLAYWAY, POLTREG,

POLWAX, R22, SHOPER, SILVAIR-REGS, SKARBIEC, STELMET, STSHOLDING, TARCZYNSKI, TORPOL, TSGAMES, TXM, UNIWHEELS, VERCOM, VIGOSYS, VISTAL, WIRTUALNA, WITTCHEN, and XTB. These companies operate in the following sectors: finance, industrial and construction manufacturing, consumer goods, healthcare, trade and services, and technology. The authors note that the research covers an exceptionally specific period marked by the global SARS-CoV-2 pandemic, which had a significant impact on investor behavior as well as the number of share offerings conducted during that time.

The research was conducted in the following stages:

1. Stage one – Companies listed on the Warsaw Stock Exchange that conducted their initial public offerings during the period 2013–2023 were identified.
2. Stage two – The level of IPO underpricing was calculated for the selected companies' shares, adjusted for changes in the WIG index on the day of the debut.
3. Stage three – The reputation of brokerage houses responsible for the share offerings of the analyzed companies was assessed.
4. Stage four – The phenomenon of IPO underpricing was examined in relation to the stock performance three and six months after the date of the initial public offering.

The degree of underpricing of the selected companies' shares was determined as the rate of return from an investment made at the issue price and liquidated at the closing price on the first day of trading, in accordance with the following formula:

$$IR = \frac{P_t - P_e}{P_e} \quad (1)$$

where:

IR – interest rate,

P_e – emission price,

P_t – the price at the moment t .

To confirm the occurrence of the phenomenon in the examined market, the level of stock price underestimation was also calculated after adjusting for the change in the WIG index during the debut day. This aims to ensure that the phenomenon is not merely a result of overall market fluctuations and prevailing trends. This value was calculated using the following formula:

$$AIR = IR - \Delta WIG \quad (2)$$

where:

AIR – adjusted investment return,

IR – interest rate,

ΔWIG – change in the WIG index during the specified period.

An analysis of the phenomenon was also conducted from the perspective of brokerage houses representing companies as underwriters. This analysis aimed to verify the hypotheses proposed by researchers R. Michaely and W.H. Shaw (Michaely, Shaw, 1994, p. 295), who observed that the level of underpricing depends on the reputation of the brokerage house representing the company. Since the reputation of the institution in question is relevant to the phenomenon from this perspective, companies represented by the bank and those represented by the brokerage house affiliated with that bank were grouped together. This allowed for an increase in group size and thus enhanced the reliability of the study. Additionally, only organizations that served this role in at least four different IPOs during the period were considered. In cases where more than one organization performed this function, the three listed first in the prospectus were included. Ultimately, this approach yielded 59 data points. If a relationship between the level of the studied phenomenon and the reputation of the underwriter is observed, Baron's model can be considered an adequate explanation of the phenomenon in the Polish market.

An econometric model was used to investigate the causes of the studied phenomenon. The assessment of the adequacy of the given theory was based on the significance level of the corresponding variables determined through the Student's t-test. These variables are:

- The rate of subscription reduction in the individual investors' tranche, intended to simulate demand for shares among investors. This variable thus approximates the influence of information asymmetry theory on the studied phenomenon.
- The offer value, serving as an analogy for company size. Larger companies are expected to have more available information, which in theory should reduce information asymmetry. Therefore, a negative relationship between this variable and the dependent variable is anticipated.
- The level of free float, defined as the ratio of shares freely traded to the total number of shares. A high level may indicate that current investors, managers, and insiders lack confidence in the company's long-term success, leading them to sell their shares. The significance of this variable helps to assess the adequacy of ownership and control theories.
- Change in the WIG index level, included to determine the extent to which the studied phenomenon is influenced by overall market fluctuations.
- Turnover ratio, defined as the ratio of the value of shares traded on the IPO day to the offer value. It is used as an indicator of the number of investors purchasing shares with the intention of quick resale. Similar to the free float level, it measures the adequacy of ownership and control theories. A higher value of this variable indicates a greater managerial interest in diversifying company ownership and benefiting from investor oversight.
- The risk-free rate.

- The issue price.
- Parkinson's Extreme Value (PEV), successfully used by J. Knopf and J.L. Teall (Knopf, Teall, 1999, p. 53) to estimate uncertainty risk on the IPO day, calculated using the formula:

$$PEV = \ln \left(\frac{P_{dmax}}{P_{dmin}} \right) \quad (3)$$

where:

P_{dmax} – the maximum share price on the IPO day,

P_{dmin} – the minimum share price on the IPO day.

In this case, uncertainty is theoretically directly proportional to the level of information asymmetry between investors and the issuer, which allows this measure to be used for verifying the adequacy of theories from this group.

In the study of the impact of IPO underpricing on stock performance over 3- and 6-month periods, in addition to the explanatory variable, which is the previously calculated level of IR (Initial Return), control variables were used to ensure model accuracy; however, these variables were not subject to interpretation. The selected control variables are:

- Offer value, intended to simulate the size of the issuer and thus the amount of information available about it.
- The company's ROA (Return on Assets) ratio. This variable accounts for the company's success in its core operations, thereby improving the model's accuracy.
- The age of the company at the time of the IPO, which is intended to simulate the amount of knowledge investors may have about the company.

Including these variables allows for a comparison of the impact of individual factors on the company's performance with the effect of IPO underpricing. Analyses conducted by the aforementioned researchers suggest that a higher level of IPO underpricing should result in poorer stock performance; therefore, the relationship between them is expected to be negative.

In studying the influence of IPO underpricing on stock performance over three- and six-month periods, a linear regression was employed with three control variables intended to ensure model accuracy but not subject to further interpretation.

4. Analysis of IPO Underpricing of Companies Listed on the Warsaw Stock Exchange – Research Results for the Period 2013-2023

In order to calculate the underpricing of selected stocks and the underpricing adjusted for changes in the WIG index on the IPO day, stock offerings on the Warsaw Stock Exchange during the period 2013-2023 were analyzed. The means and medians of returns for the analyzed periods are presented in Table 1.

Table 1.*Average and Median Rates of Return for the Analyzed Periods*

Measure	IR			AIR		
Period	1D	3M	6M	1D	3M	6M
Mean	7,51%	12,79%	11,54%	7,49%	11,41%	8,39%
Median	2,18%	7,55%	12,14%	2,50%	8,54%	9,22%

Source: Own elaboration based on data published by the Warsaw Stock Exchange.

The data presented in Table 1 indicate the presence of underpricing in the initial public offerings (IPOs) of the analyzed companies. Regardless of the chosen measure (IR or AIR), stock returns on the first day (1D) and over the following periods of 3 months (3M) and 6 months (6M) were positive for companies conducting IPOs. In order to verify the role of the underwriter's reputation and to test the assumptions of Baron's model, an analysis was conducted of the reputation of brokerage houses and the level of IPO underpricing in offerings in which they participated. Significant variations were observed between more and less prominent institutions. A summary of brokerage houses, the average underpricing levels for IPOs in which they acted as underwriters, and the number of such IPOs is presented in Table 2.

Table 2.*Summary of the Average Level of IPO Underpricing for Companies Underwritten by a Given Brokerage House and the Number of IPOs in Which It Acted as Underwriter*

Brokerage House	Number of IPOs	Level of Underpricing
Dom Maklerski PKO Banku Polskiego	9	13,74%
Dom Maklerski Banku Ochrony Środowiska S.A.	5	3,53%
Trigon Dom Maklerski S.A.	17	7,35%
Dom Maklerski mBanku S.A.	10	7,05%
Pekao Investment Banking S.A.	4	5,29%
Ipopema S.A.	4	-5,65%
Vestor Dom Maklerski S.A.	4	2,74%
Bank Zachodni WBK S.A.	6	1,44%

Source: Own elaboration based on data published by the Warsaw Stock Exchange and the prospectuses of individual companies.

The data presented in Table 2 suggest that more prominent—and thus better-regarded—brokerage houses tend to underwrite IPOs with price underpricing levels that are closer to the overall average for the entire period. Due to the relatively small sample size and the long analysis period, the average IR values for each year were also considered and compared with the annual mean. Unfortunately, none of the brokerage houses acted as underwriter in every year of the analyzed time frame. This summary is presented in Table 3.

Table 3.*Average Levels of IPO Underpricing Achieved by Companies Represented by Specific Brokerage Houses Compared with the Average IPO Underpricing Level in the Respective Year*

Brokerage House	2013	2014	2015	2016	2017	2018	2020	2021
Dom Maklerski PKO Banku Polskiego	12,05%	3,38%	-0,91%	-	11,94%	-	62,79%	-
Dom Maklerski Banku Ochrony Środowiska S.A.	18,59%	-	-4,11%	2,29%	-	-	-	-1,43%
Trigon Dom Maklerski S.A.	22,11%	1,14%	-4,49%	2,98%	-	2,36%	18,88%	8,12%

Cont. table 3.

Dom Maklerski mBanku S.A.	-	1,71%	6,00%	5,50%	-	-	-	11,14%
Pekao Investment Banking S.A.	-	-	2,38%	-	-	-	-	8,19%
Ipopema S.A.	-	-	-2,12%	-	-	-	-	-9,17%
Vestor Dom Maklerski S.A.	-	-	-	0,00%	-5,26%	1,48%	-	-
Bank Zachodni WBK S.A.	-	-	-	8,18%	0,21%	-	-	-
Annual Average	10,80%	1,97%	2,52%	5,17%	1,94%	8,67%	43,88%	4,69%

Source: Own elaboration based on data published by the Warsaw Stock Exchange and the prospectuses of individual companies.

The calculations presented in Table 3 indicate that in none of the analyzed periods was Dom Maklerski Trigon closest to the average value, despite the fact that it was the most frequently chosen institution to participate in IPOs. The IPOs involving DM mBank, which was selected far less often, were much closer to this average. However, with few exceptions, the presented values seem to follow the trend set by the average of all offerings in a given year — when the average level increases compared to the previous year, the underpricing level of shares represented by DM Trigon also rises. The only noticeable exception to this trend occurred between 2017 and 2019, when values for this brokerage house decreased despite an increase in the annual average. A similar, though less pronounced, relationship can be observed for other popular brokerage houses: DM PKO BP, DM mBank, and DM BOŚ. Based on the data presented regarding brokerage houses, it can be concluded that the reputation of a brokerage house has a significant impact on the level of IPO underpricing. It appears that brokerage houses with the highest reputations strive to maintain a moderate level of returns from IPO stocks or at least to follow the overall market trend.

For the purpose of conducting the next stage of the research, an econometric model simulating the studied phenomenon was developed. The explanatory variables described in Chapter 3 were used. The resulting multiple regression model took the following form:

$$IR = 0,01398 + 0,06378 * RED - 0,11627 * FF - 0,72288 * \Delta WIG - 0,00302 * TRN - 0,79712 * RFR + 0,00003 * OV - 0,000167 * EP + 0,72565 * PEV \quad (4)$$

where:

RED – subscription reduction rate in the individual investors' tranche,

FF – free float level,

ΔWIG – change in the WIG index level during the IPO day,

TRN – turnover ratio,

RFR – reference rate of the National Bank of Poland,

OV – offering value,

EP – issue price,

PEV – Parkinson's extreme value.

The R^2 value of the obtained model was 0,2064, while the adjusted R^2 amounted to 0,117. These values are higher or comparable to those reported by P. Pomykalski and P. Filipiak (Pomykalski, Filipiak, 2020, p. 12). The correlation matrix of the variables is presented in Table 4.

Table 4.
Correlation Matrix of Variables Used in the IR Model

	IR	RED	FF	Δ WIG	TRN	RFR	OV	EP	PEV
IR	1								
RED	0,1757	1							
FF	-0,0766	0,12118	1						
Δ WIG	-0,0828	-0,2168	-0,1033	1					
TRN	-0,0817	-0,1688	-0,0913	0,02113	1				
RFR	-0,2077	-0,1347	-0,0001	0,11552	-0,0178	1			
OV	0,2848	0,12535	-0,0033	-0,1289	-0,0313	-0,213	1		
EP	0,0040	0,13162	0,08141	-0,1178	-0,0929	-0,1351	0,0859	1	
PEV	0,3016	-0,0223	-0,052	0,01303	0,2182	-0,3353	0,07995	-0,05	1

Source: Own elaboration based on data collected by the Warsaw Stock Exchange, contained in documents published by individual companies, and from the Stockwatch.pl service.

The model derived from equation (4) was subjected to a Student's t-test to verify the significance of individual variables. The results are presented in Table 5.

Table 5.
Significance Levels of Individual Explanatory Variables in the IR Model

Significance level	0,5	0,2	0,1	0,05	0,02	0,01
RED	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
FF	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Δ WIG	Nieistotne	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
TRN	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
RFR	Nieistotne	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant
EP	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
PEV	Significant	Significant	Significant	Significant	Not Significant	Not Significant

Source: Own elaboration based on data published by the Warsaw Stock Exchange, contained in documents released by individual companies, and from the Stockwatch.pl service.

The results presented in Table 5 indicate that some of the selected explanatory variables do not have a significant impact on the dependent variable. These variables include the change in the WIG index during the IPO day, the risk-free rate, and—surprisingly—the issue price. The most significant variables proved to be OV and PEV, both related to information asymmetry. To a lesser extent, TRN and FF, which correspond to ownership and control

theories, were also significant. The variables ΔWIG , RFR, and EP were found to be completely insignificant, indicating a very low adequacy of behavioral theories.

In the next and final stage of the research, two models were developed to explain whether the underpricing of the initial stock offering affects stock price behavior over longer time periods. Two separate models were created for this purpose, covering periods of three and six months from the date of the IPO. Both models are presented in equations (5) and (6):

$$ROI3M = 0,02363 + 1,17064 * IR + 1,00252 * ROA + 0,00001 * OV - 0,00096 * AGE \quad (5)$$

$$ROI6M = 0,0555 + 0,53527 * IR + 0,49356 * ROA - 0,0000004 * OV - 0,00011 * AGE \quad (6)$$

where:

ROI3M – rate of return on investment made at the issue price over a three-month horizon,

ROI6M – rate of return on investment made at the issue price over a six-month horizon,

IR – Instant return – level of IPO underpricing,

ROA – Return on assets,

OV – Offer Value – value of the initial public offering,

AGE – age of the company.

For equation (5), the R^2 value of the obtained model was 0,488, with an adjusted R^2 of 0,4607. Considering the complexity and number of factors affecting stock market performance, this value is satisfactory. The correlation matrix of the variables is presented in Table 6.

Table 6.
Correlation Matrix of Variables Used in the ROI3M

	ROI 3M	IR	ROA	OV	AGE
ROI 3M	1				
IR	0,67083	1			
ROA	0,27475	0,14693	1		
OV	0,22607	0,28483	-0,0674	1	
AGE	-0,02083	0,06722	-0,0512	0,01413	1

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

No variables were excluded from the model, despite some explanatory variables exhibiting higher correlations with other explanatory variables than with the dependent variable. This approach was taken because this phenomenon occurred only in the case of control variables, which are not subject to interpretation. The significance levels at which individual variables were found to be significant for the overall model are presented in Table 7.

Table 7.*Significance Levels of Control Variables and the Explanatory Variable in the ROI3M Model*

Significance level	0,5	0,2	0,1	0,05	0,02	0,01	0,005	0,002
IR	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
ROA	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AGE	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

The level of underpricing proved to be highly significant for stock performance, and the relationship between the variables was found to be positive. This contradicts the general interpretation of the phenomenon, according to which this relationship should be negative. Possible explanations for this discrepancy include poor selection of variables for the model or the specific characteristics of the market during the analyzed period.

For equation (6), the R^2 value of the model was 0,0914, while the adjusted R^2 amounted to 0,4629. A noticeable decrease in the coefficient linking IR to the dependent variable was observed, indicating at least a weakening of the relationship found in the previous model. A decline in both statistics was expected, as longer time horizons typically involve more influencing factors. The correlation matrix of the variables is presented in Table 8.

Table 8.*Correlation Matrix of Variables Used in the ROI6M*

	ROI 6M	IR	ROA	OV	AGE
ROI 6M	1				
IR	0,2579	1			
ROA	0,1880	0,1217	1		
OV	0,0556	0,2848	-0,0695	1	
AGE	0,0058	0,0643	-0,0283	0,0147	1

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

As in the previous model, the variables were not excluded despite strong indications to do so. The significance levels at which individual variables were found to be relevant to the overall model are presented in Table 9.

Table 9.*Significance Levels of Control Variables and the Explanatory Variable in the ROI6M*

Significance level	0,5	0,2	0,1	0,05	0,02	0,01
IR	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant
ROA	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AGE	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

In the period covered by the ROI6M model, in addition to a decline in the overall model's accuracy, the significance of the IR level also noticeably decreased. This drop in significance, combined with a reduced coefficient for this variable, suggests that in the longer term, the initial underpricing of a company's shares ceases to impact their performance, whereas in the short term, it supports price growth. This finding contradicts other studies, which indicate a negative effect of underpricing on a company's stock performance.

5. Discussion and conclusions

Underpricing of initial public offerings (IPOs) is a commonly observed phenomenon across various markets. This study applied multiple regression analysis to examine the causes of IPO underpricing on the Polish market over the period 2013-2023. The research confirmed the existence of IPO underpricing on the first day of trading, as well as after three and six months following a company's debut on the Warsaw Stock Exchange. It was also found that IPOs conducted and managed by more prominent financial institutions were characterized by levels of underpricing more closely aligned with the average for the entire period, with no significant deviations.

Given the aim of the study and the adopted hypotheses, it is worth noting that the theories best aligned with the Polish market are those related to information asymmetry, with behavioral theories, as well as ownership and control theories playing a lesser role. This implies that, in theory, the less information is available about a company, the higher the expected level of IPO underpricing. These findings are consistent with research conducted for other time periods (Sieradzki, 2019, p. 162).

The analysis is based on a limited sample of companies conducting public offerings, which may introduce a degree of bias due to the deterministic approach employed in the sample selection process.

Based on the research conducted, it is worth noting that a higher level of IPO underpricing is associated with better stock performance over three- and six-month horizons, which contradicts the findings of other researchers (Mohammed, Joyce, 2023, p. 65), who observed the opposite relationship.

Based on the conducted analysis, the adopted research hypotheses were verified, and it was concluded that:

H₁: The phenomenon of IPO underpricing is present on the Warsaw Stock Exchange.

This hypothesis has been fully confirmed.

H₂: A higher level of IPO underpricing has a negative impact on stock performance over a three-month period, but not necessarily over a six-month horizon. This hypothesis has been partially confirmed.

Knowledge about the stock price changes of companies following underpriced equity offerings is highly important for both investors and fund managers. Consequently, this understanding enables investors to make more informed investment decisions.

In examining the consequences of a high level of IPO underpricing on subsequent stock performance, the results obtained contrast with those of other researchers. It was shown that, over longer time horizons, the level of underpricing loses its significance in relation to stock returns, while in the shorter, three-month period, it even has a positive impact on performance.

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MANAGING THE ENERGY TRANSITION OF COAL REGIONS: A DELIBERATIVE-POLYCENTRIC MODEL. A CASE STUDY OF SILESIA

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Purpose: This article examines a deliberative-polycentric model as a managing model for energy transition of coal regions.

Design/methodology/approach: This study adopts a qualitative, interpretivist research design to investigate governance dynamics within the context of the energy transition in the Silesian region of Poland.

Findings: The study reveals that stakeholders in Silesia perceive the energy transition as a profound socio-economic and cultural shift rather than merely a technological or policy-driven process. Focus group results show a strong sense of uncertainty and identity-related loss among mining communities, accompanied by concerns over job security, inadequate retraining systems, and unequal distribution of transition-related benefits. Stakeholders consistently identified governance fragmentation, weak coordination between institutional levels, and insufficient communication as major barriers to a just transition. At the same time, the research uncovered a clear appetite for more inclusive, transparent, and participatory decision-making processes. Participants expressed support for deeper engagement of local governments, civil society, and SMEs, as well as the institutionalization of deliberative mechanisms such as citizen assemblies or multi-stakeholder forums. Although participants did not use the formal terminology of polycentric or deliberative governance, their expectations aligned strongly with both models—favouring decentralization, shared authority, and long-term dialogue as prerequisites for building trust, legitimacy, and social acceptance during the transition.

Originality/value: This study offers one of the first empirically grounded assessments of how deliberative and polycentric governance models are perceived by diverse stakeholders within a coal-dependent European region undergoing structural transformation. While existing literature often discusses these governance concepts in abstract terms, this research provides concrete, bottom-up insights into their applicability, feasibility, and perceived added value in the specific context of Silesia. By foregrounding lived experiences, power asymmetries, and local expectations, the study bridges a critical gap between theoretical governance models and real-world transition dynamics. It contributes original evidence on how governance innovations could enhance procedural and distributive justice in post-mining regions and informs policy design at regional, national, and EU levels. The findings offer practical guidance for building more legitimate, adaptive, and participatory frameworks capable of supporting socially just energy transitions in structurally dependent regions across Europe.

Keywords: energy transition, coal region, deliberative management, polycentric management, governance, Silesia region.

Category of the paper: research paper.

1. Introduction

The global energy landscape is undergoing a profound transformation driven by mounting environmental imperatives, geopolitical pressures, and socio-economic shifts (Rogala, 2020). Central to this transformation is the transition from carbon-intensive energy systems to low-carbon and renewable alternatives—a process that is not merely technological, but also deeply institutional and political in nature. The European Union's commitment to climate neutrality by 2050, articulated in the European Green Deal, reflects both a strategic and normative response to the climate crisis (European Commission, 2019). However, the implementation of this agenda presents challenges in regions historically dependent on fossil fuel extraction, where economic livelihoods, cultural identities, and governance structures are closely intertwined with carbon-intensive industries (European Commission, 2020).

One such region is Silesia, located in southern Poland, which for decades has functioned as the country's coal-mining core. In this context, the energy transition cannot be reduced to technological substitution or market liberalization alone (Bondaruk, 2019). Rather, it represents a far-reaching social transformation that raises pressing questions related to employment, regional development, and social justice (Kozłowski, 2022). The gradual phasing out of coal affects not only energy systems, but also deeply embedded institutional arrangements and community narratives, making Silesia a critical case for examining the governance of just transitions (Mazurkiewicz, 2019).

Recent academic and policy debates increasingly highlight the limitations of centralized, top-down, and technocratic governance approaches in managing such complex transitions (Anfinson et al., 2023). In response, growing attention has been directed toward alternative governance models that emphasize participation, decentralization, and multi-level coordination. Deliberative and polycentric governance frameworks have been proposed as promising approaches for steering energy transitions in ways that are both socially legitimate and context sensitive. Despite their growing prominence in literature, empirical evidence on how these governance models is perceived and operationalized in coal-dependent regions at the regional (meso) level remains limited.

The purpose of this paper is to examine the deliberative–polycentric model as a governance approach for managing the energy transition in coal-dependent regions, using Silesia (Poland) as an empirical case. The study is significant because the energy transition in coal regions is

not only a policy or technological shift, but also a socio-economic and cultural transformation that raises issues of procedural legitimacy, distributive fairness, and social acceptance.

Methodologically, the study adopts a qualitative, interpretivist research design. Empirical material was collected through three face-to-face focus group discussions conducted in December 2024, involving a total of 20 participants representing key stakeholder categories, including local and regional government, civil society organizations, trade unions, and academic or policy experts. Based on prior research, the study assumes that stakeholders will (H1) perceive existing transition governance arrangements as fragmented and insufficiently inclusive, and (H2) express support for more participatory, transparent, and multi-level decision-making structures consistent with deliberative–polycentric governance.

Although deliberative and polycentric governance models are increasingly discussed in the energy transition literature, there is a notable lack of empirical studies that systematically examine how diverse stakeholders in coal-dependent regions interpret, evaluate, and formulate expectations toward these governance approaches. Research focusing on stakeholder perspectives at the regional level in Silesia remains scarce. By providing bottom-up, stakeholder-centered empirical evidence, this paper addresses this research gap and contributes practical insights relevant for regional, national, and European-level transition policy design.

2. Literature Review and Research Gap

This section reviews the existing literature on deliberative and polycentric governance in the context of energy transitions, with particular attention to coal-dependent regions. To systematically assess the state of knowledge and identify research gaps, a preliminary scoping review was conducted, drawing on peer-reviewed studies from multidisciplinary academic databases. Contemporary debates on energy transitions increasingly emphasize the need to democratize decision-making processes and strengthen public participation across multiple levels of governance (Cook, 2000; Tarasova, 2024). The shift away from centralized, technocratic models toward more inclusive and decentralized approaches reflects growing recognition of the social, political, and distributive dimensions of decarbonization. Central to this perspective is the idea that citizens and local communities should play an active role in shaping transition pathways, an approach grounded in principles of procedural and distributive justice (Chambers, 2003). Deliberative democracy has emerged as a key theoretical framework for analyzing such participatory processes (Dryzek, 2008). Rather than limiting citizenship to formal electoral participation, deliberative models conceptualize democratic legitimacy as emerging from inclusive, reasoned, and open public dialogue (Fishkin, 2003; Dryzek, 2005). In contrast to technocratic governance—where expert knowledge often dominates decision-making—deliberative approaches emphasize transparency, mutual learning, and the integration

of diverse perspectives (Dryzek, 2001). In the context of energy transitions, deliberation is particularly relevant, as decisions regarding infrastructure, energy mixes, and fossil fuel phase-out have direct and uneven impacts on citizens' everyday lives (Chilvers, Kearnes, 2016).

Alongside deliberation, the concept of polycentric governance, which is most prominently associated with the work of Elinor Ostrom (2010)—has gained increasing attention in sustainability and energy transition research. Polycentric governance refers to systems characterized by multiple, interdependent centers of decision-making operating across local, regional, national, and international levels (Hobson, 2009). Such arrangements emphasize subsidiarity, flexibility, and context-sensitive policy design, recognizing the role of municipalities, civil society organizations, energy communities, and citizens as active governance actors.

Given the socio-technical complexity of energy systems, polycentric approaches are often considered more adaptive than monocentric governance models, which may struggle to respond to rapid technological change, institutional diversity, and local variation (Jenkins, 2016). By enabling experimentation, institutional diversity, and horizontal learning, polycentric governance is frequently associated with greater resilience and innovation in transition processes (McCarthy, 2011). An emerging body of scholarship argues that deliberative and polycentric governance approaches are most effective when combined into an integrated framework (Dryzek, 2005; Carcasson, Sprain, 2010). In such models, deliberation enhances inclusivity and legitimacy, while polycentric structures provide adaptability and responsiveness under conditions of uncertainty. This integration is increasingly linked to broader debates on transformative and energy justice, which extend beyond distributive outcomes to address power relations, recognition, and participation (Chilvers, Kearnes, 2016).

Closely related is the concept of energy citizenship, which frames citizens not merely as consumers but as co-producers, co-governors, and innovators within energy systems (Devine-Wright, 2007; Szulecki, 2018). From this perspective, energy transitions are understood as deeply political and social processes requiring new forms of engagement, responsibility, and institutional design.

Despite their normative appeal, deliberative and polycentric governance models face significant practical challenges. The literature identifies persistent power asymmetries, institutional fragmentation, and coordination problems as major barriers to inclusive energy governance (Avelino, 2017; Stirling, 2014). Decision-making authorities often remain concentrated among national governments, large energy corporations, or technocratic institutions, while local authorities, civil society groups, and marginalized communities have limited influence over strategic priorities and resource allocation. Institutional fragmentation further complicates governance arrangements, as energy policy is typically dispersed across multiple sectors and governance levels (Petrovics et al., 2023). While polycentric systems can enable flexibility, overlapping mandates and unclear accountability structures may undermine coordination and strategic coherence. Research increasingly highlights the need to understand

how formal coordination mechanisms (e.g. regulatory frameworks, planning bodies) interact with informal ones (e.g. networks, partnerships, personal relationships) in shaping transition outcomes (Jordan, Schout, 2006). Meaningful dialogue and co-decision-making are also constrained by time pressures, resource limitations, information asymmetries, and the risk of symbolic participation (Fung, 2006; Fishkin, 2010). Without adequate institutional support, deliberative processes may reinforce existing inequalities or lead to stakeholder fatigue rather than genuine empowerment.

Despite the growing literature on deliberative and polycentric governance in energy transitions, several important gaps remain. First, most studies focus on national policy frameworks, urban contexts, or retrospective analyses, while the regional (meso) level—particularly in coal-dependent regions—remains underexplored. Second, there is a lack of empirical research that systematically examines how diverse regional stakeholders perceive, interpret, and evaluate deliberative–polycentric governance arrangements during ongoing transition processes. According to the literature reviewed, there are no studies that directly report on stakeholder expectations toward deliberative and polycentric governance in the context of the energy transition in Silesia. This study addresses this gap by providing bottom-up, stakeholder-centered empirical evidence from a coal-dependent region undergoing structural transformation.

3. Methods

In response to the research gaps identified in the literature, this study adopts a qualitative, interpretivist research design aimed at capturing stakeholder perspectives on governance arrangements in the energy transition of the Silesian region in Poland. The aim of the study is to explore how diverse regional stakeholders perceive the relevance, feasibility, and potential of deliberative and polycentric governance models in supporting a socially just and inclusive energy transition. Rather than evaluating existing governance structures *ex post*, the study focuses on the prospects for their future application and on the conditions necessary for their successful implementation.

A qualitative approach was considered most appropriate due to its capacity to capture the complexity of institutional change, uncover pluralistic viewpoints, and generate context-sensitive insights into stakeholder perceptions, motivations, and power asymmetries. To inform the research design, a preliminary scoping review was conducted (results presented in Table 1), combining critical literature review techniques with structured searches of multidisciplinary academic databases, including Scopus and Google Scholar. Search terms included “energy transition”, “deliberative governance in regional energy transition”, and “polycentric

governance in regional energy transition”. The findings of this review informed both the conceptual framework and the methodological strategy of the study.

The analytical themes guiding the research were selected through a combination of deductive and inductive reasoning. Deductively, key thematic dimensions were derived from the literature on deliberative democracy, polycentric governance, and just energy transitions. These strands of research consistently emphasize issues such as stakeholder participation and inclusion, power asymmetries, institutional fragmentation, coordination mechanisms, and procedural justice. Inductively, these themes were further refined through an initial reading of the focus group material, allowing empirically salient issues to emerge from participants’ narratives. This combined approach ensured that the analytical framework was both theoretically grounded and empirically sensitive. The analytical themes also informed the structure of the focus group discussion guide and the thematic blocks.

Table 1.

A preliminary scoping review

Element	Description / Findings
Objective (Aim)	To identify and compare governance approaches for managing the energy transition in selected post-mining regions in Europe: Poland, Germany, Greece, and Bulgaria.
Research Question	What governance models (Concept) are applied in post-mining regions (Population) during the energy transition (Context)?
Search Strategy	Databases: Scopus, Web of Science. Keywords used: 'energy transition', 'polycentric governance', 'post-mining regions'. Language: English.
Inclusion/Exclusion Criteria	Included: Peer-reviewed articles addressing regional governance. Excluded: National-level only analyses or purely technical studies without governance focus.
Study Selection Process	Three-step process: 1) Title screening, 2) Abstract review, 3) Full-text analysis.
Data Extraction	Information collected: Author(s), publication year, country, governance model type, and key findings relevant to deliberative or polycentric governance.
Synthesis of Findings	- Germany: Strong literature on polycentric governance in the Ruhr and Lusatia regions; mostly retrospective. - Greece: Policy-driven coal phase-out with emerging local participation; supported by EU and EIB. - Bulgaria: Grassroots energy communities forming in coal regions; supported by EU Just Transition Fund, but governance remains largely centralized. - Poland: Local civic initiatives are active, but few are formally linked to deliberative or polycentric models; literature is emerging but not model-driven.
Identifying Knowledge Gaps	Limited integration of deliberative and polycentric governance concepts across studies. Few forward-looking models exist for post-mining regional transition.
Implications for Research Design	Scoping review results informed the study's conceptual framework and methodological choice to focus on stakeholder perspectives through focus groups in Silesia.

Source: Own study.

Three face-to-face focus group discussions were conducted in December 2024 in different cities in southern Poland: on 3 December 2024 in Kraków, 5 December 2024 in Zabrze, and 6 December 2024 in Gliwice. Each session lasted approximately 70 minutes and was facilitated by the researcher using a semi-structured discussion guide. In total, 20 participants took part in the three focus groups. Participants were selected through energy transition stakeholder mapping conducted as part of desk research, including the analysis of policy

documents, strategic reports, and publicly available information on key actors involved in the regional energy transition.

All focus group sessions were conducted in person to foster richer interaction and more dynamic discussion. Notes were taken during each session, and the discussions subscribed subsequently. Focus groups can serve as approximations of deliberative forms of engagement insofar as they provide a structured setting in which participants are encouraged to reflect, exchange diverse viewpoints, and collaboratively construct meaning through facilitated dialogue. Although they do not replicate the full complexity of large-scale deliberative forums, carefully designed focus groups can function as small-scale proxies for deliberative democratic practices, particularly when they promote balanced participation and critical reflection (Parkinson, 2006). Previous research demonstrates that under such conditions, focus groups can elicit thoughtful engagement with expert knowledge and enable participants to challenge assumptions and co-produce insights (Davies, Burgess, 2004).

Focus groups were selected as the primary data collection method due to their effectiveness in promoting interactive dialogue, surfacing contested narratives, and approximating deliberative modes of engagement, consistent with the study's theoretical grounding in deliberative democratic theory. The focus groups addressed the following central themes:

- stakeholder participation and inclusion in energy governance,
- perceived power asymmetries and institutional fragmentation,
- experiences with formal and informal coordination mechanisms,
- opportunities and constraints for meaningful dialogue and co-decision-making.

The discussions were conducted in Polish and subsequently translated into English for transcription and analysis where necessary. Participants represented the following stakeholder categories:

- officials from regional and municipal governments,
- civil society organizations,
- trade union representatives,
- academic researchers and policy advisors.

This diversity reflects the multi-level and cross-sectoral nature of polycentric governance and enabled an in-depth analysis of how power relations and institutional roles are interpreted in practice.

The empirical material was analyzed using thematic coding informed by the principles of constructivist grounded theory (Charmaz, 2006). The analytical process unfolded in two iterative stages. First, initial coding was used to identify salient statements and recurring patterns across and within focus groups, with particular attention to participants' descriptions of governance structures, barriers to coordination, and inclusion in decision-making processes. Second, focused coding synthesized these patterns into broader thematic categories, guided by

sensitizing concepts derived from the theoretical framework—namely deliberation, polycentricity, institutional fragmentation, and justice.

To enhance the credibility and depth of interpretation, data triangulation was employed through the analysis of regional policy documents, media narratives, and existing scholarly literature on the Silesian energy transition. While qualitative focus group research provides rich, contextually embedded insights, it also entails certain limitations, including the risk of dominant voices, social desirability bias, and limited generalizability. These limitations were mitigated using trained moderation, the assurance of participant anonymity, and the creation of a safe environment conducive to open and honest expression.

Although the findings are not statistically generalizable, they offer significant theoretical and practical relevance for other post-industrial regions undergoing complex socio-ecological transitions. By foregrounding stakeholder experiences and governance expectations, the study contributes to academic debates on sustainability transitions and provides insights that may inform the design of inclusive and contextually appropriate energy governance frameworks.

4. Results

The focus group discussions explored how diverse stakeholder groups perceive the energy transition in the Silesian region and how they describe key challenges, participation patterns, and expectations related to governance processes. The analysis is structured around four thematic blocks derived from the discussion guide (Table 2), reflecting recurring issues raised across the focus groups.

Table 2.
Focus group thematic blocks

Thematic Block
Perception of the Energy Transition – The Local Context of Silesia
Key Challenges of the Energy Transition in Silesia
The Participation of Diverse Social Groups in the Energy Transition Process
Mechanisms for Enhancing the Quality of Social Dialogue

Source: Own study.

4.1 Perception of the Energy Transition – The Local Context of Silesia

Focus group participants described the energy transition in Silesia as a process deeply shaped by the region's industrial legacy and socio-economic identity. Trade union representatives emphasized that coal mining has historically structured not only employment patterns but also community life and collective identity. As one participant noted:

“This is not just about losing jobs. It's about losing who we are as a region”. “Mining isn't just a job here — it's our history, our families, our way of life”.

For many participants, the transition was framed as a personal and structural rupture affecting entire communities. Several respondents pointed out that the closure of mines entails not only economic loss but also a loss of social status and purpose for groups whose lives have long been connected to the coal sector.

“You’re not just closing mines — you’re closing chapters of people’s lives”.

Although participants generally acknowledged that change is inevitable, discussions were frequently marked by uncertainty and concern. Workers and residents expressed anxiety related to job security, income stability, and the risk of long-term marginalization, particularly among older workers with limited opportunities for retraining.

“We know change is coming, but no one is telling us how we fit into it”.

Local government representatives recognized these concerns while emphasizing that the transition is unavoidable and potentially transformative. They highlighted the need to secure long-term regional development through diversification, innovation, and investment in new sectors.

“This is not just about meeting climate goals. It’s about creating a future for our children that’s not tied to an industry in decline”.

Across stakeholder groups, several shared themes emerged, including the importance of ensuring social fairness, providing targeted support for vulnerable populations, and involving local communities more actively in shaping transition processes.

4.2 Key Challenges of the Energy Transition in Silesia

Participants identified a set of interrelated challenges affecting the implementation of the energy transition in Silesia. One of the most frequently mentioned concerns was the risk of large-scale job losses in coal-dependent sectors, particularly among middle-aged workers with specialized skills.

“We know change is needed, but it’s scary—we don’t know what comes next”.

“These workers can’t just switch overnight. They’ve built a life in one profession”.

The absence of effective retraining and reskilling programs was repeatedly highlighted as a critical issue. Participants feared that insufficient institutional support could lead to long-term unemployment and deepening socio-economic inequalities.

“If no one steps in with real programs, we’re just shifting people from mines to poverty”.

Uncertainty regarding future energy supply also featured prominently in the discussions. Participants expressed concern about the reliability and affordability of energy during the transition period, emphasizing the need for clear and consistent communication from public authorities.

“People are scared of blackouts. They want to know what’s coming next and when”.

At the governance level, participants described existing arrangements as fragmented and difficult to navigate. The involvement of multiple administrative levels was perceived to create unclear responsibilities and coordination problems.

“Everyone talks about cooperation, but no one knows who is actually responsible”.

Access to national and EU funding was also described as challenging, with bureaucratic complexity and political constraints limiting effective implementation. Additionally, participants stressed that certain social groups—such as older workers, rural residents, and individuals with lower educational attainment—face heightened risks of exclusion unless targeted support measures are introduced.

4.3 Participation of Diverse Social Groups in the Energy Transition Process

Across all focus groups, participants raised concerns about limited public involvement in shaping the energy transition. While trade unions and local authorities were generally seen as actively engaged, many other groups—including citizens, NGOs, local communities, and SMEs—were perceived as marginally involved.

“It feels like the same people are always at the table. Others don't even know where the table is”.

Participants attributed this limited participation to several factors, including low public awareness, insufficient information, weak trust in institutions, and limited opportunities for meaningful engagement.

“You can't expect people to take part when they don't understand what's happening or feel they won't be listened to”.

Local governments were widely regarded as potential facilitators of participation due to their proximity to residents. However, participants noted that municipalities often lack adequate financial and institutional resources.

“Local governments want to help, but without resources, their hands are tied”.

Civil society organizations and informal community groups were described as important actors in mobilizing local engagement, raising awareness, and rebuilding trust. Participants also emphasized the role of SMEs in driving innovation and anchoring economic benefits locally.

A recurring theme was the perceived need for decentralization, with participants arguing that decision-making should be shifted closer to the local level to reflect regional diversity and context-specific needs.

4.4 Mechanisms for Enhancing the Quality of Social Dialogue

Participants consistently emphasized the importance of dialogue quality for managing the energy transition. Effective engagement was described as dependent on access to clear, timely, and understandable information about planned changes and their implications.

“If you just send people a flyer or give a presentation, that's not dialogue—that's broadcasting”.

Participants highlighted the need for engagement processes to begin early and continue throughout the policy cycle. Suggested mechanisms included public consultations, participatory budgeting, civic assemblies, and multi-stakeholder forums.

Concerns were also raised regarding the structure of dialogue spaces. Participants noted that discussions are often dominated by a limited number of voices or become emotionally charged, underscoring the importance of skilled facilitation and inclusive formats.

Finally, many participants argued that dialogue should be institutionalized rather than treated as a one-off exercise, with permanent structures established to support long-term engagement.

4.5 Characteristics of a Just Transition: Stakeholder Perspectives

Participants described a just energy transition as one that prioritizes those most affected by socio-economic disruption. A recurring principle expressed in the discussions was that “no one should be left behind.”

“Justice means helping those who lose the most to also gain the most from what comes next”.

Beyond financial support, participants emphasized the importance of inclusive decision-making processes. Many stressed that communities should have opportunities to influence transition strategies, rather than being informed after decisions have been made.

“If justice is the goal, people need to be in the room when decisions are made”.

Participants also highlighted the need for continuous engagement, transparent procedures, and accessible information. The importance of coordination across different governance levels and actors was frequently mentioned, along with support for locally tailored solutions and community-led initiatives.

“Justice is not just about outcomes—it’s about who gets to shape them”.

5. Discussion

The energy transition currently unfolding in Silesia, Poland, represents a complex challenge that extends far beyond technical adjustments or economic restructuring. As demonstrated by the empirical findings, it constitutes a deep social and political transformation, involving shifts in identity, values, and modes of governance. Historically dependent on coal and heavy industry, Silesia faces the dual task of aligning with European decarbonization objectives while simultaneously addressing locally embedded concerns related to employment security, social justice, and community wellbeing (Kowalik et al., 2024; Cappellano et al., 2024). These findings reinforce the growing body of literature emphasizing that energy transitions in coal regions cannot be managed solely through top-down policy instruments but require

governance approaches sensitive to socio-cultural context and stakeholder agency (McCauley, 2017).

The results clearly indicate that stakeholders do not perceive the transition merely as an economic or technological shift. Rather, participants framed it as a rupture in cultural continuity, deeply intertwined with regional identity and collective memory. This perception aligns with research on post-industrial regions, which highlights how the decline of dominant industries often produces forms of existential insecurity, loss of status, and symbolic displacement (Healy, Barry, 2017; Sovacool et al., 2021). In Silesia, coal mining has historically functioned not only as an economic anchor but as a source of social cohesion and intergenerational pride. The findings thus underscore that ignoring these symbolic dimensions risks exacerbating resistance and undermining social acceptance of transition policies.

At the same time, the study reveals a widespread acknowledgment among stakeholders that the transition is inevitable. However, concerns were consistently raised regarding how the process is being governed. Uncertainty surrounding employment prospects, insufficient retraining opportunities, and the perceived inadequacy of support mechanisms for older or less mobile workers emerged as major sources of anxiety. These concerns resonate with earlier warnings that transitions lacking proactive redistribution and reskilling strategies may reinforce structural inequalities and deepen regional decline (Newell, Mulvaney, 2013). The Silesian case thus illustrates the importance of coupling decarbonization objectives with robust social policies capable of mitigating uneven transition impacts.

A central contribution of this study lies in its insight into how stakeholders conceptualize justice in the context of energy transition. The findings demonstrate that justice is understood not only in distributive terms—such as the allocation of funding, jobs, and compensation—but also in procedural terms. Participants repeatedly emphasized that who participates in decision-making, how information is communicated, and whether engagement is meaningful are as important as material outcomes. This aligns closely with multidimensional frameworks of energy justice, which emphasize distributive, procedural, and recognition-based dimensions (McCauley, Heffron, 2018). The frustration expressed by participants regarding superficial or symbolic consultation reflects broader critiques of technocratic governance models that marginalize civil society and local knowledge (Avelino, Wittmayer, 2016; Stirling, 2014).

The findings further highlight significant governance challenges related to institutional fragmentation. Stakeholders described the transition governance landscape as complex and difficult to navigate, characterized by overlapping responsibilities across national, regional, and municipal levels. Difficulties in accessing public and EU funding, combined with limited administrative capacity at the local level, were perceived as barriers to coherent and effective action. These observations reinforce arguments for coordinated multi-level governance frameworks capable of integrating diverse actors while remaining responsive to regional contexts (Ostrom, 2010). In this regard, the empirical evidence from Silesia illustrates how

fragmented institutional arrangements can undermine both efficiency and legitimacy in transition processes.

Although participants did not explicitly employ the terminology of polycentric governance, their expectations strongly reflected their core principles. There was broad support for decentralization, stronger roles for local governments, and enhanced collaboration between municipalities, civil society organizations, and the private sector. Stakeholders envisioned governance arrangements characterized by shared authority, contextual flexibility, and horizontal learning—features widely associated with polycentric systems (Jordan et al., 2018; Sovacool, 2019). These findings suggest that polycentric governance resonates with local expectations not as an abstract theoretical construct, but as a practical response to perceived governance shortcomings.

In parallel, participants articulated a strong demand for deliberative practices that elevate public voice and rebuild institutional trust. Calls for citizen assemblies, participatory budgeting, and inclusive forums point to a normative shift toward democratic experimentation and more dialogical forms of governance. This aspiration reflects what Dryzek (2000) describes as deliberative capacity—the societal readiness to engage in reasoned, inclusive, and reflective dialogue on contested policy issues. Importantly, participants emphasized that engagement must occur early and continuously, rather than being confined to late-stage consultations. This reinforces the argument that deliberation is not only a normative ideal but a functional requirement for sustaining legitimacy and reducing resistance during transformative change.

Taken together, the findings suggest that a deliberative–polycentric governance model may represent not merely an aspirational framework, but a practical necessity in coal-dependent regions undergoing structural transformation. Stakeholders’ emphasis on early engagement, transparent communication, and long-term dialogue underscores the role of procedural justice not only in promoting fairness, but also in enhancing the effectiveness and durability of transition policies. As the data indicate, perceptions of exclusion or predetermined decision-making can quickly erode trust and trigger resistance, undermining transition outcomes.

Finally, the Silesian case illustrates that justice in energy transitions must be understood as a multidimensional and context-sensitive concept. Beyond economic redistribution, participants highlighted the need for recognition, dignity, and meaningful participation—elements essential for addressing the symbolic and emotional dimensions of transition. A just transition, therefore, requires governance arrangements that integrate material support with inclusive decision-making and cultural sensitivity (Fraser, 2009).

By grounding these insights in stakeholder perspectives, this study contributes empirically to debates on governance innovation in energy transitions. It demonstrates how deliberative and polycentric principles are interpreted and valued at the regional level, filling an important gap in literature. In regions like Silesia, where historical legacies, social vulnerability, and political complexity intersect, such governance approaches offer a promising pathway toward transitions

that are not only low-carbon, but also socially legitimate, resilient, and democratically grounded.

6. Conclusions

This study set out to examine how deliberative and polycentric governance principles are perceived by key stakeholders involved in the energy transition of a coal-dependent region, using Silesia (Poland) as an empirical case. By drawing on qualitative evidence from focus group discussions, the research provides a bottom-up perspective on governance challenges, expectations, and opportunities in the context of a just transition.

The findings demonstrate that stakeholders in Silesia perceive the energy transition not merely as a technical or economic adjustment, but as a profound socio-economic and cultural transformation. Concerns related to employment security, regional identity, institutional fragmentation, and uneven access to decision-making processes featured prominently across all focus groups. At the same time, participants expressed a clear demand for more inclusive, transparent, and participatory governance arrangements. Although the terminology of deliberative or polycentric governance was not explicitly used by participants, their expectations closely aligned with the core principles of these models, including decentralization, shared authority, early engagement, and sustained dialogue.

By empirically documenting these perceptions, this study contributes new knowledge to the literature on energy transition governance. While existing research often addresses deliberative and polycentric governance at a conceptual level or focuses on national or urban contexts, this paper provides rare empirical insight into how these governance approaches are interpreted and valued at the regional (meso) level in a coal-dependent area. In doing so, the study addresses a clear research gap and strengthens the empirical foundations of debates on just transition governance.

From a theoretical perspective, the findings support multidimensional understandings of energy justice that integrate distributive, procedural, and recognition-based dimensions. The results highlight that governance processes—how decisions are made and who participates—are as critical to perceived justice and legitimacy as material outcomes. The study thus reinforces the relevance of deliberative and polycentric governance frameworks for analyzing and guiding complex socio-technical transitions in post-industrial regions.

From a practical standpoint, the findings have important implications for policymakers and practitioners. They suggest that effective energy transition governance in coal regions requires moving beyond centralized, technocratic approaches toward models that actively empower regional and local actors. Institutionalized mechanisms such as citizen assemblies, multi-stakeholder forums, and permanent dialogue platforms may enhance trust, improve

coordination across governance levels, and increase social acceptance of transition policies. Importantly, such mechanisms must be supported by adequate resources, clear mandates, and meaningful links to decision-making processes to avoid symbolic participation.

Several limitations should be acknowledged. First, the study is based on qualitative focus group data, which allows for in-depth exploration of stakeholder perspectives but does not permit statistical generalization. Second, although efforts were made to ensure diversity among participants, certain stakeholder groups may still be underrepresented. Third, the analysis focuses on perceptions and expectations rather than on the formal performance or outcomes of existing governance arrangements. These limitations suggest caution in extrapolating the findings beyond the specific regional context of Silesia.

Future research could build on these findings in several ways. Comparative studies across different coal-dependent regions could help assess the transferability of deliberative–polycentric governance principles across institutional and cultural contexts. Longitudinal research could examine how stakeholder perceptions evolve as transition policies are implemented over time. Further work could also explore the interaction between formal governance structures and informal civic initiatives, as well as the conditions under which deliberative mechanisms translate into tangible policy influence.

Overall, this study demonstrates that governance innovation is central to achieving a socially just and politically sustainable energy transition in coal-dependent regions. By foregrounding stakeholder perspectives, it shows that deliberative and polycentric governance models resonate with local expectations and offer a promising pathway for addressing the complex social, institutional, and cultural challenges of decarbonization. In this sense, the paper not only fills an important research gap but also provides actionable insights for designing more legitimate, inclusive, and resilient transition governance frameworks at regional, national, and European levels.

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A MULTI-AGENT FRAMEWORK FOR AI READINESS ASSESSMENT WITH ADAPTIVE SURVEYS AND PUBLIC DATA INTEGRATION

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Purpose: Organizations increasingly rely on artificial intelligence, yet most assessment tools used to evaluate AI readiness still depends on static surveys. The objective of this research is to validate Agentic AI diagnostic approach to increase effectiveness of organization AI readiness assessment.

Design/methodology/approach: This paper introduces an Agentic AI diagnostic framework that replaces questionnaires with adaptive, conversational data collection system. The proposed approach combines self-reported information with external public sources (OSINT), delivering current state and recommendations for further AI implementation. The proposed research will be conducted using the Design Science Research methodology.

Findings: The literature review identifies key challenges related to static surveys method: declining response rate, respondent fatigue and failed value proposition. As result static interviews may produce low-quality, subjective and incomplete data.

Research limitations/implications: Research limitations are related to: AI readiness indicators changing with dynamic AI development and need to ensure ethical, governance and trust for proposed solution.

Practical implications: If research hypothesis confirmed, multi-agent diagnostic system to be used in organizational AI readiness evaluation allows organizations drive assessments tailored to their needs. It is especially valid for mid-size and SMB companies, who usually have limited access to the assessment tools. Additionally the proposed framework, after successful validation, can be further adjusted to other areas of organizational assessment.

Originality/value: The proposed Agentic AI diagnostic framework replaces questionnaires with adaptive, conversational data collection system. The system combines self-reported information with external public sources to better assess current AI readiness status and propose recommendations for further AI implementation tailored to the organization needs. We describe a multi-agent architecture as a reference implementation, together with research plan and methodology.

Keywords: Agentic AI; AI readiness; Adaptive surveys; OSINT integration; Design Science Research.

Category of the paper: Research paper.

1. Introduction

Artificial intelligence (AI) has emerged as one of the fastest-growing and most transformative technologies of the past decade, with a profound and accelerating impact across industries. According to industry forecasts from IDC (IDC, 2024 report), AI is projected to contribute \$19.9 trillion to the global economy by 2030, representing approximately 3.5% of global GDP. The significance of AI is frequently compared to historical technological breakthroughs such as the steam engine, electricity and the personal computer. While such projections underline AI's economic potential, realizing this value depends less on the technology itself and more on the organizational capacity to adopt and integrate it effectively. Artificial intelligence has moved from a discrete technology investment to a general-purpose capability that reconfigures how organizations sense opportunities, learn, and execute. In this sense, "AI maturity" for an organisation is less a stock of assets and more a flow of experimentation, data stewardship, model lifecycle management, and human capital development. This approach is similar for all key technology transitions (Teece et al., 1997).

Organizations face increasing pressure to adopt AI technologies (Sullivan, Fosso Wamba, 2024, Wodecki, 2018) while navigating uncertainty, skill gaps and organizational inertia. In such environment proper assessment of current state of organisation readiness for AI technology is important element to identify gaps and define next steps (Tehrani et al., 2024). There are already frameworks and models available on the market. The Technology–Organization–Environment (TOE) Framework, developed by Tornatzky and Fleischer (1990), is widely used to assess an organization's readiness to adopt new technologies in general. Another example is Capability Maturity Model Integration (CMMI) developed at the Software Engineering Institute of Carnegie Mellon University (2002) supporting adoption of AI usage. There are also more recent models like AI Readiness Index (AIRI) and AI Maturity Frameworks (e.g., from Gartner, McKinsey, or IBM). These methodologies typically involve structured surveys, expert interviews or workshops that capture the organization's status at a given moment, offering a maturity score or classification. However, they often neglect the fact that AI integration is a highly dynamic process, influenced by rapid technological advancements, evolving market demands, internal capability development and cultural shifts. From perspective of the recommendations, existing models tend to deliver standardized recommendations, lacking the flexibility of adaptation to an organization's specifics. There is also significant difference between large organisations and small and medium companies (Ayinaddis, 2025; Moeuf et al., 2018). For large companies they have often dedicated department focusing on Innovations, including AI implementation. They work with consulting companies to help them with understanding current state of AI readiness and develop strategy moving forward. For small and medium companies process is much less defined (Schwaeke et al., 2025) and in many cases they depend on in-house AI enthusiast, who treat AI implementation as his/her job+.

Traditional assessment approaches, typically based on manual questionnaires and interviews, are time-consuming, subjective, and often poorly aligned with real-time organizational dynamics. This project addresses a need for a scalable, intelligent and dynamic approach to evaluating and enhancing AI readiness. By introducing a self-adaptive Agentic AI system that integrates both OSINT (e.g., public data, news, company reports) and validated questionnaire frameworks (e.g., TOE, AIRI), the project aims to bridge the gap between assessment and actionable guidance. Furthermore, developing such a system will allow managers to shift from reactive to proactive AI strategies, supported by automated, context-aware insights.

The proposed research will be conducted using the Design Science Research (DSR) methodology (Hevner et al., 2004; Peffers et al., 2007) and following hypothesis will be validated:

- H1: The proposed Agentic AI system will demonstrate comparable or superior effectiveness in assessing organizational AI readiness compared to manual assessments based on existing readiness model.
- H2: Integrating Open Source Intelligence with questionnaire-based data increases the depth and reliability of organizational AI readiness assessments.

2. Literature review

Jöhnk, Weißert, and Wyrcki identify organizational AI readiness as a multidimensional construct consisting of strategic alignment and vision, availability of resources and technical capabilities, internal knowledge and skills, supportive organizational culture, data and ethics governance conditions. Collectively they determine an organization's readiness to adopt and benefit from AI technologies (Jöhnk et al., 2021). To be able to measure it effectively we need well proven models and quality data to feed the model. Recent research shows that conventional data collection methodologies, particularly surveys, are currently facing a systemic crisis. This is visible through a constellation of interconnected issues, including persistently declining participant engagement, escalating respondent fatigue and limited value of participation. Since our diagnostic system relies on survey instruments as one of its core data sources, understanding these limitations is crucial for designing an adaptive methodology. This section critically reviews why current survey methods are no longer efficient and propose potential improvements.

2.1. Declining response rates

Several researches indicate decades-long decline in survey response rates across nearly all modes of data collection signals a systemic challenge to the validity of survey-based research. This trend is connected with perception of academic and social surveys as inherently "biased", transforming non-response into a form of protest. The widespread adoption of online surveys, while offering significant gains in cost-efficiency and scalability, has paradoxically failed to resolve this engagement crisis (Daikeler et al., 2020). Multiple meta-analyses show that an average response rate for online surveys at approximately 44.1% (Wu et al., 2022), drastically falling short of the 80% benchmark, often recommended by governmental bodies for ensuring sample representativeness. In-person interviews with well selected participants allows to achieve much better results (West et al., 2018) but have much higher cost and limited ability to scale, especially in case of smaller organisations.

Such low response rates introduce a significant risk of nonresponse bias. This bias occurs when the segment of the population that chooses to respond is systematically different from the segment that does not. This compromises the research findings' generalizability. Research based on unrepresentative samples risks producing findings that fail to reflect the experiences of non-responding groups, which can create a negative feedback loop that reinforces the public's perception of bias and deepens their disengagement from the research process (Scheaf et al., 2023).

2.2. Perceived burden and respondent fatigue

Beyond the initial decision to participate, the quality of participation itself is heavily influenced by the respondent perceived "cost of participation" (Kunz, Gummer, 2025). Survey methodology literature distinguishes between objective burden (measurable characteristics like length) and perceived burden (the subjective experience of that effort), with research increasingly indicating that perceived burden is the more critical factor influencing respondent behaviour and data quality. Traditional surveys often impose significant burden through complex question structures and lengthy questionnaires, which directly impacts response quality and can lead to lower engagement and low quality responses (Jeong et al., 2023). This is valid for all types of surveys, with the most scalable method (online surveys) being highly susceptible to the degrading effects of fatigue, trading convenience for data quality.

The consequences of fatigue are mostly impactful for data quality. This is visible by an increase in ambiguous or "don't know" responses, a higher rate of skipped questions and "straight-lining" (selecting the same answer repeatedly without consideration) (Ward, Meade, 2023).

2.3. The failed value proposition

To understand declining engagement, it is crucial to apply Social Exchange Theory, which posits that individual actions are motivated by the expected rewards relative to their costs (Homans, 1958; Greenberg, Dillman, 2023). In the context of a survey, participation is maximized when costs (time, cognitive effort, privacy concerns) are minimized, rewards are maximized, and the respondent sees value from the participation. From this perspective, it becomes clear that the traditional survey model largely fails the social exchange test. It is a transaction heavily directed toward the researcher, maximizing costs for the respondent while offering minimal, often intangible, rewards in return. This imbalance contributes to declining engagement, as participants increasingly view surveys as extractive interactions rather than reciprocal exchanges. Research on survey participation shows that respondents are sensitive to fairness and frequently disengage when they feel that researchers simply “take” their time and insights without offering value in return (Singer, Ye, 2013). At the same time, methodological analyses demonstrate that poorly designed self-report instruments amplify risks of common method bias and superficial responding, further undermining the validity of the collected data (Podsakoff et al., 2024).

The failure to deliver value proposition for participants results in high nonresponse or the submission of superficial answers. This undermines the willingness of individuals to put genuine thought into their responses, thereby threatening the overall reliability and validity of the gathered data.

3. Problem statement and option to address the problem

Key challenges related to typical survey methodologies are declining engagement, eroding trust, and accumulating respondent burden. These issues directly lead to lower response rates and degraded data quality, threatening the validity of the results. This establishes a clear need for innovation that fundamentally reimagines the research interaction as a reciprocal value exchange, placing the respondent’s experience and benefit at the center of the process.

Artificial intelligence usage has the potential to change survey process from a static, one-way questionnaire into a responsive interaction that adapts to the respondent while maintaining methodological control. Several researches focus on chat usage to achieve this objective (Zarouali et al., 2024; Barari et al., 2025). Proposed research will focus rather than a single, defined model that asks questions and records answers, on multi-agent architecture distributing roles across coordinated specialists. Various agents can be implement focusing on specific areas, like an agent focusing on explanation of intent of questionnaire and specific questions or an agent monitoring the respondent engagement level. When these agents operate under explicit

intervention policies with version control and logging, the system can improve respondent experience and data quality while preserving standardization and comparability.

In practice, this enables responsive interviewing that reduces cognitive load, increases comprehension of complex items, and lowers break-off rates, while preserving standardization through explicit intervention policies and transparent logs. Agentic setups can also deliver immediate, non-directive value to participants (for example neutral summaries or benchmarked feedback), which may strengthen trust and longitudinal retention without compromising instrument fidelity. At the data layer, agents can coordinate data collection, calibrate assistance intensity and trigger targeted probes, creating a closed loop that links user experience metrics with classical indicators of data quality (item nonresponse, straight lining and construct validity).

However, the same affordances introduce nontrivial challenges. First, there is a risk of an “AI interviewer effect”: even subtle clarifications or examples can shift response distributions, threatening measurement invariance across modes and waves. Second, reproducibility is fragile without strict versioning, prompt governance and intervention caps, drift in foundation models or policies can erode comparability over time. Third, transparency and consent must be elevated: respondents should know when and how agents intervene, what is logged, and what immediate feedback is algorithmically generated. Fourth, fairness and accessibility require active design of language style, reading level, and turn-taking rules. Finally, security and privacy concerns intensify when agents process open-ended text or sensitive business data, calling for on-device processing where feasible, minimal data retention and independent audits.

4. Methods

The planned research addresses a growing challenge in management sciences: how to systematically and dynamically assess an organization’s readiness to adopt new technologies (Uren, Edwards, 2023), particularly Artificial Intelligence. As AI continues to transform operational models, decision-making processes, and innovation strategies, it becomes essential to equip organizations with diagnostic tools and methodology, that are not only reliable, but also adaptive, scalable and capable of synthesizing diverse sources of information. The proposed solution is a novel, intelligent artefact based on Agentic AI, combining structured diagnostic models with open-source intelligence (OSINT) and large language model (LLM) driven reasoning. During the research following research questions will be addressed:

RQ1: How can Agentic AI be effectively used to assess organizational maturity for AI implementation by combining OSINT and survey methods?

RQ2: What factors and metrics should be considered in assessing organizational maturity, and how to combine data from open sources and survey responses in the AI maturity study?

RQ3: To what extent can automatic, AI-generated recommendations based on maturity results support organizations in identifying gaps and improving their readiness for AI?

The Design Science Research (DSR) methodology (Hevner et al., 2004; Peffers et al., 2007) provides a robust framework for addressing complex, real-world challenges through the design, construction and evaluation of artefacts that have both practical utility and theoretical relevance. DSR has gained increasing recognition in the fields of information systems, organizational studies and management sciences, where the boundaries between technological development and strategic decision-making are becoming increasingly fluid. This methodology is particularly appropriate for projects focused on building and deploying AI driven solutions, as it allows the researcher to iterate between theory, system development and empirical testing in applied contexts. The research will follow the structure proposed by Hevner and Peffers, incorporating the following interrelated phases:

- Problem identification and definition of objectives (combined into one phase) – analysing limitations of current diagnostic approaches and identifying real-world readiness gaps; outlining the requirements and success criteria for a useful and generalizable artefact.
- Design and Development – engineering the Agentic AI system through iterative prototyping.
- Demonstration and evaluation (combined into one phase) – testing the system in organizational settings, with both technical and managerial feedback loops.
- Conclusions and Communication of results – define theoretical insights based on results and publish findings in peer-reviewed venues.

Table 1.

Research plan based on Design Science Research methodology

	Name	Focus area	Activities
Phase I Months 1-4	Problem Identification & Requirements Analysis	Establish the conceptual, technical, and organizational basis for the artefact	• A systematic literature review of maturity models used in technology and AI adoption. • Comparative analysis to select the most appropriate dimensions and metrics for readiness assessment. • Interviews with decision-makers in companies to capture organizational needs and pain points. • Mapping of OSINT sources. • Data governance process definition.

Cont. table 1.

Phase II Months 5-12	Design & Development of the Agentic System	System construction and prototype development	• Building the modular architecture for the diagnostic system. • Implementation of Agent modules. • Configuring the Agentic AI logic using the ReAct framework. • Creating a recommendation engine that links readiness profiles to tailored managerial actions and change management strategies. • Designing a user interface.
Phase III Months 13-20	Demonstration & Evaluation	tests the artefact in real organizational environments, assessing both technical performance and user value	• Pilot studies in 2-3 organizations. • Data collection through real-time use of the system and parallel manual assessments conducted by experts for benchmarking. • Quantitative evaluation using statistical methods to compare accuracy, consistency, and reliability. • Qualitative evaluation through expert interviews, focus groups, and usability testing. • Generalization analysis.
Phase IV Months 21-24	Theoretical Generalization & Dissemination	insights are synthesized, findings are published, and the tool is prepared for academic and practical dissemination	• Refinement of the artefact based on feedback and pilot results. • Theoretical modelling of how Agentic systems can influence digital maturity management. • Preparation of scientific publications. • Open-access dissemination of methodological guidelines, system logic, and lessons learned to support replication and further research.

There are several recent adoptions of DSR in addressing organisation challenges related to technology implementation (Tuunanen et al., 2024) and frameworks how to use them effectively (Australian National University, Australia et al., 2020). By following DSR framework, we will ensure transparency of the research process (Hevner et al., 2024). Additionally, the project not only will deliver a functional tool but also will contribute to the academic discourse on how intelligent systems support strategic decision-making and quality improvement in organizations. This methodological choice ensures that the developed artefact is both practically deployable and theoretically grounded, addressing the identified limitations of current readiness frameworks.

The artefact at the heart of this project is an Agentic AI diagnostic system, based on multi-agent system, designed to assess an organization's readiness to adopt AI. A multi-agent system (MAS) is a software architecture in which multiple autonomous agents, computational entities with distinct goals, perceptions, and policies, collaborate within a shared environment to solve tasks that exceed the scope of a single program (Sapkota et al., 2026; Guo et al., 2024). Agents can be homogeneous or role-specialized (e.g., orchestration, domain questions, compliance), and coordinated via centralized schedulers or decentralized protocols (request-reply, publish-subscribe, contract-net). Core benefits include division of labour, parallelism and fault tolerance. Core challenges include coordination overhead, credit assignment and maintaining global consistency when agents adapt locally. Practical MAS deployments rely on service discovery and shared ontologies for semantic interoperability, plus governance layers for access

control, versioning, logging, and auditability. Proposed research, will implement agent reasoning and tool use with the ReAct framework (Yao et al., 2023), which interleaves deliberation (“reasoning”) and external actions (e.g., database queries, API calls) under explicit stepwise policies. ReAct provides a transparent scaffold for planning, evidence retrieval, and intervention control, enabling agents to justify actions, hand off subtasks and recover from failures while preserving methodological control. For AI augmented data collection, this MAS enables responsive interviewing (adaptive explanations, fatigue monitoring) within predefined intervention caps and standardized logs, so user experience can improve without sacrificing comparability, safety or reproducibility.

5. Proposed solution

Unlike static models, the artefact from this project integrates internal diagnostic data (via validated survey instruments) and external public data (via Open Source Intelligence), analyzed through a Large Language Model (LLM) based reasoning engine. This approach reflects a broader shift in the management sciences toward intelligent decision-support systems that learn from their environment and provide dynamic, tailored recommendations.

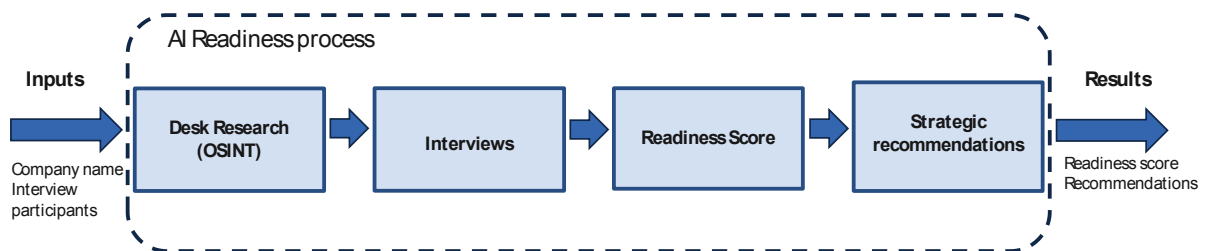


Figure 1. Flow of the proposed AI readiness process.

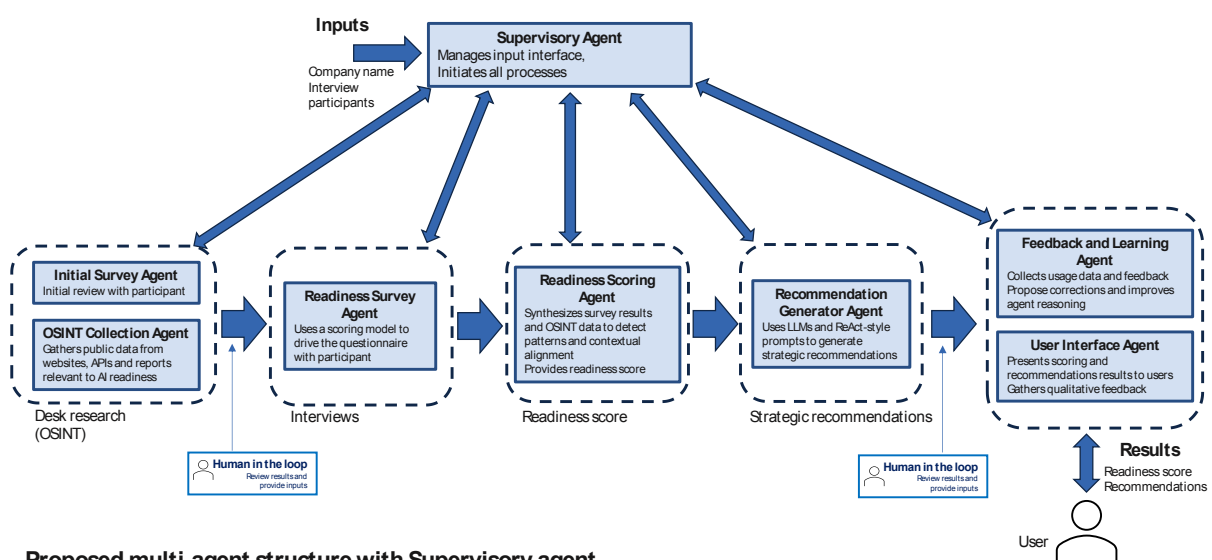
To achieve this objectives multi agent system will be implemented. The system utilizes several agents that collaborate to gather data, interact with the participant, score maturity, and generate recommendations:

- Supervisory Agent - manages the input interface and manages all processes within the system.
- OSINT Collection Agent - gathers public data from websites, APIs, and reports related to AI readiness aspects. Its task is to search publicly available resources based on company data (name, segment, NIP/REGON) to identify important information for assessing the company's AI technology utilization maturity.
- Initial Survey Agent - performs the initial review with the participant. Its task is to conduct a preliminary conversation to understand the respondent's role, assess their expectations and concerns regarding AI, and determine the areas of the main survey that require focus.

- Readiness Survey Agent - uses a scoring model to drive the questionnaire with the participant. We are looking at 3 possible options to run survey:
 - static text survey using predefined set of questions,
 - dynamic text survey with questions being adjusted based on responses and OSINT data,
 - adaptive voice survey with questions being adjusted based on responses and OSINT data.

Final decision on implementation will be based on outcome from expert interviews planned as first step.

- Readiness Scoring Agent - synthesizes the results from the survey and OSINT data to detect patterns and contextual alignment and provides the readiness score. Its main task is to prepare an integrated report assessing organizational maturity by utilizing OSINT data and respondent answers and assessing consistency (cohesion) between these sources.
- Recommendation Generator Agent - uses Large Language Models (LLMs) and ReAct-style prompts to generate strategic recommendations. Its task is to prepare a report detailing short-term (Quick Wins) and long-term developmental actions to enable effective AI implementation.
- User Interface Agent presents the scoring and recommendations results to users and also gathers qualitative feedback about proposed information and survey process.
- Feedback and Learning Agent Collects usage data and feedback. Its function is to propose corrections and improve the reasoning capabilities of the other agents.



Proposed multi-agent structure with Supervisory agent

Figure 2. Proposed structure of multi-agent system for AI readiness scoring with Supervisory agent.

Multi-agent architectures are developing very fast and offers various possible implementation options. To compare effectiveness the research will include both above presented structure with Supervisory agent as well as flat agent architecture presented below, where entire communication is happening between participating agents.

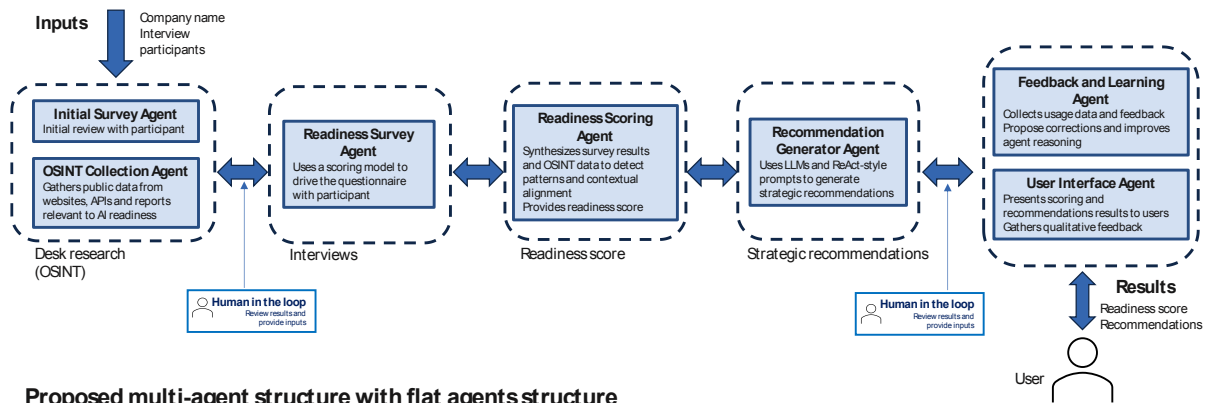


Figure 3. Proposed structure of multi-agent system for AI readiness scoring with flat agents structure.

The comparison between these two architectures will be done as part of the artefact evaluation phase. It will be based on following criteria: variance measurement in assigned maturity levels or recommendation sets for each architecture when assessment done for the same company and length of the process and participants satisfaction comparison.

The assessment starts with input data: company name and names of interview participants. As an outcome participants will receive scoring results and recommendations, both tailored for participating company.

After OSINT data collection and before results communication to the participants we have “Human in the loop” step allowing researchers to review the data and validate ability to move forward with next steps. Human validation is a safeguard, which will be used during testing phase with selected companies to test quality of the proposed approach. In case of broader adoption “human in the loop” element will be removed as otherwise would limit scalability of the artefact.

Having defined structure of the solution the study will start by expert interviews to collect additional inputs and comments helping to validate proposed structure and proposed survey options in the system before final implementation and testing with organisations. Expert Interviews will be done with selected leaders having practical knowledge and expertise in both managing organisations and technology usage.

6. Discussion and future research

Proposed research contributes to the growing discussion on how organizations can effectively assess and develop readiness for artificial intelligence adoption. Existing approaches to AI readiness often treat adoption as a static condition, overlooking the dynamic feedback loops that characterize modern AI driven organizations. By integrating Design Science Research methodology with development of Agentic AI and open-source intelligence, it offers both a theoretical and methodological framework for understanding readiness as a dynamic capability system rather than a fixed state. The following discussion reflects on the project's implications and proposes specific directions for future research.

6.1. Organizational Readiness in the age of AI

Traditional readiness frameworks view technology adoption as a linear process, starting from awareness, moving to implementation and standardization (Appio et al., 2021). However, the increasing autonomy and adaptivity of modern AI systems challenge this linearity. The proposed multi-agent artefact reframes readiness as a continuous, feedback-driven process, where assessment and capability development occur simultaneously. This extends the theoretical understanding of readiness by integrating principles of learning systems, feedback loops, and data driven adaptation.

Future research could build on this by examining how organizations use and benefit from intelligent diagnostic artefacts. How repeated interactions with adaptive systems influence organisation dynamics, particularly managerial impact, learning behaviour or decision making process.

6.2. Methodological implications in surveys

Beyond theoretical implications, the proposed artefact also carries methodological consequences for how readiness is studied. We covered in details current survey limitations - static, one-way questionnaires are increasingly insufficient for capturing complex, context sensitive processes like AI adoption. By using agentic conversational interfaces within diagnostic systems, we believe, we can design instruments that are both scalable and responsive (Barari et al., 2025). By following DSR framework we will maintain methodological rigor while improving participant engagement (Hevner et al., 2024).

Future research should empirically test these interactive designs through controlled field experiments and comparative studies. These research should help understand how AI based interactions affect response quality, perceived trust and data richness. This could help to further develop framework of AI assisted research methodologies.

6.3. Ethical, Governance, and Trust Considerations

Finally, as these systems become more autonomous, their methodological promise must be balanced by careful attention to ethical and governance challenges. As AI becomes critical part of research and management processes, issues of transparency, fairness, and trust gain more importance (Jobin et al., 2019). Agentic systems that process sensitive business or personal data must balance personalization with privacy. This will be important element while designing Agentic AI system. During our research we will continuously track level of acceptance of the artefact by research participants.

Future research should further address the ethical design principles of such systems, including explainability, data minimization, and algorithmic accountability. It should be done with objective to develop standardized governance frameworks for AI based diagnostics to ensure responsible use and increase organizational trust.

7. Summary

Artificial intelligence is rapidly growing its importance in every aspect, including organization's effectiveness. This study critically reviews current organizational diagnostic practices, with particular attention to widely used survey based assessment methods. The literature reviewed consistently demonstrates declining response rates, rising cognitive burden, survey fatigue, and growing risks of superficial or biased self-reported data. Existing research provides strong evidence that traditional static questionnaires struggle to deliver reliable and valid organizational insights in complex, rapidly evolving technological contexts. However, prior studies largely stop at diagnosing these problems. They offer limited guidance on how next-generation diagnostic systems could practically overcome these limitations, particularly in organizational settings requiring contextual interpretation, clarification of meaning, and triangulation across data sources. Moreover, current AI readiness models rely predominantly on static survey instruments, thereby inheriting the very weaknesses identified in the survey methodology literature.

The article introduces a new conceptual approach: a multi-agent, conversational diagnostic system that replaces static questionnaires with adaptive AI driven interviews and external data integration, allowing verification and richer context. This concept is based on fact that effective organizational diagnostics must shift from one directional data extraction toward interactive processes. Additionally organizational readiness assessment should be a dynamic, conversational and multi-source diagnostic activity rather than a static measurement exercise.

As organizations increasingly adopt AI technologies, reliable readiness assessment becomes critical in other areas as well, like strategic decision-making, investment prioritization and risk management. The proposed framework, after successful validation, can be further adjusted to other areas of organizational assessment, including digital transformation audits, capability maturity evaluations and change readiness diagnostics.

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CHANGES IN THE STRUCTURE OF REGIONAL TRADITIONAL PRODUCTS IN THE LUBUSKIE VOIVODESHIP IN 2006-2024

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Purpose: Analysis of changes in the structure of regional traditional products in Lubuskie Voivodship in 2006-2024.

Design/methodology/approach: Statistical analysis of data contained in the register of traditional products, kept by the Ministry of Agriculture and Rural Development. The analysis included data on traditional products registered in the Lubuskie Voivodeship in 2006-2024.

Findings: The research showed a slowdown in the dynamics of products introduced to the market, and in the last 4 years a complete halt in the process.

Practical implications: Intensifying the promotion of the regional market of traditional products and encouraging local producers to register these products on the list maintained by the Ministry of Agriculture and Rural Development.

Social implications: The research showed a slowdown in the dynamics of products introduced to the market, and in the last 4 years a complete halt in the process.

Originality/value: The article shows the current situation in the structure of traditional products and the changes that have taken place in 2006-2024. The recipients of the article may be local food producers, organizers of fairs and events related to the promotion of regional culture and consumers interested in buying traditional products.

Keywords: agri-food processing, food production, traditional products, regional culture, sustainable consumption.

Category of the paper: Research paper/Case study.

1. Introduction

The traditional products market plays an important role both in the European Union and in Poland, constituting an important element of the concept of sustainable development. It supports not only the income of farmers, enthusiasts involved in cultivating local traditions, but also integrates local communities and has a positive impact on the environment, including the diversity of agricultural production. Thanks to the use of short supply chains, this market

has unquestionable pro-ecological values, which additionally increases its importance in the context of contemporary climate challenges. At the same time, traditional products play an important role in cultivating local traditions and cultural heritage, supporting small producers in creating high-quality products. This aspect is particularly important in the case of regions "looking for" their identity, such as the "culturally and chronologically young" Lubuskie region. The decline in the dynamics of registration of traditional products in this region observed in recent years indicates the need to intensify promotional activities and activate local producers to include their products on the lists kept by the Ministry of Agriculture and Rural Development. The small but crucial market for traditional products for cultivating tradition and culinary cultural heritage requires special attention so that its potential can be fully exploited and regional traditions can be preserved in the name of intergenerational solidarity for future generations.

Therefore, this article addresses the issue of overall changes in the assortment structure of the Lubusz traditional products market (in 2006-2024) and the dynamics of registration of new, Lubusz traditional products, trying to look at the processes taking place on this market, which may allow for the identification of trends and necessary actions to be taken to develop this area, which is important for the cultural identity of the voivodeship.

2. The origins of the traditional products market in the EU and Poland

The origins of traditional products in the European Union date back to 1992, when the European Union introduced the system of Protected Designations of Origin, Protected Geographical Indications and Traditional Specialities Guaranteed. In its original version, the system had its origins in Council Resolution EEC No. 2081/92 of 14 July 1992 on the protection of geographical indications and designations of origin for agricultural and foodstuffs (Council Regulation (EEC) No 2081/92) and Council Regulation EEC No. 2082/92 of 14 July 1992 on certificates of specific character for agricultural products and foodstuffs (Council Regulation EEC No. 2082/92 of 14). Currently, issues related to the protection of regional products and those produced using traditional methods are included in EU legislation, i.e. Regulation (EU) 2024/1143 of the European Parliament and of the Council of 11 April 2024 on geographical indications for wine, spirit drinks and agricultural products, and traditional specialities guaranteed and optional quality terms for agricultural products (European Union, 2024). In Poland, the Ministry of Agriculture and Rural Development is responsible for managing the system of traditional products and geographical indications. The rules for registering designations of origin, geographical indications and traditional specialities guaranteed and maintaining the List of Traditional Products are regulated by the Act of 9 March 2023 on the registration and protection of designations of origin, geographical indications and

traditional specialities guaranteed for agricultural products and foodstuffs, wines or spirits and on traditional products. This document defines the process of assessing applications for registration, the conditions for temporary protection of names at the national level, as well as the control procedure and sanctions for non-compliant actions of producers or certification bodies (MRiRW, 2023). The List of Traditional Products available on the website of the Ministry of Agriculture and Rural Development includes products whose quality and unique features result from the use of traditional production methods for at least 25 years, constituting an element of the cultural heritage and identity of local communities. The purpose of maintaining it is to promote products manufactured in accordance with historical methods and to strengthen their recognition (MRiRW, 2023). Without a doubt, the above regulations, by creating a legal framework, have created an extremely important and interesting from the researcher's perspective, market for products related to the culinary heritage of countries belonging to the European Communities.

3. Traditional products and their quality in scientific discourse

When considering traditional (food) products and their quality, it's worth first defining the components of food product quality in general. As Skowrońska M. Walczak J. et al. (2023) note "The elements that constitute food quality include primarily safety, nutritional value, sensory appeal, authenticity, origin, functionality, aesthetic value, ethical aspects, and convenience of use" (Skowrońska et al., 2023). Observing today's realities on the food market, one may venture to say that the issue of traditional products related to the culinary heritage of the regions of the European communities is an increasingly emphasized issue in public and scientific discourse, through the conduct of many information and promotional activities in the public sphere, but also through scientific efforts. Since the beginning of the functioning of the system of these products, many researchers have taken up this topic in their studies and publications. Among them, it is worth mentioning, among others: Tregear, Arfini, Belletti, Marescotti 2007 who analyzed the impact of regional product qualification processes on the development of rural areas (Tregear et al., 2007). Meanwhile, Moschini GC, Menapace L., Pick D. (2008), they addressed this issue in the context of the impact of geographical indications on the competitiveness and quality of agricultural products (Moschini, et al., 2008). Stranieri, Orsi, De Noni, Olper (2023) analysed the relationship between the introduction of geographical indications and innovation in the agri-food sector at regional level in the EU, examining how different levels of technological advancement of regions affect this relationship. They found that in the case of less developed regions, geographical indications increase their innovation, while in the case of technologically advanced regions this impact is small (Stranieri et al., 2023).

Emphasizing traditional production methods is becoming an increasingly attractive alternative to the mass and homogeneous model of food production that dominated in the second half of the twentieth century (Bryła, 2015). There is a noticeable increase in interest in the subject of traditional and regional products. It should be emphasized that tradition does not exclude changes brought about by the implementation of innovations. The production of food with higher health standards is characterized by high labor intensity, lower efficiency, and consequently high production costs. However, Polish consumers are willing to pay for this increased quality (Sieczko, 2008). The concept of quality indicates the unique qualities of a given product or service. It is often associated with the uniqueness of food products. In practice, the concept of a traditional product is used as a synonym for a regional, local or ecological product. Therefore, when raising the issue of food quality in the context of traditional products, it is necessary to distinguish between the concepts of traditional, regional, local and ecological products. As a result of research conducted by Truefood, it was determined that a traditional food product should meet the criteria regarding production, authenticity, long-term commercial availability, and gastronomic heritage (European Union, 2009). Hence, it can be assumed that a traditional product is a product that is made from traditional raw materials, has a traditional composition, is manufactured in a traditional way, and this method can be modernized without compromising the quality of the product. The product has unique properties and features, or quality that result from production in a traditional way. It may, but does not have to, be associated with the region. It is a protected food product (Guerrero et al., 2009). It should be emphasized that traditional methods are considered to be those that have been used for at least 25 years (Ministerstwo Rolnictwa i Rozwoju Wsi, 2005). From a formal point of view, a traditional product is one that has been entered by the Minister of Agriculture and Rural Development on the List of Traditional Products (Dz.U. 2023, poz. 588). Regional products, on the other hand, can be defined as agricultural products, products and processed products of specific quality, the production of which is closely related to the conditions prevailing in a given area, and depends on the terrain, soil type, and characteristic climate (Kijak, 2008). Their characteristic features include their geographical location and several decades of production continuity (Grębowiec, 2010). From a formal point of view, a regional product can be defined as one entered into one of the three EU registers: the Register of Protected Designations of Origin, the Register of Protected Geographical Indications, the Register of Certificates of Special Character (Jakubowska-Lazęcka, 2006). A local product can be considered a product or service with which the inhabitants of the region identify. It is associated with a place in a rather narrow sense, e.g. a city, or two or three neighbouring villages. Local residents treat it as a product of everyday use, common, produced in a non-industrial, non-mass manner. It is considered environmentally friendly. It is produced from local raw materials, according to local methods. It is often produced by micro producers, which supports the local economy. It is characterized by low transport costs, has a positive impact on the environment. For people visiting (from outside) it is something exceptional,

specific (Jęczmyk, 2015). Such agri-food products are considered to be an organic product, which are characterized by high quality and do not contain harmful ingredients (Staniak, 2014). It is worth emphasizing here that some researchers claim that agri-food products as such do not have quality, but they do have physical features that are perceived by the final buyer as quality (Luning et al., 2005). Regardless of whether we are talking about traditional, regional, local or ecological products, food quality should be understood comprehensively as a set of features of a food product and factors and conditions that shape it at every stage of the life cycle. This includes both primary production, further processing, and trade in the logistics chain carried out by food operators, up to delivery to users and consumers. All these elements together ensure compliance with requirements and satisfaction of broadly understood needs (Wiśniewska et al., 2011). On the other hand, when addressing the issue of product quality, especially traditional and regional products, it is necessary to emphasize the objective difficulties in defining this concept. M. Bugdol lists the following as important reasons (Bugdol, 2008): knowledge and empiricism, changes occurring as a result of technological progress, awareness of quality systems and concepts, requirements set by the consumer, and interdisciplinarity and multidimensionality of the concept of quality.

The distinction between the concepts of traditional, regional, local and ecological products plays an important role in the process of defining and assessing their quality. It allows for the identification of characteristic components that may be subject to modifications and thus affect the assessment of quality. Product quality can be considered both from the perspective of the producer and the final purchaser. It can also be analyzed from a marketing perspective, especially in the context of promoting regional products, where the distinction between objective quality and perceived quality becomes important.

Considering the marketing quality of a regional and traditional product, it should be emphasized that it takes into account its brand with a specific verbal part and a unique graphic symbol, packaging with appropriate colors, the number of products registered so far, as well as quality markings of regional and traditional products, among which there are both those directly related to the European system of registration and protection of names of this type of products, as well as national marks characteristic of these specific products (Iwanicka, 2015).

In an attempt to generalize the concept of quality in the context of a traditional and regional product, one can refer to the definition of quality according to T. Wawaka, who defines it as the extent to which a product meets user requirements, where these requirements depend on its economic capabilities, especially income and resources (Wawak, 1989). This approach to quality emphasizes the dynamic nature, the state related to products, services, people, processes and the environment, which meets or exceeds expectations (Goetsch, Davis, 2000). It emphasizes all the properties and features of a product or service that determine its ability to meet real or supposed needs (Kotler, Kelle, 2012) satisfy needs and provide satisfaction (Butman, 1997).

The concept of quality in the context of tradition becomes much more flexible. In this light, the quality of a traditional and regional product can be modeled - individual attributes of the tradition can be subject to change. Combined with the atmosphere of innovation, this creates new opportunities for the development of economic entities (Sołdaczuk, 2024).

4. Findings

In order to understand the nature, dynamics and direction of changes in the structure of traditional products in the Lubuskie Province in the years 2006-2024, a detailed analysis of data contained in the register kept by the Ministry of Agriculture and Rural Development was carried out. The analysis covered both the period before 2020 and data from the last four years, which allows for comparison and assessment of possible transformations in the structure of the regional market for traditional products. The results of the conducted research are presented below.

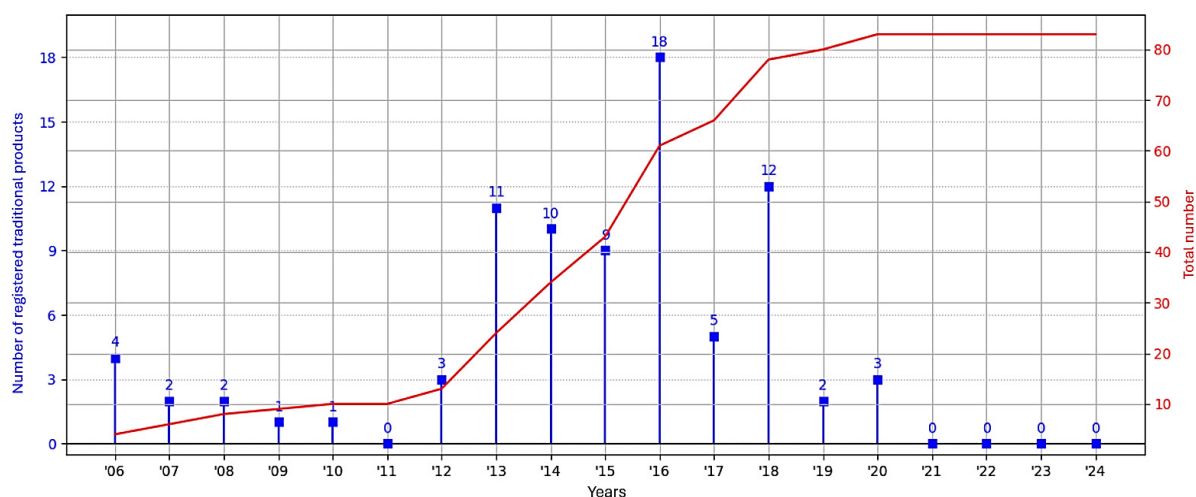


Figure 1. Dynamics of registration of traditional products in the Lubuskie Voivodeship in the years 2006-2024 in annual and cumulative terms.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

Analyzing Fig. 1 it is easy to see that in the years 2006-2018, the number of registered traditional products in the Lubuskie Voivodeship showed an upward trend, reaching a peak in 2015 (18 registered products). Then, a decrease in the number of new registrations was visible, and from 2021, no new traditional products were registered. The cumulative value stopped at the level of 83 products. Such a trend may indicate the exhaustion of the registration potential, potential unidentified barriers or the need to change priorities in the promotion of culinary heritage, including the use of new support instruments.

It is worth taking a closer look at the registration structure of individual groups of traditional products in terms of categories consistent with the list kept by the Ministry of Agriculture and Rural Development (MRiRW) such as: Dairy products, Meat products, Fishery products, Vegetables and fruits, Bakery and confectionery products, Oils and fats, Honeys, Ready meals and dishes, Drinks, Other.

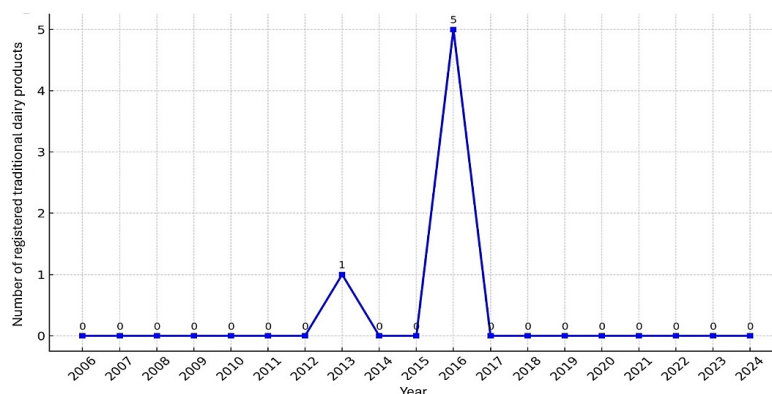


Figure 2. Number of registered traditional dairy products in the Lubuskie Voivodeship in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

Analyzing the above graph (Fig. 2), it can be stated that the general nature of the presented data suggests that the process of registering traditional dairy products in the Lubuskie Voivodeship was characterized by incidents and a low level of intensity in the analyzed period. Against this background, the year 2013 stands out clearly, in which one traditional product was registered in this category, and the year 2016, in which as many as five products were registered. Apart from these two years, the graph shows a clear dominance of zero values and a lack of a lasting upward trend. This may indicate limited motivation and interest of producers in using this form of protection of traditional regional products. It may also indicate potential barriers in registration, or insufficient promotion, an unadapted system of incentives or the exhaustion of regional potential in this area.

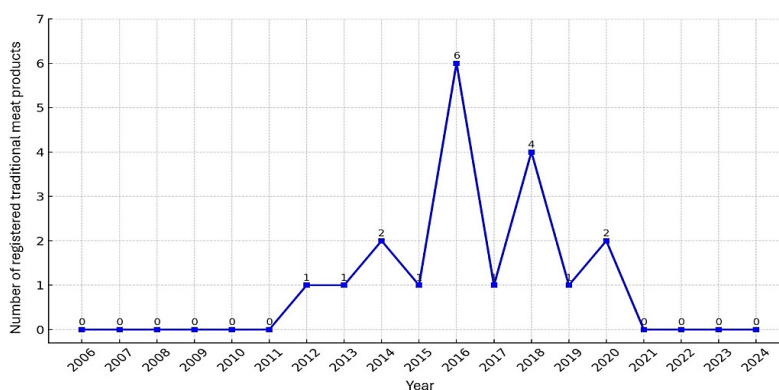


Figure 3. Dynamics of registration of traditional meat products in the Lubuskie region in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above graph (Fig. 3) shows the variability of the number of traditional meat products registered in the Lubuskie Province in the years 2006-2024. The presented data indicate significant variation in the intensity of the registration process in the analyzed period, with both moments of stagnation and periods of significant growth in the number of registrations of meat products constituting an element of the culinary heritage of the region easily distinguished. In the years 2006-2011, no product registrations were recorded in this category. A clear change occurred in 2012, when the first registration was recorded, signaling the beginning of producers' activity in this category of traditional products. In the following period, i.e. in 2013 and 2014, there was a small but noticeable increase in the number of registrations, in this period (a total of 4 products were registered) It is worth emphasizing that the highest intensity of the registration process was observed in 2016, when as many as six registrations were made, which is the peak value for the entire period under review. The year 2018 was another point of increased activity. Four products were registered then, which may suggest a second wave of interest in formalizing the status of more traditional products. After this period, a downward trend is visible. In 2020 and 2022, the number of registrations amounted to two products each, while 2021, 2023 and 2024 did not bring any new items to the list maintained by the Ministry of Agriculture and Rural Development. Analyzing the distribution of data on the graph, it is easy to notice the heterogeneous nature of the registration process, which occurred in waves, in an episodic rather than systematic manner. These fluctuations may be the result of the changing level of interest from producers conditioned by various endogenous and exogenous factors.

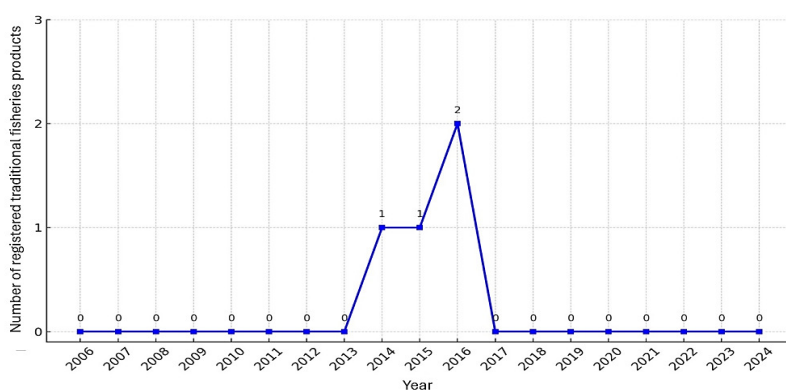


Figure 4. Registrations of traditional fishery products in the Lubuskie Voivodeship in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above graph (Fig. 4) shows that in the years 2006-2012, there were no registrations of traditional fishery products in the Lubuskie region. The first traditional products appeared in this category in 2013 (1 product), and in 2014 and 2015 the same level was maintained. The highest number of registrations was recorded in 2016 (2 products). Since 2017, there has been a complete disappearance of registrations, which lasted until 2024. This trend indicates the incidental nature of the registration process and the significantly limited dynamics of development of this category of traditional products.

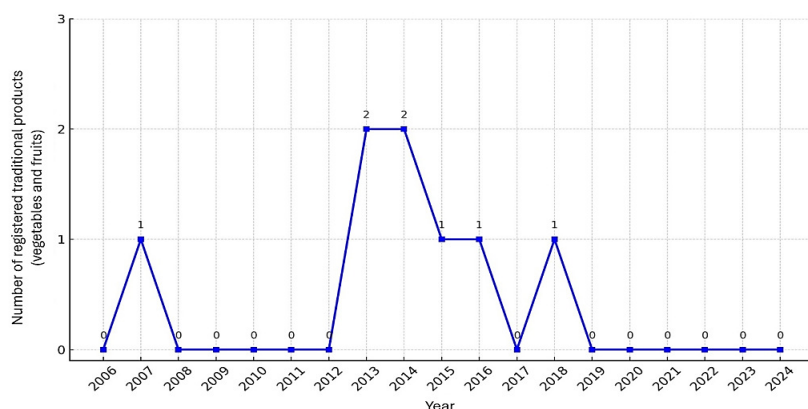


Figure 5. Number of registered traditional plant products (vegetables and fruits) in the Lubuskie Voivodeship in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above figure (Fig. 5) shows the number of traditional products from the "vegetables and fruits" category registered in the Lubuskie Province in the years 2006-2024. Data analysis indicates the highest intensity of the registration process in the years 2012-2014, when two new products were entered into the register each year. In other periods, this activity was significantly lower. Moreover, it is worth noting that since 2020 there have been no new product registrations in this category.

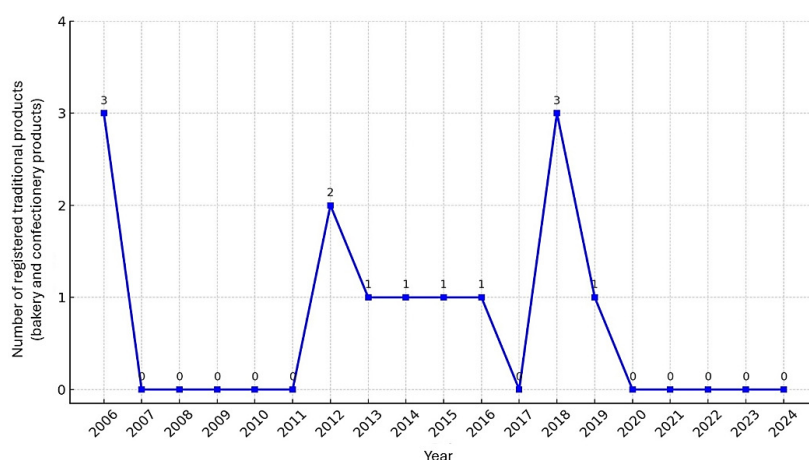


Figure 6. Number of registered traditional products in the "bakery and confectionery" category in the Lubuskie Voivodeship in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above chart (Fig. 6) illustrates the number of registered traditional products in the "bakery and confectionery products" category in the Lubuskie Province in the years 2006-2024. The highest registration volume was recorded in 2006 and 2018, when three products were registered each. In the years 2012-2016, there was a small but clearly regular activity, with one product registered each year. However, since 2020, the registration process in this category has been completely halted, which may indicate a decrease in interest from producers, exhaustion

of the regional potential for this category or limited support for the promotion of traditional products from this category.

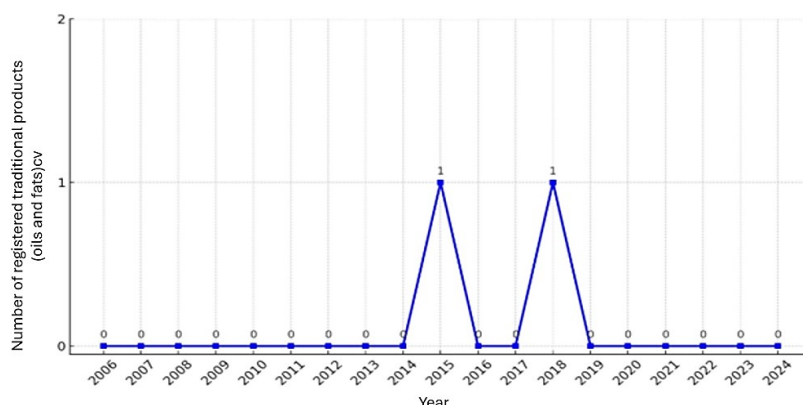


Figure 7. Number of registered traditional products – in the "oils and fats" category in the Lubuskie region in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above chart (Fig. 7) shows the number of registered traditional products in the "oils and fats" category in the Lubuskie Province - in the years 2006-2024. The presented empirical data indicate exceptionally low registration activity in this category, as only two traditional products were registered in the entire analyzed period. This happened in 2015 and 2018. In the remaining years, no new registration events were recorded. This situation may suggest the low importance of this group of products in the local culinary tradition and/or insufficient activities promoting their registration. The continued lack of registration after 2018 confirms the stagnation lasting until the end of 2024.

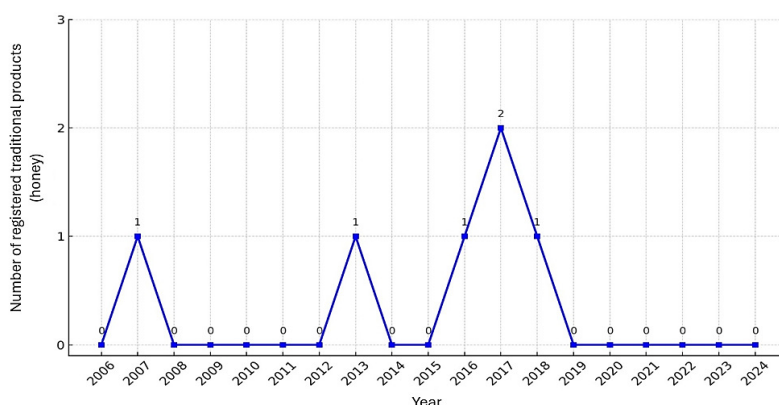


Figure 8. Annual number of registered traditional products in the 'honey' category in the Lubuskie region, 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The graph (Fig. 8) shows the annual number of registered traditional products in the "honey" category in the Lubuskie region, in the years 2006-2024. As empirical data show, the highest number of registrations was recorded in 2017 (2 products), while the remaining years were

characterized by single or no new applications. There is a clear irregularity in the registration process, with periods of several years of stagnation, interspersed with incidental increases. To sum up, the general trend indicates a low dynamics of registration of new products in this category.

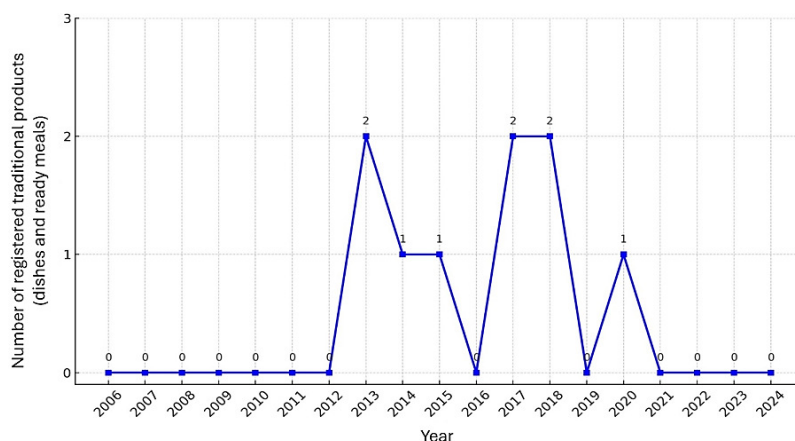


Figure 9. Number of registered traditional products in the "dishes and ready meals" category in the Lubuskie region, 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The graph (Fig. 9) shows the annual number of registered traditional products in the "dishes" category in the Lubuskie region in the years 2006-2024. As can be seen in the graph, after a period of no registrations (in the years 2006-2011), there was an increase in the activity of producers, especially visible in the years 2013, 2014, 2017 and 2018, where two registrations were recorded per year. Despite some fluctuations, there has been a moderate increase in interest in the registration of ready meals and traditional dishes since 2012. In the last 4 years (i.e. in the period 2021-2024), the lack of new registrations is again noticeable.

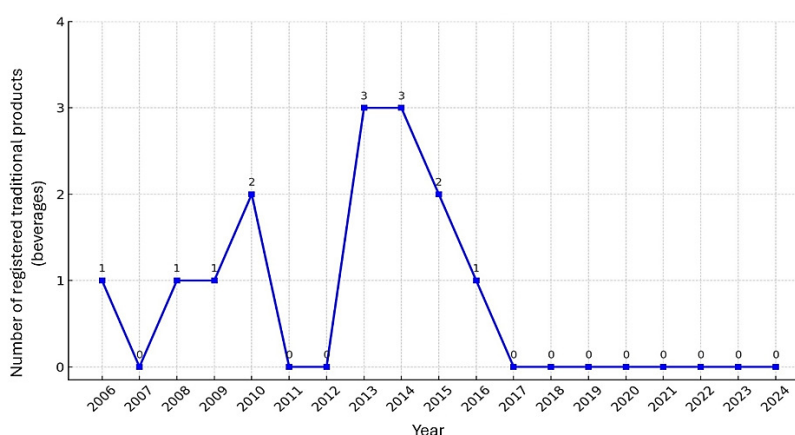


Figure 10. Number of registered traditional products in the "beverages" category in the Lubuskie region in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The graph above (Fig. 10) shows the annual number of registered products in the "beverages" category in the Lubuskie region, in the years 2006-2024. As can be seen in the graph, the highest registration activity among producers was recorded in 2013 and 2014 (3 products registered in this category), with a significant increase starting in 2010. Since 2017, the number of new registrations has been falling to zero, indicating a halt in the process of entering "new" beverages on the list of traditional products. The general trend shows an "early" increase in interest, followed by a long-term stagnation lasting until the end of the analyzed period.

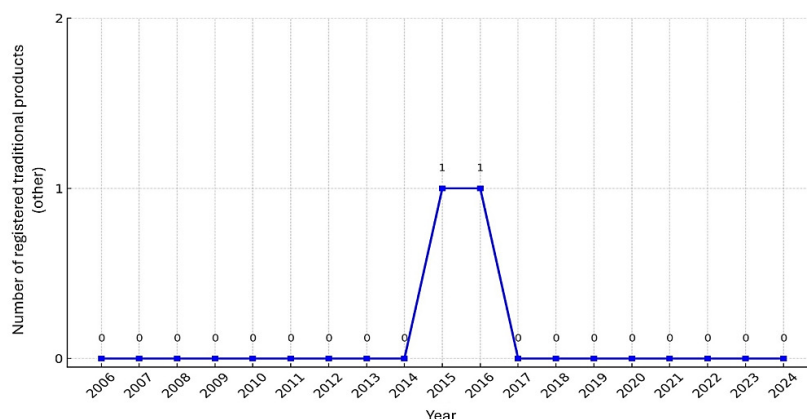


Figure 11. Number of registered traditional products in the "other" category in the Lubuskie region in 2006-2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

As the above chart (Fig. 11) shows, in the analyzed period of 2006–2024, only two cases of registration of traditional products were recorded in the Lubuskie region, in the "other" category. Both in 2015 and 2016. In the remaining period, this category is characterized by a complete lack of new registrations.

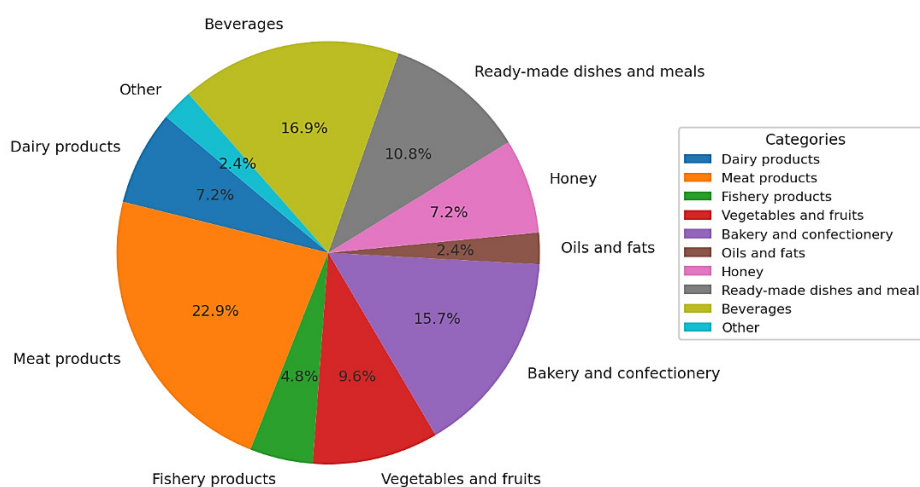


Figure 12. Current structure of regional traditional products in the Lubuskie Voivodeship - as of the end of 2024.

Source: Own study based on the analysis of data from the Ministry of Agriculture and Rural Development (MRiRW).

The above chart (Fig.12) shows the current structure of traditional regional products in the Lubuskie Province - as of the end of 2024. Empirical data indicate that the largest share in the Lubuskie market of traditional products is held by meat products (22.9%), which indicates their dominant position in the regional culinary tradition. The second largest category is beverages (16.9%), which include both alcoholic and non-alcoholic beverages, indicating their significant importance in the region famous for the production of wine, which is worth adding was the first registered regional product in the Lubuskie Province. The next places in the structure of traditional Lubuskie products were confectionery and bakery products (15.7%) and ready meals (10.8%), also constituting a significant part of the culinary heritage of the region. In addition, vegetable and fruit products (9.6%) retain a significant share in the analyzed structure. Dairy products (7.2%) and honey (7.2%) remain a moderately important element of the assortment structure of the analyzed market. At the same time, as the graph shows, fish products (4.8%) and fats (2.4%) play a marginal role in the structure of regional traditional products. It is worth noting that the category "other" (2.4%) includes other products that do not fit into the separate groups. To sum up, it should be recognized that the analysis of the graph shows the diversity of regional production of traditional food.

5. Conclusion

The analysis of changes in the structure and dynamics of registration of traditional products in the Lubuskie Voivodeship in the years 2006-2024 conducted in this article enabled the identification of key trends and indication of potential development barriers in this specialized segment of the agri-food market. As the results of the analysis conducted have shown, in the initial phase of the system's functioning, a relatively high dynamics of introducing new products to the list of traditional products, maintained by the Ministry of Agriculture and Rural Development, was observed. It seems that this state of affairs corresponded with the activation of local producers and the widely noticeable increase in interest in culinary heritage, treated as a resource also of economic importance. However, what is worth emphasizing, after 2015, there was a gradual slowdown in the dynamics of registration, and from 2021, there was a complete stagnation of new product registrations. This state of affairs can be interpreted in the light of the theory of regional development as the effect of endogenous barriers - such as the depletion of easily accessible cultural resources and/or deficits in the scope of support mechanisms and institutional coordination of this area of the regional market. In this context, the key aspect seems to be the need to rethink the strategy of influencing the market segment with appropriate instruments. This is extremely important because the traditional products market segment plays an extremely important role in the process of shaping regional identity, building regional comparative advantages and supporting the development of local micro and

small enterprises and local agricultural producers focused on the production of the analyzed traditional goods. As shown by the research on their structure in the years 2006-2024, in the analyzed period, an easily noticeable dominance of the meat, beverages, and bread and confectionery categories was noted, which may suggest a strong embedding of these products in local cultural and consumption practices. At the same time, the relatively low registration activity in the remaining categories may suggest a lack of use of the endogenous potential of the Lubuskie region, which could be developed through appropriate activation and promotional activities for the systematic increase in the offer of traditional products in the Lubuskie Voivodeship and interest in this segment of the market. Finally, it is worth emphasizing that supporting this sector of the food market is also extremely important from the point of view of shaping sustainable consumption patterns, because the functioning of the traditional food market is based on short supply chains, using local resources and distribution channels, making this market more environmentally friendly.

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THE ROLE OF E-COMMERCE IN THE DEVELOPMENT OF A TEXTILE COMPANY – A CASE STUDY

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Purpose: The aim of the article is to show how the implementation of e-commerce affects the development of a textile company and which areas of activity are subject to the greatest changes.

Design/methodology/approach: The study was based on a qualitative approach, using an in-depth interview conducted in 2025 with a Steven executive.

Findings: The results indicate that e-commerce significantly strengthens the company's development, especially in the area of sales, marketing, customer relations and organization of internal processes.

Research limitations/implications: A limitation is the analysis of a single case, which limits the possibility of generalizing the results and indicates the need for further comparative research.

Practical implications: The results obtained can be a guideline for managers planning to develop their online business and incorporate e-commerce tools into their corporate strategy.

Social implications: The study shows that the development of e-commerce is conducive to increasing the availability of products and strengthens interactions between the company and customers.

Originality/value: The value of the article results from the combination of a theoretical approach with an analysis of the real case of the company, allowing to show the practical effects of the digital transformation of the company.

Keywords: e-commerce, companies from the textile sector, qualitative interview.

Category of the paper: research paper.

1. Introduction

The development of digital technologies and the growing importance of online sales make e-commerce one of the key factors that affect the functioning of a modern enterprise. Changing consumer behaviour, the need to react faster to market expectations and growing competition

are even forcing them to adapt their own business models to the realities of the digital economy. For this reason, the analysis of the role of e-commerce in the development of enterprises, especially those with a long tradition, becomes a particularly important issue. It allows us to better understand the mechanisms of transformation and the factors that strengthen and govern their market position.

This article outlines the impact of e-commerce on the development of a company in the textile sector. A literature review, a description of the test method used and the results of a qualitative interview conducted at Steven are presented. This the analysis made it possible to identify how the introduction of online sales affects areas of the organization's operations, such as marketing, logistics, customer relations or internal structure management.

The aim of the article was to indicate the role of e-commerce as a development factor and to identify the areas that are subject to the most pronounced changes in the digitization process. The contribution of the work and its added value can be considered the combination of a theoretical approach with the analysis of a specific case. This makes it possible to capture the practical consequences of digital implementations. This, in turn, is a reference point for companies planning to develop their online business.

The originality of the undertaken subject matter stems from the combination of a theoretical approach with an analysis of a real-life case of a company operating in the textile sector, functioning under conditions of dynamic technological change and increasing competitive pressure. The literature is dominated by studies addressing general determinants of e-commerce development or sectoral analyses covering broad groups of enterprises. However, there is a lack of studies focused on an in-depth case analysis of a long-established company undergoing a process of digital transformation. The research gap particularly concerns the limited number of publications describing how the implementation of e-commerce tools affects specific areas of textile companies' operations, especially the organization of internal processes, the building of customer relationships, and the shaping of development strategies. This gap can be addressed by analysing the experience of the company Steven, which illustrates the mechanisms through which a traditional enterprise adapts to the requirements of the digital economy. It also makes it possible to capture the practical consequences of implementing e-commerce solutions in the context of the Polish market.

1.1. Determinants of the development of companies in the textile sector

A review of the literature suggests that the development of companies in the textile sector is determined by a multidimensional system of factors. These determinants include both internal conditions and economic context. Research on the competitiveness and efficiency of textile companies points to the need for access to modern technologies, cost management skills and the quality of human capital. These factors directly translate into the performance and market position of companies (Akhund, Abbas, 2023; De Jorge-Moreno, Rojas Carrasco, 2015;

Shafaei, 2009). The ability to adapt production processes to changing market standards also plays a special role. This fact has been highlighted in analyses of Spain and China, where the development of companies depended on the level of technical efficiency and integration into global value chains (De Jorge-Moreno, Rojas Carrasco, 2015; Lau et al., 2009).

Financial determinants can also be considered an important area that requires exploration. They include both the capital structure and the macroeconomic factors affecting the stability and profitability of companies. Analyses conducted in Pakistan, Bangladesh and Turkey indicate that the development of textile companies remains strongly dependent on financing decisions, debt levels and economic conditions. They affect the ability of companies to invest in modernization and expansion (Ullah et al., 2017; Chhapra, Asim, 2012; Ul Haq, 2012; Ullah et al., 2020). The results of the research confirm that a properly selected financial structure allows companies to maintain liquidity and resilience to market volatility. These factors lead to their long-term stability and ability to grow (Ahmad et al., 2015; Bashir, 2013). In the literature on Polish and the European Union, attention is drawn to an additional financial dimension, which is the importance of economic policies and regional forms of support conducive to the development of textile clusters (Jabłońska et al., 2020; Gajdová, 2024).

The growth of textile companies also remains shaped by the ability to compete in international markets. This relationship can be the result of both production efficiency and export opportunities. Research conducted in India, Ethiopia and Pakistan indicates that exports are a key factor in the development of the sector, and their level depends on product quality, innovation, labour costs and the ability to cooperate with global partners (Bhavani, Tendulkar, 2001; Desta, 2021; Javaid, Afridi, 2015). The difference in the level of competitiveness between companies results from the different ability to adapt to the requirements of international markets. This is indicated by analyses covering India and Turkey, which emphasize the role of subcontracting, local development policies and access to productive resources (Taymaz, Kiliçaslan, 2005; Dhiman et al., 2020; Narayanan, 2003). A combination of these studies leads to the conclusion that the development of textile companies remains a process dependent on the simultaneous interaction of financial, technological, organizational and market factors, as well as on their ability to function in a volatile, global economic environment.

Other research also highlights the importance of financial factors in guiding the ability of textile companies to maintain stability and further growth. It can be pointed out that the economic performance of companies depends on the capital structure, debt level and operational efficiency (which has been confirmed in analyses conducted in Bangladesh and Pakistan) (Mitra, Adhikary, 2017; Abbas et al., 2013). This approach closes the set of determinants, showing that the development of organizations in the textile sector is inextricably linked to their financial condition and ability to adapt to changing market conditions.

1.2. The role of e-commerce in the development of a company

The growth of businesses increasingly depends on the ability to use digital technologies. On the other hand, e-commerce is currently one of the most important tools to strengthen their market position. The literature emphasizes that e-commerce enables companies to increase their reach, automate processes and reach customers more effectively. This supports their development and competitiveness (Gupta, 2014; Jain et al., 2021; Rakhim et al., 2021). Its importance is emphasized in both developed and developing economies. This indicates the universal nature of this tool (Kedah, 2023).

E-commerce is also becoming a stimulator of innovation. Research shows that the implementation of digital solutions is conducive to the modernization of enterprises, increasing efficiency and the development of new forms of business. This is particularly evident in the context of European integration and global digitalization (Verbivska et al., 2023; Albăstroiu, 2007). The development of e-commerce also leads to organizational flexibility, streamlining management processes. This role is particularly prominent in companies active in international markets (Taranenko et al., 2021; Mardhiyah, 2022).

In addition, the implementation of e-commerce improves the economic results of enterprises. Companies using digital channels achieve better cost efficiency, increase the scale of their operations and strengthen their competitive position. This is particularly important for the SME sector (Andonov et al., 2021; Yacob et al., 2021). At the same time, the evolution of e-commerce indicates that its role, driven by the development of new technologies, the growing popularity of sales platforms, and the integration of artificial intelligence in business processes, will continue to grow (Ntumba et al., 2023).

The literature review provides a basis for clearly linking the concepts discussed with the constructs used in the study. The significance of e-commerce for sales, customer relations and the modernisation of internal processes, as highlighted in the sources, directly corresponds to the areas examined in the in-depth interview. As a result, the theoretical assumptions remain consistent with the adopted methodology and serve as a reference point for the interpretation of the obtained results.

2. Methods

The aim of the research was to determine how the implementation of e-commerce affects the development of a company in the textile sector and which areas of the organization's functioning are subject to the most significant changes as a result of digital transformation. It was assumed that e-commerce plays the role of an important development factor, strengthening both the company's market position and the effectiveness of its internal processes.

A conditional hypothesis was adopted in the study, assuming that the impact of e-commerce implementation on the development of a textile company is positive provided that the organisation has adequate internal resources, technological competencies, and is not significantly constrained by infrastructural or market barriers. This approach makes it possible to consider both the potential benefits and the limitations associated with the process of digital transformation.

The collected research material was subjected to a qualitative content analysis, which involved multiple readings of the interview transcript and the identification of recurring thematic categories related to the ways in which e-commerce is used in the company's operations. The analysis had an inductive character. It made it possible to identify the main areas of organizational, technological, and market changes resulting from the implementation of digital tools. The interview was conducted in the form of an individual, in-depth interview with a member of the management staff and lasted approximately 60 minutes. During the conversation, it was possible to obtain detailed information on the processes of digital transformation and the practical aspects of the functioning of the analysed enterprise.

In order to verify this hypothesis, research questions were asked about the way the company uses e-commerce in its operations, the areas that have benefited the most from the introduction of digital channels, and the challenges and benefits of online sales. The study was qualitative, and the research method used was with an executive of Steven conducted with the company's managing director Steven in 2025. The obtained research material made it possible to identify the key directions of changes related to the development of e-commerce, as well as to assess its importance for the functioning of the analyzed enterprise.

3. Results

In 2025, a qualitative interview was conducted with the managing person of Steven. The company presented operates in the textile sector and specializes in the production of high-quality socks (see Table 1). The aim of the study was to learn about the importance of the e-commerce channel in the development of a company and the impact of digital transformation on its strategy and customer relations. The conversation began with a discussion of the beginnings of the business and the decision to implement online sales. The manager indicated that this was a natural response to changing consumer behavior. The growing popularity of online shopping, especially among younger customers, prompted the company to expand its distribution to include the digital channel. The launch of the online store allowed us to reach new customers and become independent of fluctuations in demand in traditional trade.

Later in the conversation, it was pointed out that e-commerce is currently one of the main pillars of the company's development strategy. It has become an effective sales tool and, above all, a space for communication with customers and a way to build a brand image. The online platform allows the presentation of the values that are the foundation of the business and the quality, craftsmanship tradition and Polish origin of products. Technological issues were also discussed. The manager emphasized that the company regularly invests in modern IT systems. They allow for the automation of sales processes, the integration of inventory and the analysis of customer data. Thanks to this, it is possible to shorten the time of order processing and better adjust the offer to the individual needs of recipients.

The development of online sales has also affected the organizational structure of the company. There are new features related to online store support and digital marketing. Decision-making processes, on the other hand, have become more flexible and data-driven. The method of internal communication has also been changed. This contributed to increasing the efficiency of operational activities. The issue of building relationships with customers in the digital space has also become an important topic. Steven focuses on personalization of the offer, a high level of service and an intuitive store interface. It was emphasized that customer loyalty is built through the authenticity of the message and care for the shopping experience.

The importance of family tradition in online activities was also highlighted. Despite the digital nature of sales, the company consistently emphasizes its roots and values. It gradually builds trust, trying to stand out from the competition. In a world dominated by brand anonymity, history and credibility are becoming an essential element of competitive advantage. In the context of the challenges, the growing competition, the need for constant investment in marketing and technology, and the importance of logistics in maintaining a high level of customer satisfaction were pointed out. At the same time, the development of e-commerce is perceived as an irreversible direction that brings greater flexibility and resilience to market changes to the company.

In conclusion, it can be said that the interview revealed the fact that e-commerce has become both a sales channel and an integral part of Steven's growth strategy. The digitization of processes, combined with the cultivation of traditions and family values, has contributed to the strengthening of the market position. The result was the creation of a modern business model based on quality, relationships and innovation.

Table 1.

Issues of qualitative interview topics

Review question	Synthetic response (sentence equivalents)
Motives for implementing e-commerce in a company	Responding to changing consumer behavior; the need to reach younger customers; expansion of the market.
The importance of e-commerce in a company's strategy	A key pillar of development; a tool for building a brand and customer relationship; an element of image and communication of values.
The impact of e-commerce on sales effectiveness	Increase reach; increase in the number of customers; independence from traditional sales.

Technologies that support online business	Process automation; integration of warehouse systems; Analysis of customer data.
Organizational changes after the implementation of e-commerce	New features in the structure; greater decision-making flexibility; development of digital competences.
Building relationships with customers online	Personalization of the offer; care for UX; fast and friendly service; authentic brand message.
The role of family tradition in online business	Maintaining the authenticity and identity of the brand; building trust; communication of local values.
Challenges and directions of further development	Increasing competition; investments in marketing and logistics; development of social commerce and foreign expansion.

Source: In-house studies.

Figure 1 provides a synthetic assessment of the impact of e-commerce on Steven's key business areas. The analysis of Figure 1 shows that the highest level of impact was recorded in the areas of sales, marketing, customer relations, brand and image. It can be noted that these results confirm the findings of the interview, in which it was emphasized that the online channel has become the main tool for reaching recipients, building recognition and communicating the company's values.

A slightly lower importance of e-commerce is visible in logistics, technology and organizational structure. Changes in these areas result from the need to automate processes, integrate systems and adapt the management method to the specifics of online sales.

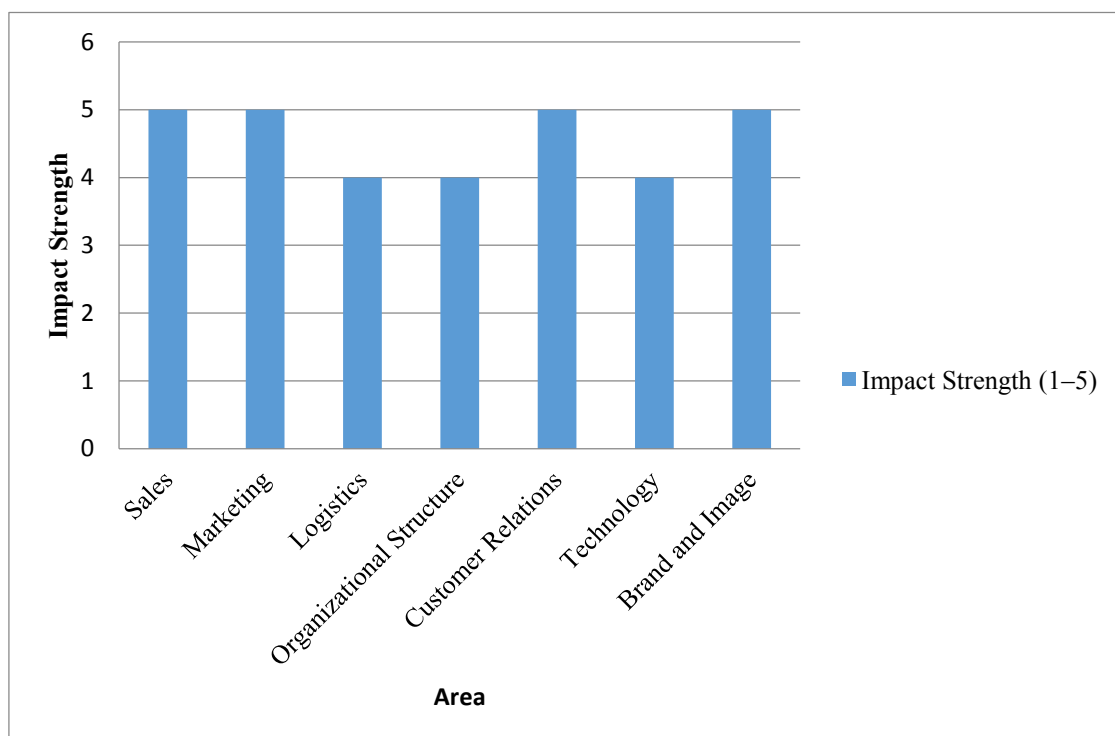


Figure 1. The impact of e-commerce on the company's areas of activity.

Source: In-house studies.

The analysis of Figure 1 shows that e-commerce can be considered a key factor in the development of Steven, having the strongest impact on the market and service sphere, and to a lesser extent - on the internal aspects of the organization.

4. Discussion

The conducted research allows us to conclude that e-commerce has become a key factor in Steven's development, which determines its development and market position. The analysis of the data obtained indicates that online sales are no longer limited to the role of only a supplementary distribution channel. Instead, it becomes the foundation of the modern business model of the company. Areas related to sales, marketing and customer relations turned out to be particularly important. It is in them that the highest level of impact has been recorded. The change in the way of communicating with recipients, the increase in the importance of personalization and the ability to present brand values in the digital space have created favorable conditions for more effective competition in the textile market.

The obtained results are consistent with the observations presented in the literature, which emphasise the growing role of e-commerce in enhancing the competitiveness of enterprises. Gupta (2014) indicates that the implementation of digital solutions enables companies to expand their market reach and improve the effectiveness of marketing activities, which is also confirmed in the analysed case. Similarly, Verbivska et al. (2023) demonstrate that the development of e-commerce fosters technological modernisation and the reorganisation of internal processes. The results of the study confirm these tendencies, while also showing that in a company with a strong tradition the transformation process requires balancing innovation with the preservation of the authentic character of the brand.

Relating the results to international studies on competitiveness and the financial conditions of the textile sector makes it possible to situate the case of the Steven company more firmly within the theoretical framework. The findings of Lau et al. (2009) and Ullah et al. (2020), which highlight the importance of technological modernisation and the strengthening of operational efficiency, are reflected in Steven's actions associated with the implementation of e-commerce, thereby increasing the coherence of the case analysis with the literature.

In addition, the implementation of the e-commerce model has resulted in noticeable transformations within the organization. The company was forced to develop its technological facilities, automate key operational processes and introduce new competencies into the organizational structure. The presented changes were not revolutionary, but their consistent implementation led to increased operational flexibility and better adaptation of the company to the requirements of the modern market. The rise of digital technologies has not been associated with a violation of the organisation's core identity, which is still based on craftsmanship and quality of workmanship.

The collected data confirms that success in the field of digital transformation becomes the result of a skilful combination of modern technological solutions with brand authenticity and customer care. In the case of Steven, the development of e-commerce has increased the scale of its operations and strengthened the company's image as a manufacturer consciously shaping

its presence in the digital space. The results of the research indicate that the further development of the company will depend on maintaining a balance between tradition and innovation, and on continuing to invest in tools supporting customer service and process integration.

Considering the findings from a counterfactual perspective expands the strategic depth of the analysis. Reflecting on how the company's development might have unfolded without the implementation of e-commerce indicates that relying solely on traditional sales channels would have limited opportunities for scaling the business, reduced resilience to demand fluctuations, and weakened the competitive position in an increasingly digital market environment. This perspective highlights that the observed effects of digital transformation would not have been achievable without consistent online expansion, reinforcing the interpretation of e-commerce as a conditionally effective factor rather than an unequivocally positive one.

The conducted research encountered some limitations. They resulted primarily from the use of the qualitative interview method, based on the perspective of one person managing the company. This fact certainly limits the possibility of a full generalization of the results. The analysis was based on respondents' declarations, which may not reflect all the nuances of internal processes. In addition, the study also did not include hard sales data or comparisons with other companies in the industry, so the conclusions focus on the interpretation of the experience of a particular company, rather than on a broad sector analysis.

5. Conclusions

The results of the research indicate the need to further strengthen the company's presence in the digital space. It is necessary to develop tools that support the personalization of the offer and deepen relationships with customers. Therefore, it is recommended to focus on the development of analytical systems that will allow for a better understanding of the behavior of recipients and on this basis to adjust both communication and assortment. It also seems justified to increase investment in digital marketing, including in channels of growing importance, such as social media or social commerce. It is justified by the fact that it is there that consumers most often interact with brands from the textile sector. Strengthening activity in these areas can contribute to expanding the group of recipients and increasing brand recognition.

In terms of internal processes, it is recommended to continue activities focused on technology integration and further automation of logistics and order handling. Increasing consistency between warehouse, sales and marketing systems can improve operational efficiency and reduce lead times, which translates directly into customer satisfaction. You may also want to consider developing your employees' competencies in digital channel management to ensure that your organization is prepared for further technological changes. The interconnection of technological, marketing and logistics processes will allow Steven to

maintain a competitive advantage, consolidate its market position and effectively respond to the growing demands of the e-commerce market.

Future research directions may focus on extending the analysis to include comparisons between textile companies of different sizes. This will allow for a better assessment of the impact of e-commerce on the entire sector. It is also worth taking into account quantitative data on sales, process efficiency and customer behavior in the future to complement the results of qualitative research. An important direction will also be the analysis of the long-term effects of digitization, including both organizational transformation and changes in the business models of family businesses.

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AREAS AND EFFECTS OF USING ICT TOOLS IN AN AGILE ORGANIZATION

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Purpose: The aim of the article is to identify the determinants and areas of use of ICT tools in agile organizations and to assess their impact on the effectiveness and flexibility of operations.

Design/methodology/approach: The study was conducted using the survey method in 2025 on a sample of 525 respondents, and the results were presented using a "mustache" chart and a Pareto chart.

Findings: It was found that ICT increases work efficiency, improves the performance of tasks and supports the functioning of organizations in the areas of sales, services and marketing.

Research limitations/implications: The limitations of the studies are their cross-sectional nature and the dominance of young respondents, which may affect the generalization of the results.

Practical implications: The results can support managers in the effective implementation of ICT solutions that promote agility and improve organizational processes.

Social implications: The use of ICT fosters the development of collaboration, communication and employee engagement in the digital environment.

Originality/value: The article brings cognitive value through an empirical assessment of the impact of ICT on organizational agility and business efficiency.

Keywords: ICT tools, agile organization.

Category of the paper: research paper.

1. Introduction

The dynamic development of information and communication technologies in recent years has significantly changed the way modern organizations function. Increasing digitization, increasing data availability and automation of operational processes have contributed to the emergence of new management models. They are based on flexibility, innovation and the ability

to react quickly to market changes (Binboga, Gumussoy, 2024). In this context, the concept of an agile organization is of particular importance. It combines the ability to adapt with the effective use of technology. The use of ICT tools in agile structures improves operational processes, but at the same time becomes a prerequisite for maintaining competitiveness and the ability to survive in a turbulent economic environment (de Santana, de Azevedo, Galegale, 2025). This topic is becoming topical, especially in the era of digital transformation, in which the ability to integrate technology with management practices is the key to sustainable development and effective functioning of enterprises (Spinello, Fabrizio, Birello, Perin, 2024).

Addressing the issue of using ICT tools in agile organizations is justified by the growing need to understand how digital technologies affect the efficiency, effectiveness and organizational culture of modern entities. In the literature on the subject, it is increasingly emphasized that the mere implementation of technological tools cannot be a guarantee of success. Only their proper use as part of agile management practices allows for the full use of the potential of ICT. The analysis of the determinants and effects of the implementation of information and communication technologies allows us to better understand the mechanisms of the functioning of the organization in the digital environment, as well as to indicate the directions for improving management processes based on the principles of agility.

The aim of the article is to identify and assess the areas of use of ICT tools in agile organizations and to determine the effects of their use on the effectiveness of enterprises. The article presents both theoretical aspects and the results of empirical research conducted in 2025 on a sample of 525 respondents. The first part discusses the essence of organizational agility and the role of ICT technology in shaping it. The second part presents the determinants and areas of application of digital tools. In the empirical part, an analysis of the research results is presented, along with interpretation and recommendations. The added value of the study is to show the relationship between the use of ICT and building the flexibility and efficiency of the organization. This can provide a benchmark for management practitioners implementing technology solutions in environments that require rapid response and adaptation.

1.1. Determinants and areas of use of ICT tools in agile organizations

In agile organizations, the use of ICT tools is determined by technological, organizational and cultural factors. A company's ability to integrate and adapt technologies that allow for a quick response to changing market conditions is crucial (Gąsiński, Kaczkowska-Serafińska, Kocot, Kwasek, 2024). The determinants of the use of ICT are primarily the digital maturity of the organization, the knowledge management strategy and the readiness of the staff to use digital tools in their daily work (Oyetade, Harmse, Zuva, 2024). An organisational culture conducive to innovation, collaboration and learning also plays a key role. It facilitates the implementation of technological solutions and increases the acceptance of change (Holubčík, Soviar, Rechterík, Höhrová, 2025). In agile structures, ICT is no longer seen as a mere technical

instrument, but is becoming an integral part of a management system that enables the synchronization of inter-team activities, effective communication, and dynamic decision-making (MILOUD, 2025).

In terms of operational management, ICT tools are particularly used in areas that require a rapid flow of information and coordination of tasks. These include, m.in example, project management, logistics, customer service, and sales and marketing processes (Binboga, Gumussoy, 2024). Digital technologies enable ongoing monitoring of progress, control of assets and real-time data analysis. This certainly promotes transparency and increases the effectiveness of actions (de Santana, de Azevedo, Galeale, 2025). In agile organizations, ICT also supports cross-departmental collaboration through the integration of communication platforms, resource planning systems, and analytics tools (Spinello, Fabrizio, Birello, Perin, 2024). Of particular importance is the use of cloud and mobile solutions, which provide access to information regardless of place and time. This becomes the foundation of working in a flexible and decentralized environment (Bayu, Raharjo, Syahbuddin, 2024).

The use of ICT in agile organizations also covers areas related to the development of human capital, innovation and improvement of decision-making processes. Digital tools support online training, competency management, knowledge exchange, and automation of administrative processes (Fukuda, Lander, Pope, 2024). This makes it possible to create a learning organization. In such a space, information is easily accessible and decisions are based on data (Gonfa, Birhanu, Gendo, 2024). In the strategic dimension, ICT allows for faster innovation, shortening the life cycle of projects and optimizing costs (Arshad, Durai Pandi, 2025). As a result, the determinants and areas of use of ICT interpenetrate each other to create a coherent ecosystem. There, technology becomes a tool to strengthen the flexibility, efficiency, and adaptability of agile organizations (Ayokunmi, Seman, Rashid, Mohamad, 2025).

1.2. Analysis of the effects of using ICT tools in an agile organization

Modern organizations increasingly perceive ICT tools as an integral part of everyday functioning. Their application and implementation is becoming one of the key factors shaping the ability of companies to operate in an agile manner (Kocot Kwasek, 2022). Information and communication technologies support both operational and strategic processes. They allow for faster response to changes in the environment, better use of resources, and more effective knowledge and information management (Suciningtias, Sudarsono, Anik, Widhyasti, 2022). In agile work environments, ICT becomes an integrating factor in the organization's activities. It strengthens cohesion between teams and allows for real-time coordination of complex processes (Salehi, 2022). As a result, technological solutions translate directly into organizational efficiency and the quality of decisions made. In turn, their absence limits the adaptability and flexibility of structures (Muhammad et al., 2021).

In the operational dimension, the use of ICT leads to noticeable improvements in areas such as sales, services, marketing or finance, where quick access to data, process automation and effective communication with customers are important (Shajrawi, Aburub, 2023). The introduction of technology in these spheres allows for optimization of activities, increased accuracy of analyses and faster response to market needs (Josyula, Suresh, Raghu Raman, 2023). At the same time, the use of IT systems in administration, training or human resource management is conducive to improving the flow of information and better utilization of the potential of employees (Sathe, Panse, 2023). At the same time, in the R&D, production and logistics departments, ICT supports performance monitoring, task planning and maintaining a high level of quality and process control (Eliwa, Jelodar, Poshdar, 2022). Such a wide range of applications indicates that digital technologies permeate all levels of the functioning of an organization. They form an intricate, integrated ecosystem that supports agile management (Weichbroth, 2022).

Thus, the use of ICT tools brings a number of positive effects for organizations. It makes it easier and more efficient to perform tasks. It certainly increases work efficiency. It also contributes to increasing the speed of action (Alaidaros, Omar, Romli, 2021). These technologies are becoming a factor supporting the implementation of current duties. In addition, they enable you to build a competitive advantage based on knowledge, innovation and flexibility (Chukwunweike, Aro, 2024). In the surveyed organizations, ICT is perceived as an indispensable solution. On the contrary, its absence is associated with a limitation of the ability to develop and adapt to changing environmental conditions (Younus, Abumandil, 2021). The positive effects of technology adoption are due to its ability to connect people, processes, and information into a coherent system where knowledge becomes a strategic resource (Mohagheghi, Lassenius, 2021). In agile organizations, ICT improves functioning, but above all, it enables the creation of an environment conducive to collaboration, innovation and continuous improvement (Orlov et al., 2021; Dzemydienė, Dzemydaitė, Gopiseti, 2022; Sutama et al., 2022; Kucuk, 2023).

2. Methods

The aim of the research was to determine the areas of organizational activity in which ICT tools are most often used, and to identify the effects of their use in the context of the functioning of agile organizations. The research was aimed both at specifying the scope of use of information and communication technologies in individual operational spheres, as well as assessing their impact on efficiency, speed of action and improvement of organizational processes. When formulating the aim of the research, the hypothesis was adopted that the implementation of ICT tools in agile organizations leads to an increase in work efficiency,

improvement of task performance and increased operational flexibility. It is therefore an important factor supporting the development of organizational agility.

The following research questions were formulated as part of the research: (1) In which areas of organizational activity are ICT tools most often used? (2) What are the main impacts of using ICT tools in agile organizations? (3) Does the use of ICT contribute to increasing the efficiency, speed and quality of task implementation in agile organizations?

The research was conducted in 2025 using the survey method on a sample of 525 respondents, representing various sectors of activity. The collected empirical data were subjected to quantitative analysis and presented in a graphical form, allowing for a clear presentation of the distribution of responses and their hierarchy. The results were presented in two types of graphs: the "mustache" chart, which allowed to illustrate the distribution and diversity of indications concerning the areas of ICT application (Fig. 2), and the Pareto chart, which enabled a hierarchical presentation of the effects of the use of ICT in agile organizations (Fig. 4). The applied research approach allowed to create a coherent picture of the use of ICT in the context of organizational agility. It has become possible to determine which technological factors in conditions of variability and uncertainty have the greatest impact on the efficiency, adaptability and improvement of processes in operating organizations.

In the course of the research, sociodemographic data were obtained, which allowed to characterize a sample of 525 respondents in terms of basic social and occupational characteristics. More women than men took part in the study. Women accounted for 57.3% of the total participants, while men accounted for 42.7%. The age structure of the sample indicates that the dominant group were young people, aged 21 to 30, who included 55.0% of respondents. A significant percentage were also participants under the age of 20 – 28.8%. People aged 31-40 accounted for 8.8%, while the 41-50 age group accounted for 6.1% of respondents. The least numerous group was made up of people over 50 years of age, whose share was 1.3%.

In terms of place of residence, the largest percentage were residents of large cities with more than 200 thousand inhabitants - 54.3%. Another group were rural residents, who accounted for 17.7% of the sample. Participants living in cities with up to 20 thousand inhabitants accounted for 11.6%, while people from cities with 21 to 50 thousand inhabitants - 9.0%. The smallest share was recorded by respondents from medium-sized cities, with 51 to 200 thousand inhabitants - 7.4%. The analysis of the financial situation of respondents shows that the majority of respondents declared a good financial situation - 52.0% of respondents. Another group consisted of people assessing their situation as average (31.6%), while 14.1% of respondents indicated a very good financial situation. Only 2.3% of respondents rated their financial situation as bad.

In terms of professional activity, respondents in permanent employment dominated, accounting for 58.9% of the sample. Another group consisted of casual workers - 18.7% of the total. Economically inactive persons accounted for 14.5% and self-employed persons - 5.0%. A small percentage of respondents, i.e. only 0.6%, ran a farm, while 2.5% combined full-time work with running a business.

The sociodemographic data obtained indicate that a diverse group of respondents participated in the survey, with a predominance of young, professionally active women living in large cities and assessing their financial situation as good or average.

3. Results

In the course of the research, we tried to determine in which areas of the organization's activity the respondents most often indicated the use of modern tools and solutions. The results are presented in Figure 1. They show a diverse structure of responses. This proves the different degrees of saturation of individual functional areas with technologies supporting management. The lowest percentage of indications concerned the study area, which received 40 responses (this represents 2.5% of the total). Not much more indications were recorded in the area of ICT service (52 responses, corresponding to 3.3%) and production (59 responses, corresponding to 3.7%). In the case of human resources management, 66 indications were recorded, or 4.2% of all responses. In turn, in the area of logistics, this percentage was higher, as it amounted to 6.1% (96 indications). Slightly more often, respondents indicated the category "other" - 115 answers, which corresponds to 7.3%, and the areas of promotion and training, which received 116 (7.4%) and 120 (7.6%) indications, respectively. The administration came in second place with 129 responses (8.2%). Finance had an even greater share, as 164 indications were recorded, i.e. 10.4%, and marketing, which received 169 indications (10.7%). The most frequently indicated areas were services and sales - with 224 (14.2%) and 225 (14.3%) indications, respectively. Due to the fact that the number of respondents was 525, and it was possible to provide several answers, these results reflect the structure of interests and activities in various areas of the organization's functioning, and not the distribution of individual preferences.

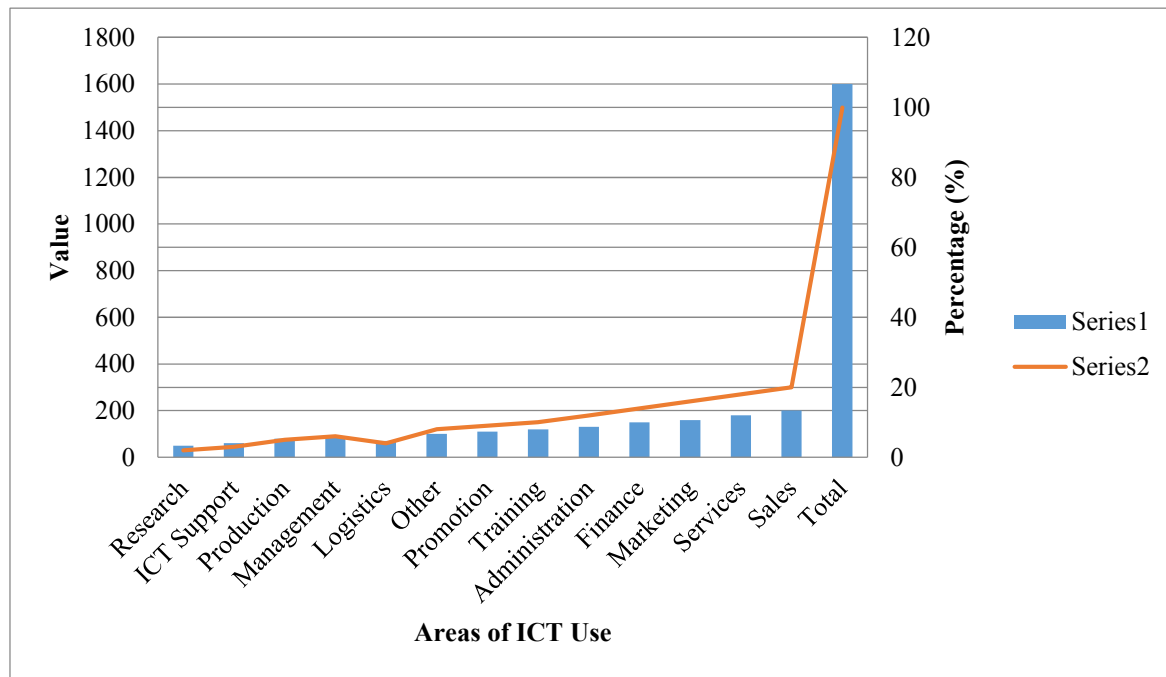


Figure 1. Areas of ICT use in an agile organization.

Source: In-house studies.

In order to analyze the data presented earlier in Figure 1, a "mustache" type diagram was used, presented in Figure 2. The choice of such a chart made it possible to capture the distribution of respondents' responses and the variation in the intensity of indications between individual areas of organizational activity. In this case, the "mustache" chart allowed for a better illustration of which categories were dominant and which were of marginal importance. There is a clear predominance of the "sales" and "services" areas, which are at the highest levels and indicate the highest frequency of occurrence among respondents. This means that it is in these segments that organizational activity and the use of modern management tools are most visible.

Lower values in areas such as "research", "ICT operation" and "production" show that they are relatively less popular fields of application of the analysed solutions. Moderate values were recorded for the categories "logistics", "promotion", "training" and "administration". This indicates their average importance in the response structure.

The use of a "mustache" type chart in this analyzed case allowed for quick detection of differences between categories and for assessment of the degree of dispersion of data. It has brought analytical value because it has highlighted the unevenness of the distribution of responses, with a clear focus in the areas of sales and services and a significant reduction in value in the research and technology spheres. Thanks to this, it became possible to graphically show the concentration of organizational activities and indicate the areas with the highest and lowest degree of use of the researched solutions.

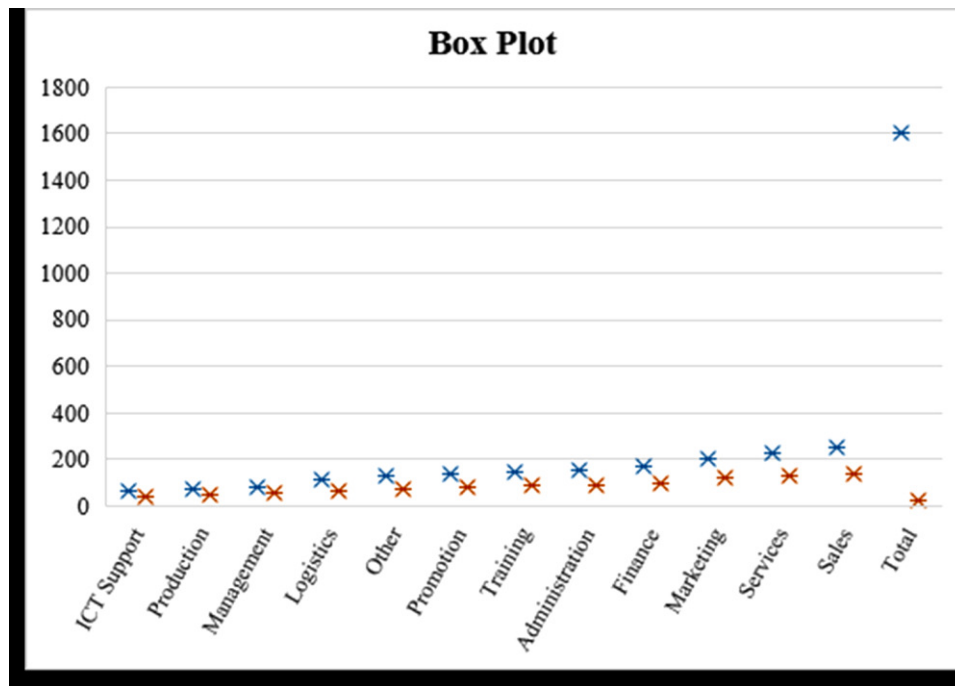


Figure 2. Differentiation of respondents' indications by areas of organizational activity (narrow chart). Source: In-house studies.

Figure 3 visualizes the effects of using ICT tools in an agile organization. The graphic layout used allowed for the simultaneous presentation of the number of indications and their percentage. This allows for a comprehensive assessment of the significance of individual effects resulting from the implementation of information and communication technologies. The data show that the vast majority of respondents attribute ICT to a function that improves and supports organizational processes. This confirms the dominance of the positive effects of implementing this type of tools.

The least indicated effect was the belief that ICT is unnecessary in the workplace. This undoubtedly proves the high level of acceptance of the technology among the respondents. It was slightly more common to say that ICT tools are indispensable in the workplace, which allows us to emphasize their growing role in the daily functioning of teams. A significant percentage of respondents indicated that the use of ICT increases the speed of action, facilitates and streamlines the performance of tasks, as well as increases work efficiency. The latter three categories received the highest values, clearly showing that IT tools are perceived primarily as a factor conducive to process optimization, better work organization and productivity growth.

Figure 3 therefore allows for a synthetic grasp of the structure of the response. It also shows a clear predominance of positive effects over neutral or negative ones. Figure 3 brings cognitive value by indicating that in the context of agile organizations, ICT primarily has a supporting function. Undoubtedly, it contributes to streamlining work and increasing the effectiveness of the tasks performed.

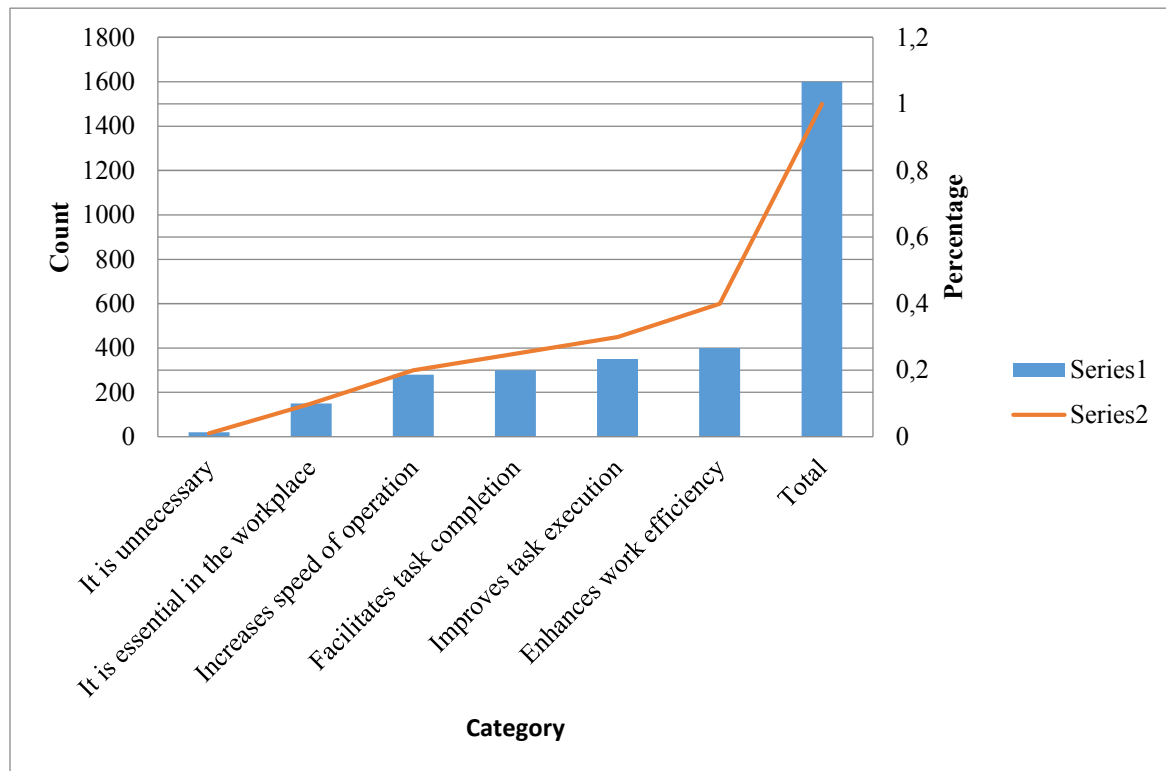


Figure 3. Effects of using ICT tools in an agile organization.

Source: In-house studies.

In order to deepen the analysis of the results presented in Figure 3, a Pareto graph was developed, which is presented in Figure 4. It allows for systematizing and hierarchically ordering the effects of using ICT tools in an agile organization. In contrast to the graph in Figure 3, which showed the general structure of respondents' responses, Figure 4 makes it possible to determine which of the examined effects are of key importance for the functioning of the organization, and which play a secondary role.

The analysis shows that the first three categories - "increases work efficiency", "improves task performance" and "facilitates task performance" - are responsible for nearly 70% of all indications, and this confirms the Pareto 80/20 principle. This means that most of the positive results of ICT implementation are concentrated around a few key areas, directly related to improving the efficiency and quality of work. On the other hand, to a lesser extent, respondents pointed to effects such as "increases speed of action" and "is indispensable in the workplace", which are supportive but not decisive. On the other hand, the statement "is unnecessary" appeared sporadically. This is a confirmation of the high level of acceptance of the technology in the organizational environment.

The use of the Pareto chart in this aspect brings analytical value. It allows you to synthetically indicate which factors bring the greatest benefits from the point of view of organizational agility. In combination with the results presented in Figure 3, it can be concluded that ICT tools improve the implementation of tasks, but above all they contribute to the increase in efficiency and effectiveness of work, being one of the main pillars of agile management.

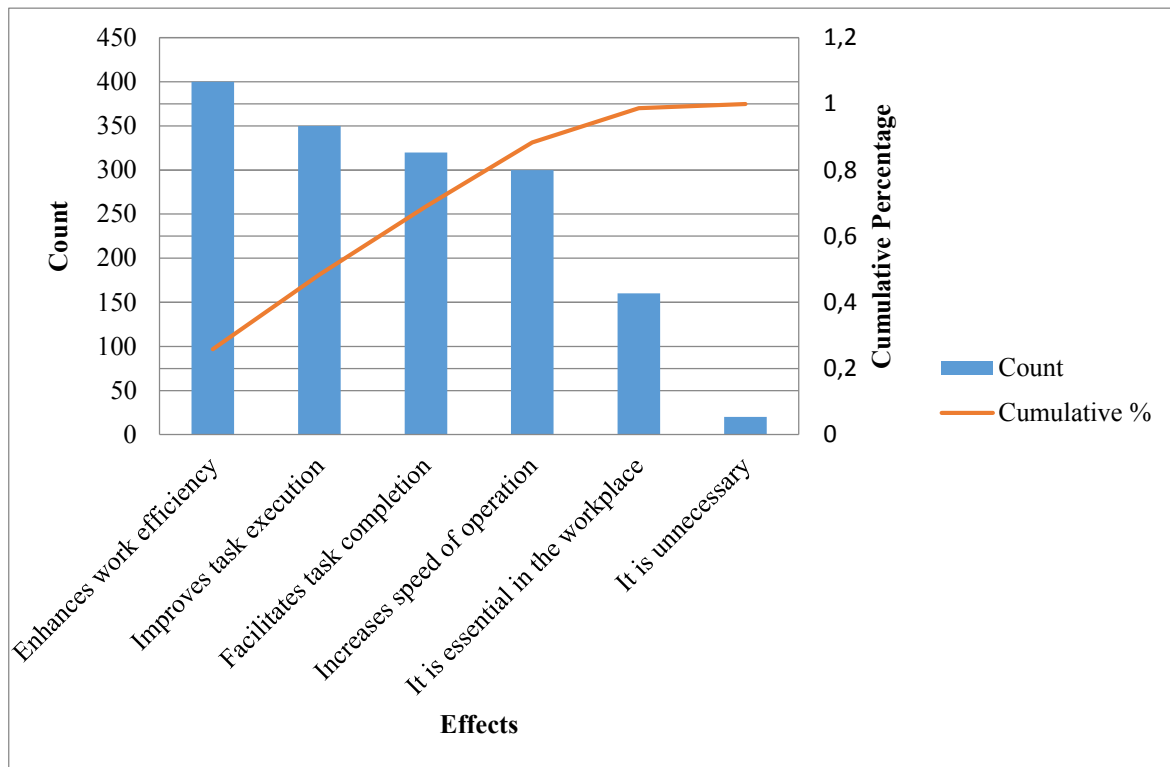


Figure 4. Effects of using ICT tools in an agile organization on the Pareto chart.

Source: In-house studies.

4. Discussion

The presented results of empirical research indicate that the use of ICT tools in agile organizations is an important element supporting both work efficiency and improving the implementation of organizational processes. The data obtained allow us to conclude that information and communication technology is widely accepted and perceived as indispensable in the workplace. Its role, in turn, goes beyond the technical aspect, becoming a tool that shapes an organizational culture based on flexibility, speed of action and cooperation.

The analyses carried out show that the key effects of the implementation of ICT are, first of all, an increase in work efficiency, improvement of the performance of tasks and facilitation of the performance of professional duties. The areas indicated in this way are responsible for a significant part of all declared effects. This is a confirmation that digital technologies play a fundamental role in improving internal processes and increasing the adaptability of organizations. At the same time, a relatively small number of respondents considered ICT unnecessary. This proves with certainty that there is a high level of technological awareness among the respondents.

The results presented in the "mustache" chart showed a clear variation in the intensity of the use of ICT tools in individual areas of organizational activity, confirming that their greatest use concerns sales and services, and to a lesser extent research, production or ICT services. In turn, the Pareto chart analysis made it possible to determine the hierarchy of ICT effects. It confirmed the fact that most of the positive results are centered around a few key factors determining the efficiency of an organization.

The collected empirical data confirmed that in agile organizations, ICT technologies have an integrating and supporting function, as they improve decision-making processes, increase the quality of internal communication and accelerate the flow of information. Research shows that the use of ICT in organizations with a high degree of agility is a strategic factor in development. It determines the ability of an organization to respond flexibly to market changes and maintain a competitive advantage.

Based on the results obtained, it is recommended that organizations, striving to increase their agility and competitiveness, consistently develop and integrate ICT tools in key areas of activity (especially in sales, services and operational processes). The implementation and replacement of information and communication technologies should be treated as a strategic element of management, allowing for flexible response to changes in the environment, faster decision-making and efficient use of resources. It is also necessary to simultaneously invest in the development of employees' digital competences and create an environment conducive to cooperation, innovation and knowledge exchange. Organizations should strive to create a model of ICT use that supports the decentralization of decisions, process automation and improvement of internal communication, while maintaining a high level of data security. The implementation and implementation of digital solutions should be linked to a continuous analysis of their impact on the efficiency and quality of work. Fiber technologies are a real tool supporting the development of an agile organizational culture.

5. Conclusions

The research had some limitations that should be taken into account when interpreting the results obtained. This research was based on a survey method. This means that the data obtained reflects the subjective opinions of respondents, and not actual measurements of the effectiveness of ICT use in organizations. The research sample, although representative in numbers, included mainly young people, mostly professionally active and living in large cities. This may have influenced the perception of the importance and role of ICT. The lack of distinction between the industries in which the surveyed organizations operate should also be included in the rebukes. Undoubtedly, this makes it difficult to fully analyse contextual differences in the way ICT tools are implemented. In addition, the study was cross-sectional

rather than longitudinal. This effect focused on the assessment of changes over time and the long-term effects of technology use in the context of organizational agility. It should also be noted that some respondents may not have had full knowledge of the strategic aspects of ICT implementation in their organizations, and this may have affected the relevance of the answers to some extent. Despite the limitations, the research results provide valuable information on the perception and importance of information and communication technologies in shaping agile organizations.

In the future, research on the use of ICT technologies in agile organizations should focus on an in-depth analysis of the relationship between the level of digitalization and the degree of organizational agility. It would also be necessary to take into account the specifics of individual industries and business models. It is worth expanding the research perspective to include long-term analysis. It would allow to assess the sustainability of the effects of technology implementation and their impact on the development of employee competencies, innovation and adaptability of the organization. An important direction may also be to explore the role of artificial intelligence, process automation and data analytics tools in supporting managerial decisions and creating a competitive advantage. Future research should also cover the cultural and social aspects of technology deployment (such as trust in digital systems, employees' attitudes towards technological change, and the impact of ICT on team relationships). It would also be interesting to conduct comparative studies internationally to identify differences in the level of digital maturity and agile management practices in different economic and cultural contexts. Such an approach will allow for a more complete understanding of the role of technology in shaping modern, flexible organizational structures capable of functioning effectively in conditions of constant variability and uncertainty.

These presented research results indicate that the use of ICT tools primarily contributes to increasing work efficiency, improving task performance and improving the organization of processes. These findings are in line with the results of other authors who analyze the relationship between ICT and organizational agility. Research by Chakravarty, Grewal and Sambamurthy (2013) confirmed that ICT competencies have both an enabling and supporting function in achieving organizational agility, which directly translates into the performance of companies. In turn, Zhang, Li and Chen (2023) proved that increasing organizational agility is an integral factor in successful digital transformation, while Elazhary, Alhawari, Alshurideh and Masa'deh (2023) showed that the quality of technological governance and IT management affects the flexibility and adaptability of an organization. The results of the research presented in another article, in which the positive effects of ICT implementation dominate, therefore remain consistent with the findings of the literature, confirming that ICT plays the role of a catalyst for efficiency and adaptability in agile organizational structures.

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SUSTAINABLE ENTREPRENEURSHIP IN CENTRAL AND EASTERN EUROPE: A COMPARATIVE ANALYSIS OF DEVELOPMENT DYNAMICS (2008-2024)

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Purpose: This study aims to assess the level and dynamics of sustainable entrepreneurship (SusE) and its three pillars – economic (EcoE), social (SocE), and environmental (EnvE) – in selected economies of the Central and Eastern European region. The study also aims to identify long-term changes that occurred during the analysed period and to determine differences between individual countries in the implementation of the concept of sustainable enterprise development.

Design/methodology/approach: The research methodology is based on quantitative comparative analysis using data for eleven Central and Eastern European countries from 2008 to 2024. The study constructed a synthetic index of sustainable entrepreneurship, aggregating three pillars: economic, social, and environmental, based on standardised data from the Eurostat database. Descriptive statistics, linear trends, and dynamics of change were calculated. This approach enabled an assessment of the level, stability, and direction of sustainable entrepreneurship development in both a long-term and comparative perspective.

Findings: The research results indicate a systematic increase in the level of sustainable entrepreneurship in all analysed countries between 2008 and 2024. Significant variation in the SusE was found between countries in the region, with Czechia, Poland, Slovakia, Hungary, and Slovenia leading the way. The environmental pillar exhibited the highest growth dynamics. The social pillar was the most stable. Countries with lower starting levels demonstrated a relatively faster growth rate, confirming the convergence process and the mutual reinforcement effect between pillars.

Research limitations/implications: The study is limited by the macroeconomic level of analysis and the selection and aggregation of variables into a synthetic indicator. Future research could include sectoral or microeconomic analyses, as well as the identification of institutional and technological determinants.

Practical implications: The results can provide a basis for formulating integrated public policies that support sustainable entrepreneurship in the region.

Social implications: The study emphasises the significance of sustainable entrepreneurship in enhancing the quality of life, preserving the environment, and promoting social cohesion.

Originality/value: This paper adds value through a long-term, multidimensional analysis of sustainable entrepreneurship in Central and Eastern Europe using a synthetic indicator.

Keywords: sustainable entrepreneurship; Central and Eastern Europe; synthetic indicator; development dynamics.

Category of the paper: research paper.

1. Introduction

Over the past two decades, the concept of sustainable development has become one of the key paradigms defining the directions of economic, social, and environmental change. Sustainable entrepreneurship, as an extension of the classic idea of entrepreneurship, combines three key dimensions - economic, social, and environmental - enabling value creation in a way that does not limit future development opportunities. The theoretical section of the article emphasises that sustainable entrepreneurship goes beyond the traditional perspective of profit and efficiency, integrating the assumptions of the Triple Bottom Line, the circular economy, socially responsible entrepreneurship, and green innovation. Contemporary literature emphasises its holistic nature and the need to treat it as a process that encompasses the simultaneous creation of economic value, social capital, and a positive ecological impact.

The importance of sustainable entrepreneurship is particularly important in the countries of Central and Eastern Europe, which have undergone dynamic economic, institutional, and social transformations since 2004. These processes, including the modernisation of economic structures, strengthening innovation potential, and the implementation of EU environmental regulations, create unique conditions for analysing sustainable entrepreneurship from a comparative perspective. However, this region remains diverse in terms of the pace of adoption of sustainable development principles, the level of human capital, the quality of institutions, and the implementation of environmental policies. Despite growing academic interest in research in this part of Europe, there is still a lack of studies that approach sustainable entrepreneurship holistically, combining the three pillars in a coherent analytical model and examining their interdependencies.

To address this gap, this article presents an empirical assessment of the level and dynamics of sustainable entrepreneurship in eleven Central and Eastern European countries between 2008 and 2024. This study aims to assess the level and dynamics of sustainable entrepreneurship, as well as its three pillars – economic, social, and environmental – in selected regional economies, and to identify long-term changes and differences between countries. The study utilises a multidimensional synthetic indicator of sustainable entrepreneurship (SusE), built on three components - economic entrepreneurship (EcoE), social entrepreneurship (SocE), and environmental entrepreneurship (EnvE). This unified index enables a holistic assessment of development, cross-country comparisons, and an analysis of the dynamics and stability of individual pillars.

The study's findings allow us to determine whether Central and Eastern European countries are evolving toward a model of entrepreneurship consistent with the concept of sustainable development, and which pillars (economic, social, and environmental) play a key role in shaping their development trajectories. This article contributes to the literature by combining a coherent theoretical framework with empirical analysis based on multi-year data. It provides

a comprehensive picture of sustainable entrepreneurship in a region that, despite its growing economic importance, remains under-researched from the perspective of integrated development indicators.

The originality of the presented material lies in its comprehensive, comparative analysis of the dynamics of sustainable entrepreneurship in Central and Eastern Europe from 2008 to 2024. The research presented in this article integrates cross-country data to examine long-term structural changes related to sustainability-oriented entrepreneurship (existing studies typically focus on a single country or a short period). The methodological approach and the scope of the dataset contribute new empirical evidence to the literature, particularly in the context of post-transition economies.

2. Literature review

The concept of sustainable entrepreneurship is rooted in entrepreneurship theory and the core principles of sustainable development. Its origins date back to the 21st century (Abbas, Bulut, 2024). In the literature, the term first appeared in the context of green or social entrepreneurship. Then, these concepts began to be integrated into the broader framework of sustainable development. The authors focus on economic, social, and environmental goals (Diepolder et al., 2021; Rosário, Figueiredo, 2024).

Sustainable entrepreneurship is a business process that fosters social and ecological development (Alkathiri et al., 2024). Cohen and Winn (2007) and Dean and McMullen (2007) indicated that entrepreneurs can contribute to reducing the negative externalities of the economy. Environmental protection should be achieved through the creation of innovative market solutions. Shepherd and Patzelt (2011) emphasised the preservation of nature, community, and life-support systems. They argued that sustainable entrepreneurship is a form of activity that strives to balance what should be developed and what should be preserved.

More recent studies (e.g., Farny, Binder, 2021; Rosário et al., 2022) emphasise that sustainable entrepreneurship links sustainable development to traditional entrepreneurship. It integrates economic, social, and ecological goals. Sustainable entrepreneurship entails entrepreneurs generating profits, also having a positive impact on nature and society (Ribeiro, Leitão, 2024). Entrepreneurs develop innovations that benefit the circular economy and improve the well-being of local communities (Kowalska, Misztal, 2023). Such entrepreneurship provides a platform for creating an innovative, inclusive, and responsible business model.

A comparison of these definitions shows that, though there is an ordinary core meaning, the priorities in the methodologies of researchers differ. While some authors focus on the value creation process (Cohen, Winn, 2007; Belz, Binder, 2017), others highlight the entrepreneur as a change agent (Shepherd, Patzelt, 2011; Farny, Binder, 2021), and others on the integration of

the three dimensions of sustainable development (economic, social, and environmental). This diversity of definition reflects the interdisciplinary nature of the phenomenon itself and its maturing development in the scientific literature.

Table 1.
Sustainable entrepreneurship - definition

Year	Author	Definition
2007	Cohen, Winn	“Sustainable entrepreneurship is the examination of how opportunities to bring into existence ‘future’ goods and services are discovered, created and exploited, by whom and with what economic, psychological, social and environmental consequences”
2007	Dean, McMullen	“Sustainable entrepreneurship [is] the process of discovering, evaluating, and exploiting economic opportunities that are present in market failures which detract from sustainability, including those that are environmentally relevant”
2010	Schaltegger	“Sustainable entrepreneurs introduce sustainable innovations to the market, which aim and/or effect to contribute to the solution of social or environmental problems”
2011	Shepherd, Patzelt	“Sustainable entrepreneurship is focused on the preservation of nature, life support, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where gain is broadly construed to include economic and non-economic gains to individuals, the economy, and society”
2021	Farny, Binder	“Sustainable entrepreneurship describes the nexus between sustainable development and entrepreneurship. Entrepreneurs aspire to create viable market solutions and intend to act as change agents who realize and exploit opportunities for sustainable development”
2022	Rosário, Cruz, Pires	“In a sustainability context, entrepreneurship can be defined as the process of discovering, creating, and exploiting opportunities to produce goods and services while considering the potential environmental, social, economic, and psychological consequences”
2023	Kowalska, Misztal	"It can be defined as starting and running a business based on incorporating the goals and principles of sustainable development into the company's strategies, business models and operating style"
2024	Guttermann	“Sustainable entrepreneurship is the continuing commitment by businesses to behave ethically and contribute to economic development while improving the quality of life of the workforce, their families, the local and global community as well as future generations”

Source: own study based on the literature on the subject.

Various theoretical paradigms also mark the theory. The Triple Bottom Line philosophy (Elkington, 1997) emphasises the pursuit of economic, social, and environmental goals. Resource-based and innovation theories view sustainable entrepreneurship as achieving a competitive advantage through intangible resources. Institutional theory, in contrast, emphasises the regulatory, policy, and normative structures that encourage sustainability-oriented business practice (Atobishi, Podruzsik, 2025).

Sustainable entrepreneurship can be quantified based on three pillars that are interconnected and reflect the holistic sustainability performance of entrepreneurial activity (Diepolder et al., 2024; Bakry et al., 2022, 2024):

- The economic pillar is the ability of entrepreneurship to promote growth, innovation, and sustainable competitiveness. It records variables such as business start-up rates, high-tech jobs, productivity, and R&D expenditures. Economic success in sustainable entrepreneurship is not an end in itself, but rather a means of promoting social and environmental goals.

- The social pillar focuses on the human and social aspects of entrepreneurship. It concerns how companies contribute to social inclusion, job quality and local well-being. Sustainable entrepreneurship helps develop human capital, ethical standards, and societal harmony. Measuring this aspect is typically through indicators such as labour participation rates, equality in entrepreneurship, access to SME funding, or social innovation engagement.
- The ecological pillar examines how entrepreneurial activity impacts natural resources and ecosystems. It tracks the extent to which firms reduce pollution, responsibly generate waste, and use clean technologies. Some of the standard drivers include CO₂ intensity of emissions, the percentage of renewable energy consumed, energy efficiency, and the adoption of green innovation. The dimension reflects firms' long-term environmental accountability and contribution towards driving climate neutrality goals.

Since it is a multidimensional concept, sustainable entrepreneurship has also been evaluated using composite indices that aggregate multiple variables into a single index. Existing international measures, such as: the Global Entrepreneurship Monitor (GEM), the Global Sustainable Competitiveness Index, serve as valid benchmarking points but also fail to capture the nexus between entrepreneurship and sustainability—especially for transitioning European economies (Sulong et al., 2024; Bindeeba et al., 2025).

The construction of a Sustainable Entrepreneurship Index (SEI) involves some methodological steps (Al-Thani, Koc, 2024; Mondal et al., 2025):

- selection of indicators that proxy the three pillars (economic, social, environmental),
- normalisation of data - to ensure comparability across countries and years,
- weighting and aggregation - usually done with equal or expert-opinion-based weights,
- validation - either through correlation analysis or tests of composite reliability.

The region is undergoing a transition from an efficiency-based to an innovation-based economy, facing challenges such as limited access to green finance, resource-use-intensive lock-ins in industries, and a less established environmental consciousness (Kowalska et al., 2024; Csákné et al., 2025). Measuring sustainable entrepreneurship through a composite index enables the monitoring of these multilateral phenomena and the comparison of each country's approach toward a competitive and sustainable economy.

Although the literature on sustainable entrepreneurship has expanded significantly in recent years, most studies focus on Western European economies or analyze selected countries individually. Comparative analyses covering Central and Eastern Europe as a region, especially over a long-term perspective, remain limited. Moreover, there is a lack of studies that simultaneously examine development dynamics and sustainability-oriented entrepreneurial indicators across multiple CEE countries. According to the literature reviewed, there are no studies that comprehensively analyze sustainable entrepreneurship development in Central and Eastern Europe for the period 2008–2024. Therefore, this study addresses an important research gap and contributes to the existing body of knowledge.

3. Methods

3.1. Research objective, research problem, subject area, and research period

This study aims to assess the level and dynamics of sustainable entrepreneurship (SusE) and its three pillars – economic (EcoE), social (SocE), and environmental (EnvE) – in selected economies of the Central and Eastern European region. The study also aims to identify long-term changes that occurred during the analysed period and to determine differences between individual countries in the implementation of the concept of sustainable enterprise development.

The research question of this article is to determine the actual level and direction of sustainable entrepreneurship development in Central and Eastern European countries. Specifically, it addresses the question of whether entrepreneurship in this part of Europe is evolving towards a model consistent with the principles of sustainable development, or whether an approach focused primarily on achieving economic goals remains the dominant one. It is also important to determine whether these changes are sustainable and multidimensional in nature, and whether they are comparable across the region's economies.

The Central and Eastern European region is a particularly interesting area of research, as entrepreneurship plays an important role in the processes of economic growth and convergence with Western European countries. At the same time, these economies are characterised by a relatively short period of operation under conditions of full integration with the European Union and varying rates of implementation of social and environmental standards. It raises significant doubts about whether the development of entrepreneurship in the region is systemic and sustainable, or a selective effect limited to specific areas of economic activity.

The research area encompasses entrepreneurship analysed at the national level, understood as an element of the economic system shaped by the macroeconomic, institutional, and regulatory conditions characteristic of Central and Eastern European countries. This approach allows us to view sustainable entrepreneurship not only through the lens of individual economic entities but also as a phenomenon with broad developmental implications.

The 2008-2024 research period was chosen due to:

1. The availability of comprehensive, comparable Eurostat data since 2008 (this year saw the harmonisation of many structural indicators, allowing for the consistent construction of economic, social, and environmental indicators).
2. The significance of 2008 as the beginning of the global financial crisis provides a starting point for analysing the resilience, flexibility, and adaptability of enterprises in the region.
3. The period of intensive adaptation of Central and Eastern European economies to EU policies (including climate packages and sustainable development strategies - Europe 2020, Fit for 55, European Green Deal).

4. The availability of data until 2024, which allows for the capture of the latest trends in the development of sustainable entrepreneurship, including post-COVID-19 and under current economic and regulatory changes.

It allows the research period to encompass both the years of macroeconomic shocks and the phases of stabilisation and acceleration of the transformation towards a sustainable economy.

The literature on the subject is dominated by studies that analyse individual dimensions of entrepreneurship separately - economic, social, or environmental. However, comprehensive analyses integrating these three pillars into a single, synthetic indicator are lacking, particularly in Central and Eastern European countries. This study fills this research gap by constructing and applying a composite indicator of sustainable entrepreneurship, enabling the assessment of the level and dynamics of this phenomenon in a comparative and long-term perspective.

The issues discussed are significant from both the theoretical and practical perspectives of economics. From a theoretical perspective, the study contributes to the development of the concept of sustainable entrepreneurship through its operationalisation and empirical verification in a macroeconomic context. In turn, from an applied perspective, the obtained results provide valuable information for public decision-makers, entrepreneurship support institutions, and entrepreneurs, providing a basis for designing and evaluating policies and instruments that foster sustainable economic development.

3.2. Research hypotheses

Based on the literature review and the adopted research concept, one main hypothesis (H0) and five specific hypotheses (H1, H2, H3, H4, H5) were formulated.

The main hypothesis (H0) is that *between 2008 and 2024, there was a systematic increase in the level of sustainable entrepreneurship in Central and Eastern European countries, resulting from the simultaneous improvement of economic, social, and environmental pillars*. Its justification lies in the fact that sustainable entrepreneurship is emerging in conditions of simultaneous growth in economic efficiency, social capital quality, and environmental responsibility. The coherence of public policies, the growing role of EU regulations, and the increased level of socio-economic development support the simultaneous improvement of all three pillars.

The first specific hypothesis (H1) is that *the level of sustainable entrepreneurship in Central and Eastern European countries varies significantly between countries*. It stems from institutional, developmental, technological, and social differences. The countries studied differ in terms of governance quality, economic structure, and degree of implementation of EU policies. These different conditions result in significant differences in the level of all three pillars of entrepreneurship.

The second specific hypothesis (H2) is that *the dynamics of change in the environmental pillar were higher than in the economic and social pillars during the analysed period*. The environmental pillar is strongly stimulated by EU directives, restrictive climate regulations,

and investment support (ETS, Fit for 55). As a result, enterprises adapt more quickly ecologically than economically or socially.

The third specific hypothesis (H3) is that *the greatest stability of changes over time characterises the social pillar of sustainable entrepreneurship*. Human capital, job quality, and the level of social security change gradually. Labour market policies and social institutions are stable and long-term, limiting fluctuations.

The fourth specific hypothesis (H4) is that *the countries with lower initial levels of sustainable entrepreneurship showed a relatively higher rate of growth in this indicator between 2008 and 2024*. According to the convergence theory, less developed economies grow faster. They can easily adapt existing solutions and catch up institutionally. Growth dynamics are relatively higher in these areas.

The fifth specific hypothesis (H5) is that *the changes in the economic, social, and environmental pillars mutually reinforce each other, creating a systemic effect*. The economic pillar supports social and environmental investments, and stable social and ecological conditions increase economic efficiency. A co-reinforcing system is created, in which improvement in one pillar supports the development of the others.

3.3. Research stages

The study was conducted in four main stages. Indicators were created, and simplifications were applied due to the lack of a uniform international indicator of sustainable entrepreneurship. Data are sourced entirely from Eurostat, ensuring methodological consistency and comparability across countries and over time.

1. Stage 1 of the study - variable selection and normalisation.

In the first stage, analytical variables comprising the three pillars of sustainable entrepreneurship: economic, social, and environmental were selected and normalised. Min-max normalisation was applied, transforming the variables to a range of 0-1, enabling comparability across time and across countries. The analysis covered eleven Central and Eastern European countries from 2008 to 2024 – Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia, and Slovenia.

The economic entrepreneurship indicator is a synthetic measure that describes the level and dynamics of enterprise activity, encompassing: quantitative, production, and investment dimensions. It was constructed based on the following variables:

- number of enterprises,
- value of global production,
- total purchases of goods and services,
- investment rate of the enterprise sector.

The selection of variables was based on the assumptions of economic growth theory, entrepreneurship theory, and structural economics, which suggest that entrepreneurship is a process of creating added value, accumulating capital, and transforming resources into productive and innovative activities. Combining these variables enables the conceptualisation of entrepreneurship in quantitative, economic, and dynamic dimensions.

The social entrepreneurship indicator reflects the social impact of enterprise operations, encompassing employment quality and labour productivity. The index is based on the following variables:

- personnel costs,
- wage levels,
- social security costs,
- number of employees,
- labour productivity,
- gross value added per employee.

The selection of indicators is consistent with: human capital theory, labour economics, and the concept of inclusive growth, according to which the development of entrepreneurship should contribute not only to increased production but also to improved working conditions, employment stability, and the efficient use of labour resources.

The environmental entrepreneurship indicator describes the impact of enterprises on the natural environment, based on the level of pollutant emissions. The following variables were used to construct the index:

- CO₂ emissions,
- methane (CH₄) emissions,
- nitrous oxide (N₂O) emissions,
- sulfur oxide (SO₂) emissions,
- nitrogen oxide (NO_x) emissions,
- ammonia (NH₃) emissions.

The variables were selected in consideration of the assumptions of environmental economics and the theory of internalising external costs. The emissions approach is commonly used as a measure of environmental burden and simultaneously allows for the comparison of enterprises' environmental performance across time and space.

2. Stage 2 of the study - construction of pillar indicators - EcoE, SocE, EnvE.

In the second stage, synthetic indicators of economic, social, and environmental entrepreneurship were developed. An equal-weighted aggregation method was used due to the lack of empirical evidence to differentiate the significance of individual variables and the need to maintain comparability across countries and years. For each pillar, the following were calculated:

- descriptive statistics (mean, median, SD, min, max),
- trend line with coefficient of determination:

$$\begin{aligned} EcoE &= \alpha_0 + \alpha_1 \cdot time + \varepsilon, \\ SocE &= \alpha_0 + \alpha_1 \cdot time + \varepsilon, \\ EnvE &= \alpha_0 + \alpha_1 \cdot time + \varepsilon. \end{aligned} \quad (1)$$

The interpretation of R^2 :

- 0-0.5 - satisfactory,
- 0.5-0.6 - poor,
- 0.6-0.8 - satisfactory,
- 0.8-0.9 good,
- 0.9-1.0 very good.

3. *Stage 3 of the study - construction of a synthetic indicator of sustainable entrepreneurship (SusE).*

$$SusE = EcoE + SocE + EnvE \quad (2)$$

The following were calculated:

- descriptive statistics (mean, median, SD, min, max),
- trend line with the coefficient of determination (according to the previously adopted scale).

This procedure allowed for the assessment of both the level and dynamics of sustainable entrepreneurship development in Central and Eastern European countries from 2008 to 2024.

4. *Stage 4 of the study - a sustainable entrepreneurship ranking for Central and Eastern European countries.*

In the final, fourth stage of the study, a ranking of Central and Eastern European countries was created based on average SusE values, which enabled the identification of leaders and countries with lower levels of the sustainable entrepreneurship index. The ranking is synthetic in nature and encompasses the full cross-section of the years studied, enabling the assessment of each country's long-term position.

4. Results

Table 2 presents synthetic indicators of economic, social, and environmental entrepreneurship in Central and Eastern European countries in 2008-2024 (EcoE, SocE, EnvE – the three pillars of the synthetic indicator of sustainable entrepreneurship in Central and Eastern European countries in 2008-2024 – SusE). Their values range from 0 to 1 – the higher the indicator level, the higher the level of development of a given pillar of sustainable entrepreneurship.

The economic entrepreneurship indicator in Central and Eastern European countries from 2008-2024 is a synthetic measure of the activity and development potential of the business sector, integrating information on the scale of companies' operations, their production results, market connections, and propensity to invest.

A systematic increase in the EcoE is observed in all analysed countries between 2008 and 2024, with a particularly pronounced acceleration observed after 2013. This trend may indicate:

- improved economic efficiency of the enterprise sector, manifested by an increase in the scale and results of production activities,
- increased capital expenditures, including investments in modern technologies and innovation,
- increased resilience of enterprises to economic fluctuations and macroeconomic shocks,
- gradual stabilisation of business conditions, favouring long-term development planning.

Countries such as the Czechia, Poland, and Estonia achieve the highest and most stable EcoE values, indicating a strong foundation for the development of sustainable entrepreneurship.

The social entrepreneurship indicator in Central and Eastern European countries from 2008 to 2024 is a synthetic measure that describes the level and dynamics of the social impact of enterprises on the economy, measured in terms of employment, working conditions, and labour productivity.

Table 2 shows a clear and systematic increase in the SocE in all countries. This trend may indicate:

- improved working conditions and wage levels, reflected in rising personnel costs and social security benefits,
- increased quality of human capital and the efficiency of its utilisation, reflected in increased labour productivity and gross value added per employee,
- the growing importance of employment as a component of enterprise development strategies, measured by changes in the number of employees,
- the gradual strengthening of the social dimension of economic development, including greater labour market inclusiveness and stabilisation of employer-employee relations.

The highest SocE values are in Slovenia, the Czechia, and Estonia, indicating a very high level of social development in the context of entrepreneurship.

The environmental entrepreneurship indicator in Central and Eastern European countries from 2008 to 2024 is a synthetic measure that assesses the environmental impact of business activity, taking into account greenhouse gas and air pollutant emissions. It allows for comparisons of the environmental performance of the business sector nationally and over time.

Table 2 shows an increase in EnvE in all countries (especially after 2015). This trend may indicate:

- improved environmental performance of businesses, manifested by reduced greenhouse gas and air pollutant emissions,
- the growing importance of environmental protection policies and sustainability standards in business operations,
- the implementation of modern technologies and pro-environmental practices in production,
- the increasing resilience of the business sector to regulatory and social pressures related to environmental protection.

Countries such as the Czechia, Slovakia, Slovenia, and Romania have achieved values close to 1.00 in recent years, indicating a very high level of environmental target achievement.

Table 2.

Synthetic indicators of economic, social and environmental entrepreneurship, Central and Eastern European countries (2008-2024)

Country	Synthetic indicator (pillars of SusE)	Year																
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Bulgaria	EcoE	0.77	0.71	0.64	0.69	0.72	0.7	0.73	0.74	0.73	0.77	0.81	0.85	0.84	0.83	0.84	0.84	0.85
	SocE	0.63	0.61	0.61	0.63	0.63	0.64	0.66	0.7	0.72	0.77	0.81	0.87	0.89	0.88	0.88	0.89	0.9
	EnvE	0.66	0.71	0.69	0.64	0.68	0.79	0.74	0.72	0.76	0.76	0.79	0.83	0.87	0.86	0.87	0.87	0.88
Croatia	EcoE	0.97	0.89	0.76	0.73	0.71	0.71	0.7	0.75	0.75	0.8	0.83	0.88	0.83	0.82	0.82	0.83	0.83
	SocE	0.87	0.84	0.84	0.82	0.8	0.81	0.83	0.84	0.86	0.89	0.92	0.95	0.93	0.92	0.92	0.93	0.94
	EnvE	0.59	0.67	0.67	0.68	0.73	0.83	0.87	0.82	0.85	0.82	0.86	0.9	0.95	0.94	0.94	0.95	0.96
Czechia	EcoE	0.86	0.77	0.83	0.88	0.87	0.85	0.83	0.85	0.85	0.9	0.95	0.96	0.92	0.91	0.91	0.92	0.93
	SocE	0.82	0.77	0.79	0.81	0.8	0.79	0.79	0.81	0.83	0.87	0.91	0.93	0.91	0.9	0.91	0.92	0.93
	EnvE	0.66	0.72	0.74	0.72	0.74	0.77	0.78	0.76	0.79	0.81	0.85	0.91	1	0.99	0.99	0.99	0.99
Estonia	EcoE	0.7	0.57	0.59	0.7	0.74	0.79	0.76	0.77	0.78	0.84	0.88	0.92	0.87	0.86	0.87	0.87	0.88
	SocE	0.69	0.65	0.66	0.7	0.72	0.74	0.76	0.77	0.79	0.83	0.87	0.9	0.9	0.89	0.89	0.9	0.91
	EnvE	0.65	0.7	0.65	0.66	0.66	0.65	0.65	0.71	0.71	0.69	0.72	0.83	0.96	0.95	0.95	0.96	0.97
Hungary	EcoE	0.81	0.72	0.73	0.75	0.74	0.73	0.78	0.81	0.82	0.88	0.93	0.99	0.97	0.96	0.97	0.97	0.99
	SocE	0.8	0.75	0.76	0.77	0.76	0.78	0.79	0.82	0.83	0.86	0.9	0.91	0.88	0.87	0.88	0.89	0.9
	EnvE	0.78	0.85	0.85	0.84	0.9	0.89	0.88	0.88	0.89	0.84	0.84	0.9	0.93	0.92	0.93	0.94	0.96
Lithuania	EcoE	0.69	0.51	0.52	0.6	0.66	0.7	0.72	0.74	0.75	0.81	0.89	0.94	0.9	0.89	0.9	0.91	0.92
	SocE	0.59	0.54	0.56	0.59	0.6	0.62	0.65	0.67	0.71	0.75	0.81	0.72	0.74	0.73	0.74	0.74	0.75
	EnvE	0.81	0.92	0.89	0.85	0.85	0.89	0.88	0.84	0.85	0.84	0.79	0.84	0.81	0.8	0.81	0.82	0.83
Latvia	EcoE	0.77	0.58	0.6	0.67	0.76	0.77	0.76	0.78	0.79	0.85	0.87	0.91	0.85	0.84	0.84	0.85	0.85
	SocE	0.69	0.62	0.63	0.65	0.68	0.7	0.71	0.73	0.75	0.78	0.85	0.9	0.9	0.89	0.91	0.92	0.92
	EnvE	0.84	0.87	0.87	0.89	0.87	0.87	0.86	0.86	0.87	0.84	0.83	0.82	0.88	0.87	0.88	0.89	0.91
Poland	EcoE	0.77	0.7	0.73	0.77	0.76	0.78	0.81	0.82	0.81	0.84	0.94	0.97	0.94	0.93	0.94	0.94	0.95
	SocE	0.7	0.69	0.72	0.73	0.73	0.73	0.74	0.75	0.76	0.8	0.87	0.91	0.91	0.9	0.91	0.92	0.93
	EnvE	0.77	0.83	0.83	0.84	0.86	0.87	0.89	0.9	0.92	0.89	0.9	0.96	0.97	0.96	0.96	0.97	0.97
Romania	EcoE	0.81	0.68	0.66	0.77	0.73	0.7	0.71	0.78	0.76	0.78	0.82	0.88	0.86	0.85	0.86	0.87	0.88
	SocE	0.71	0.66	0.67	0.68	0.68	0.71	0.72	0.71	0.75	0.8	0.72	0.77	0.77	0.76	0.77	0.78	0.79
	EnvE	0.68	0.76	0.8	0.77	0.8	0.84	0.86	0.86	0.92	0.94	0.93	0.92	0.99	0.98	0.98	0.99	0.99
Slovakia	EcoE	0.6	0.5	0.71	0.73	0.73	0.79	0.79	0.81	0.82	0.86	0.93	0.91	0.86	0.85	0.85	0.87	0.9
	SocE	0.75	0.73	0.78	0.8	0.8	0.79	0.79	0.82	0.83	0.86	0.89	0.91	0.91	0.9	0.92	0.93	0.95
	EnvE	0.6	0.65	0.66	0.7	0.74	0.78	0.79	0.79	0.83	0.83	0.86	0.92	1	0.99	0.99	0.99	1
Slovenia	EcoE	0.88	0.77	0.74	0.75	0.75	0.74	0.75	0.76	0.78	0.84	0.88	0.9	0.83	0.82	0.83	0.84	0.87
	SocE	0.84	0.8	0.82	0.83	0.81	0.81	0.83	0.84	0.87	0.89	0.92	0.94	0.94	0.93	0.95	0.97	0.98
	EnvE	0.69	0.73	0.73	0.74	0.77	0.79	0.84	0.87	0.89	0.9	0.89	0.91	0.98	0.97	0.98	0.98	0.99

Source: own study based on the Eurostat database, <https://ec.europa.eu/eurostat>, accessed: 04.12.2025.).

Between 2008 and 2024, Central and Eastern European countries saw a systematic increase in all three pillars of sustainable entrepreneurship – EcoE, SocE, and EnvE. These indicators synthetically reflect, respectively: the activity and development potential of enterprises,

the social impact of economic activity, and the impact of the business sector on the natural environment. An increase in EcoE indicates increasing economic efficiency, investment in innovation, and stabilisation of economic conditions. An increase in SocE indicates improved working conditions, the development of human capital, and increased inclusiveness in the labour market. An increase in EnvE, on the other hand, reflects the increasing ecological efficiency of enterprises, the implementation of pro-ecological technologies, and the importance of environmental protection policies. The highest values of individual indicators are observed in countries such as the Czechia, Estonia, Slovenia, and Slovakia, demonstrating a strong foundation for the development of sustainable entrepreneurship in the region.

Table 3 presents basic descriptive statistics for the synthetic indicators related to the pillars of sustainable entrepreneurship (SusE) – EcoE, SocE, EnvE in Central and Eastern European countries between 2008 and 2024.

An analysis of the synthetic indicators for the three pillars of sustainable entrepreneurship in Central and Eastern European countries from 2008 to 2024 reveals both common development trends and significant differences between countries. The presented table includes mean, median, minimum, maximum, and standard deviation values, allowing for a more comprehensive assessment of the stability and variability of individual pillars.

Considering EcoE, the mean values range from 0.77 (Lithuania, Bulgaria) to 0.88 (Czechia). The medians are close to the mean in most countries, indicating a relatively symmetrical distribution of the indicator. The highest median value was recorded in the Czechia (0.88), with high values also found in Poland, Hungary, Croatia, Slovakia, and Slovenia (around 0.82). The lowest median value is in Lithuania (0.75), confirming the greater instability of the economic conditions for entrepreneurship. The maximum values reach as high as 0.99 in Hungary, while the minimum values drop to 0.50 in Slovakia and 0.51 in Lithuania (indicating significant differences in the stability of economic conditions). The standard deviation of EcoE is highest in Lithuania (0.14) and Slovakia (0.11) - indicating significant temporal variability. The most stable conditions were recorded in the Czechia and Slovenia (0.05 each), as well as in Croatia (0.07). The countries with the highest average EcoE values – Czechia (0.88), Hungary (0.86), and Poland (0.85) – are characterised by a favourable economic environment and relatively high resilience to cyclical changes.

Regarding SocE, mean values range from 0.68 in Lithuania to 0.88 in Croatia and Slovenia. The highest medians are found in Croatia and Slovenia (both 0.87), as well as in the Czechia, Hungary, and Slovakia (around 0.83), indicating a consistently high level of the social pillar of entrepreneurship. The lowest median was again recorded in Lithuania (0.71). In Bulgaria, Poland, and Latvia, the medians are lower than the average, suggesting the impact of periodic increases on the average value. The maximum values reach 0.98 in Slovenia and 0.95 in Croatia, while the minimum values fall to 0.54 in Lithuania and 0.61 in Bulgaria. The standard deviations are lowest in Romania (0.04) and Slovenia (0.06) - indicating a high degree of stability in the social conditions for entrepreneurship. The greatest variability is observed in

Bulgaria (0.11) and Latvia (0.11). The highest mean SocE values, recorded in Slovenia and Croatia (both 0.88), indicate well-developed social capital, education, safety, and social support systems.

Mean EnvE values are generally high, ranging from 0.77 in Estonia and Bulgaria to 0.90 in Poland. The highest median values were recorded in Poland (0.90), Romania (0.92), Hungary, and Slovenia (both 0.89), confirming consistently high levels of environmental activities. The differences between the median and mean in Czechia and Estonia, however, indicate greater variability in this pillar over time. Maximum values reach 1.00 in Czechia and Slovakia, indicating that the highest possible values were achieved in selected years. The lowest minimum values are recorded in Croatia (0.59) and Slovakia (0.60). The standard deviation is lowest in Latvia (0.02) and Lithuania (0.03) - indicating stable and consistent development of environmental policies. The greatest variability is observed in Estonia (0.13), as well as in Slovakia and the Czechia (0.11 each). Countries with the highest average values - Poland (0.90), Romania (0.88), and Latvia (0.87) are distinguished by the intensive implementation of pro-environmental measures and the high effectiveness of their environmental policies.

Table 3.

Synthetic indicators of economic, social and environmental entrepreneurship, Central and Eastern European countries (2008-2024) – basic descriptive statistics

Country	Synthetic indicator (pillars of SusE)	Basic descriptive statistics				
		Mean	Standard deviation	Median	Max	Min
Bulgaria	EcoE	0.77	0.06	0.77	0.85	0.64
	SocE	0.75	0.11	0.72	0.90	0.61
	EnvE	0.77	0.08	0.76	0.88	0.64
Croatia	EcoE	0.80	0.07	0.82	0.97	0.70
	SocE	0.88	0.05	0.87	0.95	0.80
	EnvE	0.83	0.11	0.85	0.96	0.59
Czechia	EcoE	0.88	0.05	0.88	0.96	0.77
	SocE	0.85	0.06	0.83	0.93	0.77
	EnvE	0.84	0.11	0.79	1.00	0.66
Estonia	EcoE	0.79	0.10	0.79	0.92	0.57
	SocE	0.80	0.09	0.79	0.91	0.65
	EnvE	0.77	0.13	0.71	0.97	0.65
Hungary	EcoE	0.86	0.10	0.82	0.99	0.72
	SocE	0.83	0.06	0.83	0.91	0.75
	EnvE	0.88	0.04	0.89	0.96	0.78
Lithuania	EcoE	0.77	0.14	0.75	0.94	0.51
	SocE	0.68	0.08	0.71	0.81	0.54
	EnvE	0.84	0.03	0.84	0.92	0.79
Latvia	EcoE	0.78	0.09	0.79	0.91	0.58
	SocE	0.78	0.11	0.75	0.92	0.62
	EnvE	0.87	0.02	0.87	0.91	0.82
Poland	EcoE	0.85	0.09	0.82	0.97	0.70
	SocE	0.81	0.09	0.76	0.93	0.69
	EnvE	0.90	0.06	0.90	0.97	0.77
Romania	EcoE	0.79	0.07	0.78	0.88	0.66
	SocE	0.73	0.04	0.72	0.80	0.66
	EnvE	0.88	0.09	0.92	0.99	0.68

Cont. table 3.

Slovakia	EcoE	0.79	0.11	0.82	0.93	0.50
	SocE	0.84	0.07	0.83	0.95	0.73
	EnvE	0.83	0.13	0.83	1.00	0.60
Slovenia	EcoE	0.81	0.05	0.82	0.90	0.74
	SocE	0.88	0.06	0.87	0.98	0.80
	EnvE	0.86	0.10	0.89	0.99	0.69

Source: own study based on the Eurostat database, <https://ec.europa.eu/Eurostat>, 04.12.2025.

Analysis of descriptive statistics for EcoE, SocE, and EnvE reveals relatively high levels of indicators (with notable differences in stability and variability among the studied countries). In most cases, the medians are close to the mean values, suggesting relatively symmetrical distributions of indicators over time. EcoE is characterised by moderate variability – the highest and most stable values were recorded in the Czechia, Poland, and Slovenia, while the greatest variability was observed in Lithuania and Slovakia. SocE exhibits high levels and stability in countries such as Slovenia, Croatia, and the Czech Republic, whereas it has lower and more volatile values in Bulgaria and Lithuania. EnvE, on the other hand, achieves the highest average values among the analysed areas, with particularly stable development observed in the Baltic States and Poland, and greater variability in Estonia, the Czechia, and Slovakia.

Table 4 presents the linear trend equations for the synthetic indicators related to the pillars of sustainable entrepreneurship (SusE) – EcoE, SocE, EnvE in Central and Eastern European countries between 2008 and 2024. These equations allow for an assessment of the direction and dynamics of change in the studied countries. The trend slopes provide information about the rate of change over time. The coefficients of determination R^2 indicate the degree of fit of the linear model to the empirical data and, therefore, the stability of the observed trends.

Regarding EcoE, positive slopes are observed in most of the analyzed countries, confirming the systematic improvement in economic conditions conducive to entrepreneurship. The strongest growth is in Lithuania (0.0256), Hungary (0.0190), Estonia (0.0177), and Poland (0.0165). At the same time, very weak trends were observed in Croatia (0.0014) and Slovenia (0.0060), indicating marginal changes in this area. An assessment of trend stability shows that the highest R^2 values were obtained in Poland (0.8593), Lithuania (0.8346), and Hungary (0.8270), indicating well-formed and regular upward trends. In contrast, the exceptionally low R^2 value in Croatia (0.0093) indicates the lack of a clear, stable economic trend over time. These results indicate that, despite the generally positive direction of change, the EcoE is characterized by significant variation in strength and stability across countries.

SocE in all analyzed countries exhibits positive slopes, indicating an improvement in the social conditions that influence entrepreneurship. The highest growth is in Bulgaria (0.0223) and Latvia (0.0212), as well as in Estonia (0.0179) and Poland (0.0172). The lowest slopes were observed in Romania (0.0076) and Croatia (0.0082) - indicating a slower pace of social change in these countries. At the same time, the social pillar is characterized by very high trend stability – the highest R^2 values were obtained in Slovakia (0.9456), Estonia (0.9324), Bulgaria (0.9212), and Poland (0.9069). The lowest linear model fit was observed in Croatia ($R^2 = 0.6676$),

although the trend remained upward there as well. This indicates that improving social conditions is a universal process, but its pace and regularity vary across countries.

EnvE is characterized by the greatest dynamics of change. In most countries, the growth rate is significantly higher than in the economic and social pillars. The highest slope values are observed in Slovakia (0.0261), Estonia (0.0233), the Czechia (0.0221), Croatia (0.0218), and Slovenia (0.0199). Very low growth was recorded in Latvia (0.0012) and Hungary (0.0073), and in Lithuania, the trend is negative (-0.0043), indicating a slight deterioration in the environmental pillar over time. Analysis of the coefficients of determination confirms the high stability of this pillar – the highest R^2 values were achieved in Slovakia (0.9636), Slovenia (0.9606), Romania (0.9220), Poland (0.9115), and the Czechia (0.9092). The lowest R^2 values are found in Latvia (0.0644) and Lithuania (0.3702), indicating high variability and no clear trend in these countries.

Table 4.

Synthetic indicators of economic, social and environmental entrepreneurship, Central and Eastern European countries (2008-2024) – trend lines

Country	Synthetic indicator (pillars of SusE)	Trend line
Bulgaria	EcoE	$y = 0.0112x + 0.6674; R^2 = 0.7205$
	SocE	$y = 0.0223x + 0.5477; R^2 = 0.9212$
	EnvE	$y = 0.0149x + 0.6376; R^2 = 0.8609$
Croatia	EcoE	$y = 0.0014x + 0.788; R^2 = 0.0093$
	SocE	$y = 0.0082x + 0.8034; R^2 = 0.6676$
	EnvE	$y = 0.0218x + 0.6288; R^2 = 0.8892$
Czechia	EcoE	$y = 0.0075x + 0.8143; R^2 = 0.5818$
	SocE	$y = 0.0104x + 0.7584; R^2 = 0.8013$
	EnvE	$y = 0.0221x + 0.6367; R^2 = 0.9092$
Estonia	EcoE	$y = 0.0177x + 0.6279; R^2 = 0.7642$
	SocE	$y = 0.0179x + 0.6368; R^2 = 0.9324$
	EnvE	$y = 0.0233x + 0.5595; R^2 = 0.7789$
Hungary	EcoE	$y = 0.019x + 0.6849; R^2 = 0.827$
	SocE	$y = 0.0101x + 0.7413; R^2 = 0.8023$
	EnvE	$y = 0.0073x + 0.8178; R^2 = 0.6404$
Lithuania	EcoE	$y = 0.0256x + 0.5369; R^2 = 0.8346$
	SocE	$y = 0.014x + 0.5509; R^2 = 0.7744$
	EnvE	$y = -0.0043x + 0.8812; R^2 = 0.3702$
Latvia	EcoE	$y = 0.0144x + 0.6548; R^2 = 0.6205$
	SocE	$y = 0.0212x + 0.5879; R^2 = 0.9143$
	EnvE	$y = 0.0012x + 0.8555; R^2 = 0.0644$
Poland	EcoE	$y = 0.0165x + 0.6982; R^2 = 0.8593$
	SocE	$y = 0.0172x + 0.6513; R^2 = 0.9069$
	EnvE	$y = 0.0115x + 0.7962; R^2 = 0.9115$
Romania	EcoE	$y = 0.0117x + 0.683; R^2 = 0.6496$
	SocE	$y = 0.0076x + 0.6638; R^2 = 0.743$
	EnvE	$y = 0.0182x + 0.7188; R^2 = 0.922$
Slovakia	EcoE	$y = 0.0187x + 0.6262; R^2 = 0.7005$
	SocE	$y = 0.0132x + 0.726; R^2 = 0.9456$
	EnvE	$y = 0.0261x + 0.5957; R^2 = 0.9636$
Slovenia	EcoE	$y = 0.006x + 0.7538; R^2 = 0.2936$
	SocE	$y = 0.0116x + 0.7762; R^2 = 0.8775$
	EnvE	$y = 0.0199x + 0.6824; R^2 = 0.9606$

Source: own study based on the Eurostat database, <https://ec.europa.eu/Eurostat>, 04.12.2025.

In summary, the environmental pillar is characterised by the highest dynamics and the most pronounced growth trends, the social pillar by the greatest stability and consistency of change, while the economic pillar, despite positive trends, remains the most diverse among Central and Eastern European countries. These results confirm that the process of sustainable entrepreneurship in Central and Eastern Europe:

- is progressing multidimensionally,
- its pace and coherence depend on the specific characteristics of the given country and the prevailing development priorities.

Table 5 presents the sustainable entrepreneurship indicator (SusE) for Central and Eastern European countries from 2008 to 2024. The indicator provides an aggregated measure of the level of entrepreneurship development in economic, social, and environmental terms. Values ranging from 0 to 1. The higher values indicate higher levels of sustainable entrepreneurship in the analysed countries.

Data analysis reveals a clear and long-term upward trend in SusE across all analysed Central and Eastern European countries from 2008 to 2024. In the long term, a systematic increase in the level of sustainable entrepreneurship is observed (despite temporary declines or stagnation in the initial period – especially in the years 2009-2012, related to, among other things, the global financial crisis). The changes may indicate:

- the growing importance of sustainable development standards in economic policies and business practices,
- the gradual integration of economic, social, and environmental goals into enterprise development strategies,
- improved efficiency of the enterprise sector in a changing institutional and regulatory environment,
- increasing the adaptability of enterprises to macroeconomic, social, and environmental challenges.

Throughout the analysed period, the highest and most stable SusE values were achieved by the Czechia, Poland, Hungary, Slovakia, and Slovenia, reaching a value of approximately 0.95 in 2023-2024. It demonstrates a very high level of sustainable entrepreneurship development, resulting from relatively strong economic foundations, a high level of social development, and the effective implementation of pro-ecological solutions. The Baltic countries (Estonia, Lithuania, and Latvia) are characterised by dynamic growth in SusE values, especially after 2013, indicating consistent catching up and effective adaptation of enterprise structures to the requirements of sustainable development. On the other hand, Bulgaria and Romania, despite lower initial values, show a clear improvement in SusE levels (throughout the study period), suggesting a gradual strengthening of entrepreneurial potential and the growing importance of social and environmental aspects in economic activity. Notably, the strongest increase in the SusE occurred after 2015. It can be attributed to:

- intensification of EU policies regarding sustainable development and energy transition,
- increased investment in innovation and environmentally friendly technologies,
- improved quality of labour market institutions and employment conditions,
- strengthening corporate social responsibility (CSR) as a sustainable element of business models.

Table 5.

Synthetic indicator of sustainable entrepreneurship, Central and Eastern European countries (2008-2024)

Country	Synthetic indicator	Year																
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Bulgaria	SusE	0.69	0.68	0.65	0.65	0.68	0.71	0.71	0.72	0.74	0.77	0.80	0.85	0.87	0.86	0.86	0.87	0.88
Croatia	SusE	0.81	0.80	0.76	0.74	0.75	0.78	0.80	0.80	0.82	0.84	0.87	0.91	0.90	0.89	0.89	0.90	0.91
Czechia	SusE	0.78	0.75	0.79	0.80	0.80	0.80	0.80	0.81	0.82	0.86	0.90	0.93	0.94	0.93	0.94	0.94	0.95
Estonia	SusE	0.68	0.64	0.63	0.69	0.71	0.73	0.72	0.75	0.76	0.79	0.82	0.88	0.91	0.90	0.90	0.91	0.92
Hungary	SusE	0.80	0.77	0.78	0.79	0.80	0.80	0.82	0.84	0.85	0.86	0.89	0.93	0.93	0.92	0.93	0.93	0.95
Lithuania	SusE	0.70	0.66	0.66	0.68	0.70	0.74	0.75	0.75	0.77	0.80	0.83	0.83	0.82	0.81	0.82	0.82	0.83
Latvia	SusE	0.77	0.69	0.70	0.74	0.77	0.78	0.78	0.79	0.80	0.82	0.85	0.88	0.88	0.87	0.88	0.89	0.89
Poland	SusE	0.75	0.74	0.76	0.78	0.78	0.79	0.81	0.82	0.83	0.84	0.90	0.95	0.94	0.93	0.94	0.94	0.95
Romania	SusE	0.73	0.70	0.71	0.74	0.74	0.75	0.76	0.78	0.81	0.84	0.82	0.86	0.87	0.86	0.87	0.88	0.89
Slovakia	SusE	0.65	0.63	0.72	0.74	0.76	0.79	0.79	0.81	0.83	0.85	0.89	0.91	0.92	0.91	0.92	0.93	0.95
Slovenia	SusE	0.80	0.77	0.76	0.77	0.78	0.78	0.81	0.82	0.85	0.88	0.90	0.92	0.92	0.91	0.92	0.93	0.95

Source: own study based on the Eurostat database, <https://ec.europa.eu/eurostat>, 04.12.2025.

In summary, between 2008 and 2024, Central and Eastern European countries have seen significant progress in sustainable entrepreneurship. The growth of SusE confirms a gradual shift from an entrepreneurship model primarily based on economic growth to a more sustainable approach that simultaneously considers social and environmental aspects.

Table 6 presents basic descriptive statistics for the synthetic sustainable entrepreneurship indicator (SusE) for Central and Eastern European countries from 2008 to 2024. The summary includes mean values, medians, minimum values, maximum values, and standard deviations, enabling the assessment of both the level of sustainable entrepreneurship development and its stability and variability over time.

Analysis of the mean values indicates a relatively high yet varied level of SusE across the studied countries. The highest mean values are achieved in Czechia and Hungary (both 0.86), as well as in Poland and Slovenia (both 0.85) - indicating a well-developed, sustainable entrepreneurship model that integrates economic, social, and environmental aspects. The lowest mean values were recorded in Bulgaria and Lithuania (both 0.76) and Estonia (0.78), which may indicate a slower pace of integrating individual pillars of sustainable development into business operations. The SusE medians are very close to the mean values in most countries, suggesting a relatively symmetrical distribution of observations over time. The highest median values are found in Slovenia (0.85) and Hungary (0.85), as well as in Poland and the Czechia (0.83 and 0.82, respectively). The lowest median values are found in Bulgaria (0.74) and Estonia (0.76), confirming the more volatile and less stable development of sustainable

entrepreneurship in these countries. The range of variation of the SusE, defined by the minimum and maximum values, indicates significant differences between countries. The highest maximum values (0.95) are achieved in Czechia, Hungary, Poland, Slovakia, and Slovenia, indicating a very high level of implementation of sustainable entrepreneurship principles in the final years of the analysed period. In contrast, the lowest minimum values are in Estonia and Slovakia (0.63 each), as well as in Bulgaria (0.65) - indicating a greater sensitivity of these economies to economic fluctuations or delays in implementing the sustainable development concept in its initial phases. The standard deviation confirms the varying degree of stability of the SusE over time. The highest volatility is observed in Estonia and Slovakia (both 0.10) and Poland (0.08), which may reflect dynamic transformation processes and a rapid pace of catching up. The most stable SusE values were recorded in Croatia, Lithuania, Latvia, Romania, and Slovenia (standard deviation of 0.06), indicating more fluid and gradual changes in sustainable entrepreneurship.

Table 6.

Synthetic indicator of sustainable entrepreneurship, Central and Eastern European countries (2008-2024) – basic descriptive statistics

Country	Synthetic indicator	Basic descriptive statistics				
		Mean	Standard deviation	Median	Max	Min
Bulgaria	SusE	0.76	0.08	0.74	0.88	0.65
Croatia	SusE	0.83	0.06	0.82	0.91	0.74
Czechia	SusE	0.86	0.07	0.82	0.95	0.75
Estonia	SusE	0.78	0.10	0.76	0.92	0.63
Hungary	SusE	0.86	0.06	0.85	0.95	0.77
Lithuania	SusE	0.76	0.06	0.77	0.83	0.66
Latvia	SusE	0.81	0.06	0.80	0.89	0.69
Poland	SusE	0.85	0.08	0.83	0.95	0.74
Romania	SusE	0.80	0.06	0.81	0.89	0.70
Slovakia	SusE	0.82	0.10	0.83	0.95	0.63
Slovenia	SusE	0.85	0.06	0.85	0.95	0.76

Source: own study based on the Eurostat database, <https://ec.europa.eu/Eurostat>, 04.12.2025.

Descriptive statistics of the SusE indicate that Central and Eastern European countries are demonstrating significant progress in sustainable entrepreneurship, with varying levels and dynamics of change across countries. The highest average and maximum values are achieved by countries with relatively strong institutional and economic foundations, confirming the crucial role of a stable economic, social, and regulatory environment in the long-term development of sustainable entrepreneurship.

Table 7 presents the linear trend equations for the synthetic indicator of sustainable entrepreneurship (SusE) in Central and Eastern European countries from 2008 to 2024. These equations enable us to assess the direction and dynamics of long-term changes in sustainable entrepreneurship levels. The coefficients of determination, R^2 , provide information on the degree of fit of the linear models to the empirical data, and therefore, on the stability of the observed trends.

All analysed countries exhibit positive slopes, which clearly confirm the systematic increase in SusE throughout the study period. It indicates a consistent improvement in the integration of economic, social, and environmental dimensions within the enterprise sector in Central and Eastern European countries. The highest growth dynamics are observed in Estonia (0.0196), Slovakia (0.0193), Bulgaria (0.0161), and Poland (0.0151). It indicates intensive convergence processes and rapid catching up in terms of sustainable entrepreneurship. In these countries, the observed improvement was clear and systematic, as confirmed by high values of the coefficients of determination. Slightly lower, but still significantly positive, growth rates were recorded in the Czechia (0.0134), Hungary (0.0121), Latvia (0.0122), Romania (0.0125), Slovenia (0.0125), and Lithuania (0.0118). These values indicate a stable, albeit more moderate, dynamic of change, characteristic of countries with relatively higher initial levels of the SusE. The slowest rate of growth in SusE was observed in Croatia (0.0105), which may suggest that an earlier level of sustainable entrepreneurship was achieved or that the pace of further change was slower during the analysed period.

Analysis of the R^2 coefficients of determination indicates a very good fit of the linear models to the empirical data in all the studied countries. The highest R^2 values were obtained in Romania (0.9412), Slovakia (0.9403), Estonia (0.9390), and Poland (0.9369), confirming the existence of strong, regular, and stable upward trends. High R^2 values were also found in Hungary (0.9276), Bulgaria (0.9076), the Czechia (0.9000), and Slovenia (0.8976). The lowest, although still relatively high, trend fit was observed in Croatia (0.7727), which may indicate larger fluctuations in the SusE over time or a more complex course of change, less well described by a simple linear model.

Table 7.

Synthetic indicator of sustainable entrepreneurship, Central and Eastern European countries (2008-2024) – trend lines

Country	Synthetic indicator	Trend line
Bulgaria	SusE	$y = 0.0161x + 0.6176$; $R^2 = 0.9076$
Croatia	SusE	$y = 0.0105x + 0.74$; $R^2 = 0.7727$
Czechia	SusE	$y = 0.0134x + 0.7364$; $R^2 = 0.9$
Estonia	SusE	$y = 0.0196x + 0.6081$; $R^2 = 0.939$
Hungary	SusE	$y = 0.0121x + 0.748$; $R^2 = 0.9276$
Lithuania	SusE	$y = 0.0118x + 0.6563$; $R^2 = 0.8633$
Latvia	SusE	$y = 0.0122x + 0.6994$; $R^2 = 0.8875$
Poland	SusE	$y = 0.0151x + 0.7152$; $R^2 = 0.9369$
Romania	SusE	$y = 0.0125x + 0.6885$; $R^2 = 0.9412$
Slovakia	SusE	$y = 0.0193x + 0.6493$; $R^2 = 0.9403$
Slovenia	SusE	$y = 0.0125x + 0.7375$; $R^2 = 0.8976$

Source: own study based on the Eurostat database, <https://ec.europa.eu/eurostat>, 04.12.2025.

The results presented in table 7 indicate a clear, long-term increase in the synthetic indicator of sustainable entrepreneurship across all Central and Eastern European countries. High values of the coefficients of determination confirm the stability and consistency of the observed trends, while the variation in the directional coefficients indicates varying rates of implementation of

sustainable entrepreneurship principles, depending on the economic, institutional, and structural characteristics of individual countries. These results confirm that the process of developing sustainable entrepreneurship in the region is gradual, yet lasting and systematic.

Table 8 presents the sustainable entrepreneurship ranking for Central and Eastern European countries from 2008 to 2024. The ranking is based on the average values of the synthetic sustainable entrepreneurship indicator (SusE) for Central and Eastern European countries from 2008 to 2024. It is intended as a ranking and complements the statistical analysis, enabling the synthetic identification of leaders and countries with relatively lower levels of sustainable entrepreneurship.

Table 8.

Sustainable entrepreneurship ranking for Central and Eastern European countries (2008-2024)

Sustainable entrepreneurship - ranking of Central and Eastern European countries		
Position in the ranking	Country	Mean of SusE
1-2	Czechia	0.86
1-2	Hungary	0.86
3-4	Poland	0.85
3-4	Slovenia	0.85
5	Croatia	0.83
6	Slovakia	0.82
7	Latvia	0.81
8	Romania	0.8
9	Estonia	0.78
10-11	Bulgaria	0.76
10-11	Lithuania	0.76

Country	Mean of SusE
Hungary	0.86
Czechia	0.86
Slovenia	0.85
Poland	0.85
Croatia	0.83
Slovakia	0.82
Latvia	0.81
Romania	0.8
Estonia	0.78
Lithuania	0.76
Bulgaria	0.76

Source: own study based on the Eurostat database, <https://ec.europa.eu/eurostat>, 04.12.2025.

Czechia and Hungary occupy the highest positions, followed closely by Poland and Slovenia, confirming their sustained advantage in integrating economic, social, and environmental dimensions. Bulgaria and Lithuania, on the other hand, remain among the countries with the lowest average SusE values, despite an upward trend observed over time.

5. Discussion

The empirical findings confirm that, between 2008 and 2024 in Central and Eastern European countries experienced a systematic increase in the level of sustainable entrepreneurship, measured by the synthetic indicator SusE. This result is consistent with a growing body of literature that highlights the progressive integration of economic, social and environmental objectives in economic activities - particularly in economies operating within the European Union regulatory framework (Shepherd, Patzelt, 2011; Farny, Binder, 2021; Rosário, Figueiredo, 2024). The observed upward trend supports the argument that sustainable entrepreneurship is increasingly perceived not as an alternative model but as an integral component of long-term economic development.

The analysis of the economic pillar (EcoE) reveals relatively high dynamics in countries that initially exhibited lower levels of economic development, such as Lithuania, Estonia, and Poland. This finding aligns with the convergence hypothesis and is consistent with earlier studies indicating that catching-up economies tend to experience faster improvements in entrepreneurial performance under conditions of institutional stabilisation and access to EU funds (Kowalska, Misztal, 2023; Kowalska et al., 2024). At the same time, the observed variation in the stability of EcoE trends across countries (particularly in smaller or structurally constrained economies) confirms the role of economic structure and vulnerability to external shocks, highlighted in institutional and resource-based theories of entrepreneurship (Cohen, Winn, 2007; Atobishi, Podruzsik, 2025).

The social pillar (SocE) proved to be the most stable component of sustainable entrepreneurship over the analysed period. This stability is consistent with the assumptions of human capital theory and inclusive growth frameworks - emphasise the long-term and path-dependent nature of changes in employment conditions, labour productivity, and social security systems (Diepolder et al., 2021; Rosário et al., 2022). High and stable SocE values observed in countries such as Slovenia, Czechia, and Croatia reflect the institutional maturity of labour markets and confirm earlier findings that social dimensions of sustainable entrepreneurship evolve more gradually than economic or environmental ones (Farny, Binder, 2021).

The environmental pillar (EnvE) exhibited the highest dynamics of change, which strongly supports the theoretical arguments stressing the role of regulatory pressure and policy-driven incentives in shaping pro-environmental entrepreneurial behaviour (Dean, McMullen, 2007; Schaltegger, 2015). The rapid growth of EnvE in most countries confirms that EU climate and environmental policies act as a significant catalyst for green innovation and technological modernisation. This result aligns with recent empirical studies, which demonstrate that regulatory frameworks can transform environmental constraints into entrepreneurial opportunities (Bakry et al., 2022; Alkathiri et al., 2024). However, weaker or less stable trends

observed in Lithuania and Latvia suggest that regulatory stimuli alone may be insufficient without complementary technological capabilities and sectoral adaptation.

A comparative analysis of the three pillars reveals that the development of sustainable entrepreneurship in Central and Eastern Europe follows an asymmetric yet interdependent trajectory. Although all dimensions demonstrate upward trends, their pace and stability differ across countries, confirming that a complex interaction of institutional quality, economic structure, and public policy priorities shapes sustainable entrepreneurship. The identified systemic effect, whereby improvements in one pillar stimulate progress in others, supports the holistic understanding of sustainable entrepreneurship proposed in the Triple Bottom Line framework and contemporary sustainability-oriented entrepreneurship theories (Elkington, 1997; Shepherd, Patzelt, 2011). At the same time, the differentiated national trajectories highlight the importance of country-specific conditions in shaping sustainable entrepreneurial outcomes.

6. Conclusions

This study presents a comprehensive and comparative assessment of sustainable entrepreneurship development in Central and Eastern Europe from 2008 to 2024 (providing both theoretical and empirical insights into the dynamics of sustainability-oriented entrepreneurial activity in post-transition economies). The results clearly demonstrate that sustainable entrepreneurship in the region has evolved in a systematic and multidimensional manner, encompassing simultaneous improvements in economic, social, and environmental dimensions.

One of the key contributions of this research is the identification of heterogeneous national development paths combined with a gradual convergence process. While countries such as: Czechia, Poland, Hungary, Slovakia, and Slovenia maintain leading positions due to stronger economic foundations, mature labour market institutions, and more advanced environmental policies, countries with lower initial levels of sustainable entrepreneurship exhibit relatively higher growth dynamics. This finding extends existing convergence-oriented theories by demonstrating that catch-up processes also apply to sustainability-oriented entrepreneurship, not just to traditional economic indicators.

The analysis highlights the differentiated roles of individual pillars. The environmental dimension emerged as the most dynamic component - confirming the strong influence of EU climate and environmental regulations on entrepreneurial behaviour. In contrast, the social pillar exhibited the highest stability over time, reflecting the long-term and institutionally embedded nature of labour market and social security systems. These findings reinforce

theoretical perspectives that emphasise the asymmetric yet interdependent evolution of sustainability dimensions within entrepreneurial systems.

Importantly, the study demonstrates the existence of a systemic effect in sustainable entrepreneurship development, whereby progress in one pillar supports improvements in others. This result provides empirical support for holistic frameworks such as the Triple Bottom Line and sustainability-oriented entrepreneurship theories, confirming that sustainable entrepreneurship should be analysed as an integrated system rather than as a set of isolated dimensions.

Despite its contributions, the study is subject to several limitations. First, the analysis is conducted at the macroeconomic level, which limits the ability to capture firm-level heterogeneity and sector-specific dynamics. Second, the construction of the synthetic indicator relies on the selection and aggregation of available secondary data, which may not fully reflect qualitative aspects of entrepreneurial sustainability, such as organisational culture or managerial intentions. Third, equal weighting of the indicator components (while methodologically justified) may obscure differences in the relative importance of individual pillars across countries.

These limitations indicate directions for future research. Further studies could incorporate micro- and meso-level data, explore sectoral differences, and apply alternative weighting or validation methods. Extending the analysis to include institutional, technological, and financial determinants would allow for a deeper understanding of the mechanisms driving sustainable entrepreneurship in transition economies.

From a broader perspective, the findings of this study are relevant not only to academic research but also to public policy and support systems for entrepreneurship. The results may support policymakers in designing more coherent and targeted strategies that simultaneously promote economic competitiveness, social inclusion, and environmental responsibility. Moreover, the proposed synthetic indicator can serve as a practical analytical tool for monitoring the development of sustainable entrepreneurship over time and evaluating the effectiveness of policy interventions at both national and regional levels.

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KNOWLEDGE MANAGEMENT IN THE CONTEXT OF EVIDENCE-BASED MANAGEMENT AND INTEGRATED QUALIFICATIONS SYSTEM

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Purpose: The article is focused on presenting the main authors contributing to the development of knowledge management (KM) in organizations, evidence-based management (EBM) and Integrated Qualifications System (IQS) and exploring their different views. The aim of this article is a literature review to assess existing knowledge, identify gaps, and recognize areas requiring additional research. Based on the identified gaps and trends, the review provides a basis for formulating a theoretical framework for authors' own research - distinguish the interrelations between Knowledge Management (KM) in organizations, Evidence-Based Management (EBM) and Integrated Qualifications System (IQS) in Poland. The article aims to explore how these three components can be integrated to enhance decision making processes, support competency development, and improve organizational performance - presenting authors' conceptual model.

Design/methodology/approach: The article aims to explore how these three components can be integrated to enhance decision making processes, support competency development, and improve organizational performance. It also seeks to identify opportunities and challenges in implementing evidence-based practices and national qualification frameworks as tools for knowledge management in organizations.

Findings: The findings of this article highlight that knowledge alone is insufficient without mechanisms for its validation and application, just as qualifications without knowledge management risk becoming static and outdated. Evidence-based decision-making serves as the bridge between these two domains, ensuring that organizational strategies are grounded in empirical data, stakeholder insight, and real-world outcomes.

Originality/value: An identification the interrelations between Knowledge Management (KM) in organizations, Evidence-Based Management (EBM) and Integrated Qualifications System (IQS) in Poland and presenting authors' conceptual model.

Keywords: Knowledge Management, Evidence-Based Management, Integrated Qualifications System.

Category of the paper: Literature review.

1. Introduction

Nowadays, organizational success is increasingly determined by the ability to manage knowledge effectively. Knowledge Management (KM) in organizations refers to the systematic processes of acquiring, creating, storing, sharing, and applying knowledge to achieve strategic goals, foster innovation, and maintain competitive advantage. This capability is particularly important in the context of globalization, digital transformation, and the growing complexity of business environments. As markets evolve rapidly and workforce requirements shift, organizations must develop adaptive systems to ensure that the skills and competencies of their employees remain aligned with strategic priorities.

In contemporary practice, these processes are increasingly aligned with Evidence-Based Management (EBM) principles, which advocate for managerial decisions grounded in the best available evidence, including empirical research, organizational data, professional expertise, and stakeholder input. EBM promotes the use of the best available evidence from multiple sources — including scientific research, organizational data, stakeholder perspectives, and the professional expertise of managers — to support management practices. Within the human resources and learning development context, EBM ensures that talent management, training, and organizational change initiatives are not only based on tradition or intuition, but are supported by verifiable data and outcomes. By combining rigorous evidence with contextual judgement, EBM increases the likelihood of implementing policies and practices that deliver measurable results.

In Poland, the Integrated Qualifications System (IQS) offers an innovative approach to aligning individual skills with labor market needs, thereby serving as a valuable tool for evidence-based decision-making in organizations. The IQS is a comprehensive framework for the description, validation, and certification of qualifications, incorporating both formal education and non-formal learning achievements. It is closely linked to the Polish Qualifications Framework (PQF), which, in turn, is aligned with the European Qualifications Framework (EQF). This equalization ensures transparency, comparability, and portability of qualifications across different sectors and European countries.

The IQS enables employers, industry associations, and other stakeholders to participate directly in the creation and maintenance of qualification standards. By defining qualifications in terms of learning outcomes — what an individual knows, understands, and is able to do — the system provides a clear and measurable basis for assessing competencies. For organizations, this facilitates more accurate recruitment, targeted professional development, and the strategic deployment of human resources. It also enables the recognition of skills gained outside traditional educational pathways, thus expanding the talent pool available to employers.

Integrating the IQS into organizational knowledge management strategies enhances the ability to identify current competency gaps, forecast future skills requirements, and design training programs that are directly relevant to business objectives. Furthermore, the system supports the implementation of evidence-based HR policies by offering a robust framework for measuring and verifying qualifications, which can be used to assess the return on investment in learning and development initiatives.

The synergy between KM, EBM, and the IQS offers significant potential for improving organizational adaptability and resilience. Knowledge management guarantees that critical information and expertise are effectively captured and disseminated within the organization; EBM ensures that decisions are informed by the best available evidence; and the IQS provides that employee skills are formally recognized and aligned with market demands. Together, these approaches create a comprehensive, data-driven framework for managing organizational capabilities in a rapidly changing environment.

The article is focused on presenting the main authors contributing to the development of knowledge management (KM) in organizations, evidence-based management (EBM) and Integrated Qualifications System (IQS) and exploring their different views. The aim of this article is a literature review to assess existing knowledge, identify gaps, and recognize areas requiring additional research. Based on the identified gaps and trends, the review provides a basis for formulating a theoretical framework for authors' own research - distinguish the interrelations between Knowledge Management (KM) in organizations, Evidence-Based Management (EBM) and Integrated Qualifications System (IQS) in Poland. The article aims to explore how these three components can be integrated to enhance decision making processes, support competency development, and improve organizational performance - presenting authors' conceptual model. It also seeks to identify opportunities and challenges in implementing evidence-based practices and national qualification frameworks as tools for knowledge management in organizations.

2. Knowledge Management in organizations– theoretical approach

One of the most important organizational resources is knowledge. Every organization possesses this resource, but it is not always able to fully utilize it to increase the efficiency of other resources.

In practice, every initiative or action aimed at modern solutions draws on the concept of effective knowledge management to some extent (Craciun, Dumitru, 2011). The pursuit of effective knowledge management as a key organizational resource leads to the creation and implementation of management methods that support the processes of acquiring, transferring, and utilizing knowledge within the organization. These methods are often well-known and

previously used, but their modern application requires modifications in terms of assumptions, procedures, and instrumentation. Therefore, it can be assumed that knowledge management is becoming a driver of change in organizational and management areas.

The fundamental components of various definitions of knowledge include (Huseman, Goldman, 1999):

- experience, which encompasses the historical perspective of knowledge, the cumulative intellectual resources gathered in the past,
- truth, which represents the true state of affairs,
- judgment, which is the ability to assess an unknown situation within the context of a chosen value system,
- intuition, which provides the ability to make decisions in the absence of complete information,
- a system of cultural and ethical values that influence behavior and explain established habits.

Knowledge also has specific attributes that determine its importance to the organization. It acquires appropriate meaning in relation to specific tasks (it is relativized), is collectivized through the creation of networks of relationships, becomes accessible to others, and is externalized.

Knowledge in contemporary organizations is increasingly less linked to knowledge acquired from the environment – valuable knowledge is received through participation in organizational processes. In this sense, organizational knowledge arises from the integration of information streams (including codified knowledge from the environment) with the reality in which the organization operates, as only such knowledge captures the essence and specificity of the value creation process. It is characterized by subjectivity and does not reflect objectively effective solutions, but rather appropriate to the context of value generation. Knowledge generated within the organization is particularly valuable, as it is highly specific, unique, tacit, and difficult to replicate – thus becoming a source of competitive advantage. External knowledge is more widespread – accessible to others – and abstract, as well as more expensive. Widely available external knowledge, combined with unique internal knowledge, can become a source of new solutions.

From the perspective of the level of organizational knowledge, the following categories can be distinguished:

- external knowledge, which determines the overall situation in the organization's environment and allows for the identification of opportunities and threats, influencing decisions regarding the future functioning of the organization,
- at the organizational level – what the organization as a whole knows and how it can utilize it; it is a key factor in development and achieving competitive advantage,

- at the individual level – the knowledge of individual individuals, strongly based on experience; this knowledge is a fundamental element of the organization's knowledge, although sharing it can be difficult.

For the purposes of identifying knowledge gaps and selecting the optimal knowledge management strategy, we can distinguish knowledge: knowledge possessed by the organization, knowledge not possessed by the organization's environment, and non-existent knowledge (knowledge that has not yet been created). An organization can develop existing knowledge, strive to create new knowledge, and, if gaps are identified, seek to obtain knowledge from market participants.

Knowledge itself produces nothing—it becomes productive only when applied to a specific task. Knowledge becomes more valuable when applied, and its resources, supported by practical experience, naturally grow. Knowledge not translated into concrete action becomes useless, but taking action without specific knowledge is dangerous.

Nowadays the importance of knowledge in creating an organization's competitive advantage is constantly increasing (Barua, 2021). This is the result of turbulent changes taking place in various spheres. I. Nonaka and H. Takeuchi argue that knowledge is the only resource that determines an organization's competitiveness and, therefore, its survival in the market (Nonaka, Takeuchi, 1995). Currently, in times of rapid growth in knowledge resources and deep specialization, it is not enough to utilize only one's own potential and knowledge base – knowledge from all available sources must be accumulated. Knowledge is a valuable resource due to its increasing growth rate (the value generated from utilized knowledge increases the more it is utilized), while the growth rate of tangible resources decreases. The development of the resource-based approach to management has changed the perception of strategic resources. Tangible resources have ceased to play a primary role in achieving sustainable competitive advantage – this role has been assumed by intangible resources, which are seen as a source of advantage and a source of increased organizational value.

It's worth emphasizing that organizations learn by practically utilizing accumulated knowledge resources and providing employees with opportunities to draw conclusions from their actions and their outcomes (Obeso et al., 2020). This phenomenon is called sense-making, which involves developing coherent interpretations of past events, which can then influence changes in actions, understanding relationships, and adapting to the demands of the situation. Employee knowledge is widely recognized as one of the most important resources of any organization, enabling it to achieve a competitive advantage in the market (Argote, Ingram, 2000).

Towards the dynamic changes occurring in the environment, once developed, skills and competencies cannot be static – they must be subject to continuous evolution. For knowledge to become a key factor in an organization's competitive advantage (Al-Hakim, Hassan, 2016; Aldehayyat et al., 2021; Yap, Toh, 2020; Zain, Latief, 2020), the following conditions must be considered:

- competitive advantage must be consciously and carefully built,
- organizations should focus their efforts on internal sources of competitive advantage, such as knowledge resources, skills, and core competencies, which enable effective competition in diverse environmental conditions, as well as enabling them to shape that environment in some way,
- core competencies become not only a source of competitive advantage but also a factor determining its sustainability,
- unique individuals and teams play a significant role in building competitive advantage and enable the activation of other sources of competitive advantage within the organization,
- the development of core competencies and skills must anticipate market trends and competitor strategies.

The concept of knowledge management, however, is ambiguous. Just as there is no universally accepted definition of knowledge, there is also no single definition of knowledge management. Knowledge management is interdisciplinary in nature, hence some treat it as an independent system, while others focus on its connections with the process of creating and implementing an organization's strategy (Wiig, 1997).

Knowledge management is a multidimensional, controversial, and widely debated concept – it means different things to different professional groups: for IT specialists, it's the accumulation and codification of knowledge; for finance professionals, the measurement of intellectual capital; for human resources specialists, the development of knowledge resources; and for artificial intelligence specialists, the representation of knowledge. For strategists, knowledge is a fundamental resource in the process of building competitive advantage. Representatives of various disciplines therefore argue about what knowledge management is, what its determinants and characteristics are, and what conditions an organization must meet to implement this concept. However, there are many common areas among the trends and inspirations mentioned and discussed.

When analyzing the presented definitions of knowledge management, it is important to emphasize certain common features:

- it is most often perceived as a process leading to the identification, accumulation, creation, and utilization of knowledge,
- it is focused on achieving organizational goals, particularly creating and maintaining a competitive advantage,
- it involves motivating employees to share knowledge and creating an appropriate environment, procedures, and systems for knowledge transfer within the organization,
- the usefulness of knowledge management is closely related to its application dimension.

Furthermore, the diverse approaches to knowledge management allow us to formulate the following conclusions (Krawczyk-Sołtys, 2013):

- most authors attempt to capture the essence of knowledge management by distinguishing processes that impact knowledge resources – thus, the process approach dominates,
- the systemic aspect of knowledge management processes is often emphasized,
- an important element of knowledge management is the usefulness of the concept in achieving organizational goals – the usefulness of the concept is closely related to its application dimension.

Knowledge management at the organizational level is primarily associated with the creation of a knowledge management strategy and an organizational culture focused on knowledge accumulation and sharing; at the group level – with activities related to the coordination of cooperation consisting in creating conditions for sharing existing knowledge and creating new knowledge through well-organized group cooperation; at the individual level it must take into account the processes of using accumulated knowledge, generating new knowledge during the implementation of a task and codifying knowledge at the end of its implementation (Vyas, Bhalla, Najneen, 2020).

To sum up - it can be concluded that knowledge management should be utilitarian in nature, supporting the resolution of knowledge management problems to meet customer expectations in an increasingly competitive market. It should focus on the practical aspects of knowledge utilization in all processes that increase the organization's competitiveness. It should be an integral part of the entire organization's management, particularly human resources management, encompassing all management levels, taking into account the role of time and adapting intellectual assets to market conditions in advance (Romero-Hidalgo et al., 2021).

Knowledge management, understood in this way, will enable the achievement of strategic goals by streamlining the organization's operations, more efficient use of resources, skills, abilities, experience, developed policies and procedures, and technological capabilities. A comprehensive approach to knowledge management, taking into account all its aspects, guarantees the organization's long-term, favorable competitive position in the market.

3. The basic principles of Evidence-Based Management

The basic idea of Evidence-Based Management is that sound quality decisions require both critical thinking and use of the best available evidence. Of course, all practitioners use evidence in their decisions. But few pay attention to the quality of the evidence and tend to base their decisions on only one source. The result is decisions that rely on unfounded beliefs, fads and

fashions, and the unsupported though popular ideas of management gurus. The bottom line is bad decisions, poor outcomes, and little understanding of why things go wrong.

Evidence-Based Management seeks to improve the way decisions are made. It is an approach to decision-making and day-to-day work practice that helps practitioners to critically evaluate the extent to which they can trust the evidence they have at hand. It also helps practitioners identify and evaluate additional evidence relevant to their decisions.

EMB is about making decisions through the conscientious, explicit, judicious use of the best available evidence from multiple sources by (Barends, Rousseau, Briner, 2014):

- asking: translating a practical issue or problem into an answerable question,
- acquiring: systematically searching for and retrieving the evidence,
- appraising: critically judging the trustworthiness and relevance of the evidence,
- aggregating: weighing and pulling together the evidence,
- applying: incorporating the evidence into the decision-making process,
- assessing: evaluating the outcome of the decision taken to increase the likelihood of a favorable outcome.

Usually evidence mean information: facts or data supporting (or contradicting) a claim, assumption. It may be based on numbers, or it may be qualitative or descriptive. Evidence may come from scientific research suggesting some relatively generalizable facts about the world, people, or organizational practices. Evidence may also come from local organizational or business indicators, such as company metrics or observations of practice conditions. Even professional experience can be an important source of evidence, such as when an entrepreneur learns from having launched a variety of businesses that one particular approach seems more likely to pay off.

Most management decisions are not based on the best available evidence. Instead, practitioners often prefer to base decisions solely on their judgment derived from personal experience. However, personal experience alone is not a reliable source of evidence because it is highly susceptible to systematic errors (Bazerman, 2009).

Another heavily used source of evidence seems to be what other organizations are doing. Through benchmarking and so-called best practices, practitioners sometimes copy the methods and procedures of other organizations without critically evaluating whether those practices are actually effective and, if they are, whether they are also likely to work in a different context. At the same time, there are many barriers to evidence-based practice. Few practitioners have been trained in the skills required to critically evaluate the trustworthiness and relevance of the information they use. In addition, important organizational information may be difficult to access, and what is available can be of poor quality. Finally, practitioners are often unaware of the current scientific evidence available on key issues in the field (Kahneman, 2011).

According to the principles of evidence-based practice, evidence from four sources should be taken into account (Barends, Rousseau, and Briner, 2014):

- evidence from the scientific literature - many practitioners learn about research findings in their education or professional courses, new research findings are produced regularly, and these findings can often change our understanding;
- evidence from the organization - it can be financial data, such as cash flow or cost, or business outcomes, such as return on investment or market share. Also it can come from customers or clients in the form of customer satisfaction, repeat business, or customer recommendations or from employees through information about retention rates or levels of job satisfaction;
- evidence from practitioners - this type of evidence is sometimes referred to as tacit knowledge. Professional experience differs from intuition and personal opinion because it reflects the specialized knowledge or expertise acquired by repeated experience and practice of technical activities. Thoughtful practitioners also use their experience to judge whether research findings apply in a particular situation or a proposed solution is likely to work in a particular context. If relevant and trustworthy, experiential evidence plays a key role in the decision-making process;
- evidence from stakeholders - internal stakeholders include employees, managers, and board members. Stakeholders outside the organization, such as suppliers, customers, shareholders, the government, and the public at large, may also be affected. Stakeholder values and concerns are a reflection of what stakeholders believe to be important, which in turn affects how they tend to react to a decision's possible consequences.

A fundamental principle of evidence-based practice is that the quality of our decisions is likely to improve the more use we make of trustworthy evidence, meaning the best available evidence.

But evidence is not answers, it does not speak for itself. Evidence comes with a large degree of uncertainty. Evidence-based practitioners therefore make decisions based not on conclusive, solid, up-to-date information but on probabilities, indications, and tentative conclusions.

4. The Integrated Qualifications System in Poland – conceptual framework and implementation

In the context of future skills, it is important to pay special attention to those involved in the key transversal competencies, including critical thinking and comprehensive problem-solving skills, team work, the ability to adapt to new conditions, leadership skills and those relating to attitudes of openness and tolerance in an age of multiculturalism (Krawczyk-Sołtys, Wojtal, 2024, 2025).

The concept of lifelong learning is based on the recognition that the primary place of adult learning is no longer solely school or other educational institution, but also, and perhaps primarily, the workplace. In a knowledge-based economy, the learning culture developed within organizations becomes a factor in progress and social development. Investing in knowledge and qualifications supports the development of industries based on intellectual capital, which in turn contributes to increased earnings and a higher standard of living for citizens in the long term. Creating conditions that support individual enterprises in building and developing human capital adequate to their needs and achieving a knowledge-based competitive advantage, and thus in achieving economic success, is the responsibility of the state, local authorities, the enterprise itself, and intellectual and academic communities.

Implementing activities related to the broadly understood development of citizens at all stages of their lives and in diverse contexts therefore requires the creation of a policy that encompasses all paths for developing competencies and achieving qualifications (formal, non-formal, and informal) and is focused on ensuring coherence between them.

This directly points to the importance of systemic solutions for external validation of the competencies of labor market participants. If companies are not as good at evaluating employee competencies at the selection stage as is commonly believed, a transparent, reliable, and principled assessment of candidates' competencies and qualifications, conducted by professionally trained individuals, could become a significant alternative. This solution could be a national qualifications system, particularly the Polish Qualifications Framework and the National Qualifications Register (Sienkiewicz et al., 2013).

In Poland, one of the solutions aimed at supporting the development of the lifelong learning concept is the Integrated Qualifications System. Its basic elements derive largely from the Recommendations of the European Parliament and the European Council on the establishment of a European Qualifications Framework for lifelong learning. Qualifications described in the language of learning outcomes are primarily intended to contribute to the modernization of education and training systems, provide clear information for employers and employees, increase employability, mobility, and social integration of employees and learners. They are also intended to enhance the coherence of informal, non-formal, and formal learning and support validation. They are crucial for individuals, providing them with the opportunity to demonstrate their actual competences" (Dybaś, Pieńkosz, 2019).

In 2016, the Integrated Qualifications System (IQS) Act came into force, defining the system as a set of principles, standards, new functions and roles, and procedures governing the activities of various entities (individuals and institutions) involved in awarding qualifications and ensuring their quality. The Act provides information on which qualifications have been included in the IQS by law and which may be included at the request of an interested entity (Pieńkosz, Maj, 2024).

Equitable and inclusive access to educational and development services is also crucial (OECD, 2007). Considering the user of the Integrated Qualifications System (IQS), i.e., the individual wishing to identify and validate their knowledge, competencies and obtain a certificate, the following issues are important.

The adopted regulations are intended to contribute increasing the credibility and ensuring the comparability of qualifications awarded both in Poland and abroad, as well as to better match employee knowledge competencies to the needs of the labor market (Trawińska-Konador, 2020).

The Polish Qualifications Framework (PQR), encompassing all types of qualifications awarded in Poland, is a tool that, thanks to a series of reforms implemented in the education system, can function at the national and international levels. The approach of creating qualifications based on learning outcomes, their transfer, validation, and quality assurance in accordance with European standards became part of the entire formal education system (general, vocational, and higher education) even before the development and adoption of the PQF (Cedefop, 2025).

Learning outcomes are the reference point for all mechanisms and tools comprising the Integrated Qualifications Framework. The learning outcomes approach combines key European tools developed over the past decade, in particular the European Qualifications Framework and, at the national level, the qualifications frameworks developed in individual Member States. Learning outcomes are increasingly influencing the definition and description of qualifications and curricula, as well as the processes of assessment, teaching, and training. This approach was first explicitly formulated in European strategic documents in 2003 and has since been systematically promoted in the EU's policy agenda for education, training, and employment.

The PQF, similarly to the EQF, distinguishes eight levels of qualifications. The PQF level descriptors refer to the full spectrum of learning outcomes required for qualifications, i.e., knowledge, skills, and social competences. The descriptors of subsequent PQF levels reflect increasingly higher requirements in these areas. The PQF, as part of the Integrated Qualifications System, provides a common frame of reference for qualifications awarded in Poland (Trawińska-Konador, 2020).

Employee involvement is one of the most important factors contributing to the better use of their skills and higher productivity in the workplace. Increasing employee participation in the decision-making process on the organization of work and management can contribute to the better use of skills in the workplace (Heryanto, Aulawi, Munthe, 2020).

The integration of IQS mechanisms into HR and recruitment practices has significantly improved the transparency of competency requirements. Surveys conducted among employers by the Polish Agency for Enterprise Development (PARP) in 2023 showed that 64% of large and medium-sized enterprises use IQS-aligned qualification standards when defining recruitment criteria or developing employee training plans. Furthermore, nearly 40% of employers indicated that the IQS framework facilitated cross-sector recruitment by providing

clear competency descriptors and levels compatible with the European Qualifications Framework (EQF) (PARP, 2024).

From a professional development perspective, the IQS has also become a key reference for the design of upskilling and reskilling programs. Between 2020 and 2024, over 120,000 training participants in public and private education institutions received qualifications aligned with the IQS. Data from the National Training Fund (NTF) indicate that the share of funded courses based on IQS-referenced qualifications increased from 22% in 2019 to 57% in 2023, illustrating a structural shift toward competence-based development (Ministerstwo Rodziny i Polityki Społecznej, 2024).

The Integrated Qualifications System also influences employee professional and spatial mobility. Linking the Integrated Qualifications System (IQS) levels to the European Qualifications Framework (EQF) promotes both vertical and horizontal professional mobility within the country and the European Union. According to Cedefop (Cedefop, 2023), Poland has recorded a 23% increase in intra-EU recognition of professional qualifications since 2018, largely due to the interoperability of IQS qualification levels. 68% of individuals obtaining market qualifications changed or advanced their professional role within a year after validation, while 27% transitioned to a different sector or region, confirming IQS' role in enhancing employability and flexibility. Moreover, employers and training institutions report that the IQS framework has improved the efficiency of HR planning. In a 2024 74% of respondents from HR departments indicated that the standardization of qualifications under IQS simplified competency mapping and succession planning. At the same time, over 60% of training providers acknowledged that IQS increased the perceived credibility and transferability of their educational offer, encouraging employees to pursue structured qualification pathways rather than isolated short courses (Instytut Badań Edukacyjnych – Państwowy Instytut Badawczy, 2024).

To sum up, the IQS has shifted from a primarily regulatory framework to a data-driven tool supporting workforce development and mobility. Its measurable impact can be seen in recruitment practices, employee training, and the growing interoperability of qualifications across the EU. Quantitative evidence confirms that IQS not only strengthens the connection between education and the labor market but also contributes to building a culture of lifelong learning and competence-based employment in Poland.

The position of a company operating in a knowledge-based economy increasingly depends on the quality of its intangible resources, i.e., human capital. Human capital plays a strategic role in the organization and is considered a potential source of competitive advantage. Modern organizations are therefore forced to seek tools that enable them to properly diagnose, assess, and develop employee competencies, as employee knowledge largely determines a company's success.

5. Conceptual model integrating Knowledge Management (KM), Evidence-Based Management (EBM), and the Integrated Qualifications System (IQS)

Knowledge enables people to make decisions, take action and solve problems, to allow the implementation of strategies and achievement of objectives (Mol et al., 2013). The focus of knowledge management on organizational performance is increasing. Open innovation is the key to improving knowledge management. Knowledge management is used to develop innovation and achieve sustainability. In this case, organizational performance plays a role in achieving the status of being a competitive company.

There is still a lack of adequate knowledge (tacit and explicit) on how to combine social, environmental and business aspects into the core processes of the organization and how to overcome existing barriers to encourage companies in the pursuit of their goals. As a consequence, interdisciplinary knowledge processes need to be investigated in the context of various fields in an integrative manner.

That's why the dynamics of Knowledge Management within the context of Evidence-Based Management and the Integrated Qualifications System is significant.

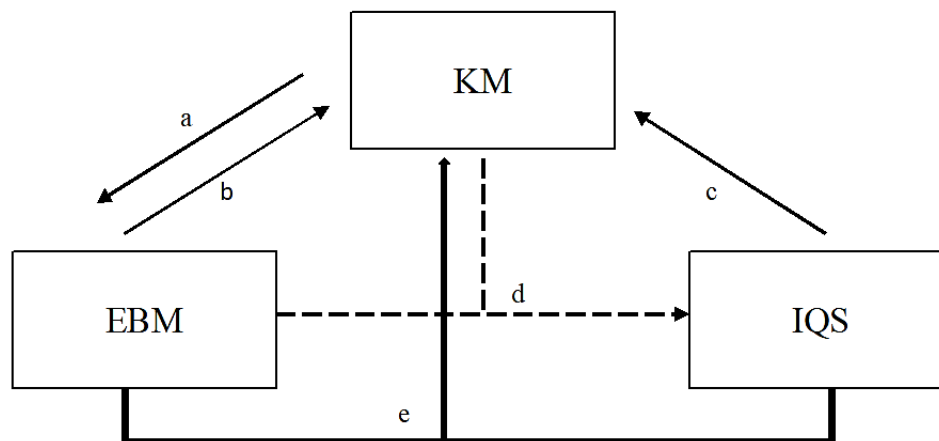
The literature was selected to ensure a comprehensive and multifaceted approach to the analyzed issue. Domestic and international publications were included to present diverse approaches. The criteria for selecting literature were its currency, credibility, and relevance to the topic. The most recent studies, reflecting the current state of research, were included, as well as classic works that provide the theoretical foundation for the area.

Particular attention was given to scientific publications, institutional reports, and expert studies of recognized substantive and methodological value. This literature review enabled to understand the theoretical foundations of the problem and relate them to current trends.

As a result of literature review it was founded that a specific model integrating Knowledge Management (KM), Evidence-Based Management (EBM), and the Integrated Qualifications System (IQS) isn't directly provided. Insomuch as authors created their own conceptual model (**Figure 1**) which is focused on using EBM to systematically capture, share, and apply organizational knowledge, ensuring this knowledge aligns with and develops the skills and competencies defined within the IQS to achieve strategic organizational goals. Key elements of this model include a supportive organizational culture, technological infrastructure for knowledge sharing, robust EBM processes to identify and use reliable data, and mechanisms to link this evidence to the development and certification of knowledge and skills outlined in the IQS:

- Knowledge Management (KM) is the overarching process of identifying, capturing, structuring, and disseminating knowledge within an organization to improve its performance and foster innovation.

- Evidence-Based Management (EBM) is a decision-making framework that advocates for the use of the best available scientific evidence to inform management practices and policies, ensuring that decisions are based on reliable data rather than assumptions or gut feelings.
- Integrated Qualifications System (IQS) is a framework for defining, recognizing, and certifying the skills and knowledge that individuals and organizations need to perform effectively in a given field or industry.
- Organizational Culture - a supportive and cooperative environment that motivates personnel to share their expertise and innovate, which is crucial for the successful implementation of both KM and EBM.
- Technology & Infrastructure - tools and systems that facilitate the storage, retrieval, and dissemination of explicit knowledge, ensuring accessibility and timely distribution.



- a - resource for
- b - ensures evaluation
- c - sets benchmark for competencies and knowledge required
- d - identify knowledge gaps and develop programs
- e - leads to further improvements

Figure 1. Conceptual model integrating Knowledge Management (KM), Evidence-Based Management (EBM), and the Integrated Qualifications System (IQS).

Source: Own study.

Authors' in their model propose the following integrating connections (**Figure 1**):

- KM as a foundation - KM practices provide the structure for knowledge creation, storage, and sharing. This knowledge then becomes the resource for EBM.
- EBM guides knowledge application - EBM principles ensure that the knowledge captured through KM is evaluated for its validity and relevance, guiding its application in decision-making and strategic planning.
- IQS as the target for skill development - the IQS sets the benchmark for the competencies and knowledge required. KM and EBM work together to identify

knowledge gaps and develop programs (like training or learning initiatives) that build the skills defined in the IQS.

- Feedback loop for continuous improvement - the application of evidence-based knowledge within the context of the IQS creates a continuous feedback loop, where the performance of individuals and processes is evaluated, leading to further improvements in knowledge management and skills development.

In essence, an integrated conceptual model would use the systematic processes of KM, guided by the rigor of EBM, to develop and apply knowledge that demonstrably meets the specific skills and knowledge requirements set forth in the IQS, ultimately driving organizational effectiveness and innovation.

An identification the interrelations between Knowledge Management (KM) in organizations, Evidence-Based Management (EBM) and Integrated Qualifications System (IQS) presented in authors' conceptual model form the basis for research aimed at empirically confirming the model's assumptions and identifying factors determining its effectiveness in practice: qualitative research (in-depth interviews and case studies), creation of diagnostic tools, validation of the model through quantitative research and formulate practical recommendations for implementing the model in organizations in Poland.

6. Discussion

The literature review presented in this article and authors' conceptual model demonstrates that the integration of Knowledge Management (KM), Evidence-Based Management (EBM) and the Integrated Qualifications System (IQS) provides a robust, synergistic approach developing and sustaining organizational competitiveness in the modern economy.

First, it is evident that KM is essential for capturing, structuring, and applying knowledge assets across organizational processes. Second, EBM offers a disciplined, data-driven approach to managerial decision-making. Third, the IQS serves as a powerful enabler for aligning workforce competencies with labor market demands. By defining qualifications in terms of explicit learning outcomes, the IQS offers a transparent and standardized structure for recognizing skills acquired through both formal education and informal or non-formal learning. The alignment of the IQS with the Polish Qualifications Framework (PQF) and, by extension, the European Qualifications Framework (EQF) ensures the comparability and portability of qualifications. This not only benefits individuals seeking mobility within the European labor market but also assists employers in benchmarking skill levels and qualifications across borders.

The findings of literature review highlight that knowledge alone is insufficient without mechanisms for its validation and application, just as qualifications without knowledge management risk becoming static and outdated. Evidence-based decision-making serves as the bridge between these two domains, ensuring that organizational strategies are grounded in empirical data, stakeholder insight, and practical outcomes.

This article explores the intersection of these three domains, analyzing how the principles of KM and EBM can be operationalized through the application of the IQS in organizational contexts. Integrating these approaches can support strategic talent management, enhance innovation, and strengthen an organization's position in the knowledge-based economy.

The intersection of these three domains provides a model for building organizational resilience and adaptability:

- KM ensures knowledge is captured, retained, and shared effectively.
- EBM ensures decisions are informed by the best available evidence.
- IQS ensures that skills and qualifications are clearly defined, measurable, and aligned with organizational needs.

Together, they create an integrated framework that supports continuous learning, responsive talent management, and sustainable competitive advantage.

However, the successful implementation of this integrated approach requires not only organizational commitment but also systemic collaboration between employers, educational institutions, industry bodies, and policymakers. Without such cooperation, the potential of the IQS to meet evolving labor market needs and support evidence-based talent strategies will be underutilized.

Between 2018 and 2024, within the framework of EU-funded system projects co-financed by the European Social Fund (ESF), over 3,000 analyses of market qualifications were conducted, and approximately 280 new qualifications were entered into the IQS Register (IBE, 2024). The validation process is based on empirical evidence, and decisions on the inclusion of qualifications are made using quality criteria and data on labor market demand for specific competencies across economic sectors.

The practical application of Evidence-Based Management is also evident in the projects of the Polish Agency for Enterprise Development (PARP), which since 2016 has implemented programs based on sectoral data analysis. 34 sectoral competence maps were developed, identifying key qualifications in industries such as ICT, logistics, construction, automotive, and energy. Based on research results and consultations with industry organizations, more than 200 sectoral qualifications aligned with labor market needs have been created (PARP, 2024). Empirical data are used not only to design new qualifications but also to monitor the effectiveness of training and programs financed from public funds.

Elements of EBM are increasingly being adopted by enterprises and educational institutions that use the IQS. Training providers, vocational universities, and labor market institutions apply data-driven approaches to analyze qualifications, validation results, and graduate employability indicators.

In summary, Poland serves as a noteworthy example of a country that has consistently implemented the principles of EBM within its qualifications policy and competence management systems. The integration of EBM and IQS has contributed to greater transparency in educational and vocational training decision-making, more efficient investment in human capital, and stronger links between education, research, and the economy. This integrated, data-driven approach enables the creation of a lifelong learning system based on verified evidence, reliable qualifications, and the actual needs of the labor market.

Based on the findings above, the following recommendations can be proposed for organizations, policymakers, and HR practitioners seeking to leverage the synergies between KM, EBM, and the IQS:

- embed IQS principles into organizational HR strategy,
- strengthen collaboration between employers and qualification authorities,
- integrate EBM practices into learning and development,
- use Knowledge Management systems to capture and disseminate skills insights,
- leverage IQS for talent mobility and career pathing,
- promote the recognition of non-formal and informal learning,
- develop cross-sector skills forecasting mechanisms,
- foster a culture of continuous learning,
- monitor and evaluate integration outcomes,
- policy support for IQS uptake in organizations.

7. Conclusions

After literature review assessing existing knowledge, identifying gaps, and recognizing a basis for formulating a theoretical framework for authors' own research areas the interrelations between Knowledge Management (KM) in organizations, Evidence-Based Management (EBM) and Integrated Qualifications System (IQS) was distinguished.

The presented in article conceptual model represents an attempt to integrate three complementary approaches: Knowledge Management, Evidence-Based Management, and Integrated Qualifications System. The aim of this integration was to build a coherent framework that will allow for a better understanding of how knowledge—scientific, expert, and practical—can be effectively used in decision-making processes and in developing the

competencies of individuals and organizations. This model assumes that effective knowledge management cannot be limited to information collection but must encompass its critical verification, validation, and utilization based on empirical evidence, which is the essence of the evidence-based approach.

The model expands existing approaches to knowledge management, which have often focused on technological or process-based aspects (Nonaka, Takeuchi, 1995; Davenport, Prusak, 1998). The proposed approach shifts the emphasis to the use of knowledge in decision-making practice, invoking the principles of EBM—that is, decision-making based on the best available scientific evidence, organizational data, and professional experience. Thus, the model bridges the gap between knowledge management theory and practical management.

The inclusion of the Integrated Qualifications System (IQS) in the model aims to emphasize the importance of knowledge validation and certification as an element consistent with the EBM concept. As a tool for organizing and certifying qualifications acquired through various forms of learning, the IQS represents a practical dimension of knowledge management on a macro scale, combining individual knowledge with institutional and systemic knowledge. In this sense, the IQS can be considered an instrument for implementing EBM in public policies related to education, the labor market, and competency development.

Of course, this concept is not without its limitations. First, implementing the model requires organizational maturity in knowledge management and a culture of openness to data and scientific evidence. Second, the complexity of qualification systems and the diversity of knowledge sources can lead to difficulties in ensuring consistency across decision-making levels. Third, the lack of standardized tools for measuring "EBM maturity" can hinder objective assessment of implementation effectiveness. Despite these limitations, the model opens up broad prospects for further research.

In summary, the presented model is conceptual in nature, but its practical importance is significant. Therefore, it seems necessary to conduct empirical research in this area, which will enrich scientific knowledge, rationalize the research methodology, as well as allow to formulate more recommendations for practice.

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FOOD SAFETY MANAGEMENT ON MERCHANT SHIPS: AN ORGANISATIONAL ANALYSIS

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Purpose: The purpose of this paper is to assess how food safety management systems (GHP/HACCP) function in practice on merchant ships operating as closed organisational environments. The study aims to identify strengths, systemic weaknesses, and managerial challenges in the implementation of hygiene practices under maritime operational constraints.

Design/methodology/approach: The study adopts a qualitative case study approach based on participatory observation conducted on two sister container vessels operating under the Maltese flag. Data were collected through methodological triangulation, including participant observation, informal interviews with crew members, photographic documentation, and analysis of onboard catering and hygiene records. The findings were analysed thematically and evaluated against international guidelines for shipboard food safety management (WHO, EMSA), within the broader framework of organisational and quality management.

Findings: The results indicate that while basic structural elements of GHP/HACCP systems are in place, their effectiveness is limited by gaps in corrective action documentation, inconsistent process enforcement, and informal deviations from established procedures. Temperature monitoring, hygiene routines, and access control provide a functional safety baseline; however, weaknesses in CAPA implementation, thawing practices, product labelling, and supplier communication reduce overall system reliability.

Research limitations/implications: The study is limited by its qualitative design and focus on two vessels operating under a single flag state, which restricts the generalisability of the findings. The participatory nature of observation may also introduce observer bias. Future research should expand this approach through cross-national comparative studies and examine the influence of organisational culture, economic constraints, and management policies on the long-term effectiveness of food safety systems at sea.

Practical implications: The findings highlight the need for managerial interventions focused on strengthening documentation discipline, corrective action tracking, and procedural consistency rather than introducing additional formal requirements. Low-cost organisational tools—such as standardised CAPA records, controlled thawing procedures, hygiene supply checklists, and structured supplier evaluation—may significantly improve food safety performance and operational resilience on merchant ships.

Social implications: Improving food safety management on merchant ships contributes to the protection of seafarers' health and well-being in environments with limited access to medical services. Enhanced organisational control of hygiene practices may also reduce the risk of foodborne disease transmission across international maritime routes, supporting broader public health objectives and responsible maritime operations.

Originality/value: This paper provides original empirical insights into the real-world functioning of food safety management systems on merchant ships using participatory observation. By framing food hygiene as an organisational and managerial issue rather than solely a technical or microbiological problem, the study offers practical value for shipowners, safety managers, and researchers interested in quality management within closed and resource-limited occupational environments.

Keywords: food safety management, quality management, risk management, organisational practices, closed systems.

Category of the paper: research paper.

1. Introduction

According Food safety on merchant ships poses a significant challenge due to limited access to resources, extended supply chains, and working conditions within an environment isolated from land-based sanitary infrastructure. From an organisational and management perspective, shipboard food safety represents a complex system of interrelated processes requiring continuous supervision, coordination, and risk control. International organisations, such as the World Health Organization (WHO) and the European Maritime Safety Agency (EMSA), emphasise the need to comply with Good Hygiene Practice (GHP) principles and implement Hazard Analysis and Critical Control Points (HACCP) systems in maritime settings, where lapses may lead not only to health consequences but also to operational disruptions and organisational inefficiencies (WHO, 2011a). An essential sanitary supervision tool onboard is the Ship Sanitation Control Certificate (SSCC), issued by authorised bodies following an inspection assessing hygiene conditions, water safety, waste management, and food handling. This document aims to prevent the spread of communicable diseases via international maritime transport and is required under the International Health Regulations (IHR).

Compliance with the requirements necessary for positive SSCC inspection outcomes involves both appropriate infrastructure and the effective functioning of food safety management systems based on the ongoing application of GHP/HACCP principles (WHO, 2011b). From a food technology perspective, it is crucial to ensure cold chain continuity, proper storage conditions, and strict time-temperature control throughout the entire cycle - from loading goods to preparation and serving. However, the effectiveness of these technical controls depends largely on organisational practices, staff accountability, and the consistency of monitoring procedures. As Skawińska and Zalewski (2022) point out, temperature standards in the cold chain are critical to food quality, and failure to maintain appropriate conditions results in economic losses and increased microbiological risk. Merchant ships operate as closed environments where the quality of food and hygiene is vital not only for crew health and performance but also for overall operational safety. Proper food handling,

storage, and preparation become especially important during long voyages with limited access to fresh supplies (Grappasonni et al., 2013, 2018).

Outbreaks of acute gastroenteritis affect millions worldwide and are often transmitted through contact with infected individuals, contaminated food or water, and unclean surfaces. Such scenarios are particularly common in semi-closed environments such as ships (Jenkins, 2021). In these settings, weaknesses in organisational control mechanisms may amplify the consequences of individual procedural errors. The *Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates*, published by WHO, provides guidance on sanitation practices and the assessment of health conditions on board both passenger and cargo vessels (WHO, 2011b). The document underscores the importance of maintaining hygiene standards in food handling, waste disposal, water quality, and prevention of cross-contamination in enclosed kitchen spaces.

Research by Grappasonni et al. (2018) found that catering staff on merchant ships answered 68% of food hygiene knowledge survey questions correctly, with trained individuals scoring significantly higher in areas such as personal hygiene, temperature control, cross-contamination prevention, and awareness of foodborne pathogens. These findings suggest that formal training alone is insufficient if not supported by effective organisational oversight, routine supervision, and practical reinforcement of procedures.

Merchant ships typically lack medical personnel, may remain at sea for several weeks, and operate in a confined, hermetic environment. Despite relatively small crew numbers, seafarers are exposed to a relatively high risk of infection, including foodborne illnesses (Mouchtouri et al., 2010). Disruptions in the microbiological stability of food may lead to the growth of pathogens such as *Salmonella spp.*, *Listeria monocytogenes*, or *Bacillus cereus*, especially when storage conditions are inadequate, thawing is done improperly, or clean and dirty areas are not clearly separated (Bintsis, 2017; Kaur, Yemmireddy, 2023). From a management perspective, such risks highlight the importance of preventive system design rather than reactive intervention, particularly in environments with limited access to external medical support (Scuri et al., 2019).

Despite the existence of detailed guidelines from WHO and EMSA regarding food hygiene on ships, their translation into everyday organisational practice and managerial decision-making remains insufficiently documented. There is a lack of current analyses focusing on the actual functioning of food safety management systems, including hygiene practices, temperature logging, thawing methods, supplier feedback mechanisms, and the management of critical deviations (Corrective and Preventive Actions-CAPA) aboard merchant vessels (Karkori, 2024). Importantly, few studies employ participatory observation as a methodological tool for evaluating quality and risk management in real operational conditions, despite its potential to reveal organisational gaps and procedural oversights that may not be captured during formal inspections.

The objective of this study was to conduct an on-site evaluation of selected food hygiene practices as elements of food safety and risk management systems implemented on two sister container vessels. The analysis focused on compliance with GHP/HACCP principles and international maritime hygiene regulations, with particular emphasis on refrigeration records, thawing procedures, galley organisation, CAPA documentation, procurement protocols, and supplier evaluation systems. Using a qualitative, participatory observational approach, the study aimed to identify organisational and procedural weaknesses that may compromise the effectiveness of food safety management in closed maritime environments. By highlighting real-world hygiene challenges and organisational shortcomings, this research contributes to the understanding of quality and risk management in isolated work systems and provides practical insights for improving food safety governance aboard merchant ships.

2. Materials and methods

This study was designed as a qualitative participatory observational case study focusing on the practical functioning of food safety and quality management systems in closed maritime environments. The research was conducted on two sister container ships flying the Maltese flag, classified in the AIS system as Cargo Ship (HAZ-C). Each vessel is 197 m long and 30 m wide, with a gross tonnage of 26,342 GT, and was built in 2003. The ships operate regular commercial routes in the Mediterranean and Middle East regions. The selection of the vessels was purposive, based on their identical technical specifications, catering infrastructure, flag state, and operational profile, allowing for a comparative organisational analysis under comparable management conditions. Additionally, the choice of the studied units was determined by the author's opportunity to conduct long-term participatory observation and access onboard operational documentation on these sister vessels, which enabled in-depth analysis under real working conditions. Full food provisioning typically takes place in the home port (Valletta, Malta), with partial replenishment at selected transshipment ports. Each vessel has a similar catering infrastructure comprising the galley, reefer room, dry provision store, dishwashing area, and two mess rooms. The crew consists of 24 members, mainly of Filipino and European nationalities (including Polish, Romanian, and Ukrainian). The cook and steward (messman) are Filipino nationals.

2.1. Research tools and data sources

Data collection was based on methodological triangulation, combining participant observation, informal interviews, photographic documentation, and document analysis. Participant observation was conducted over two consecutive periods of approximately three

weeks each. The researcher adopted a dual role as observer and participant, being involved in daily catering-related activities such as meal preparation and distribution, cleaning routines, and food storage. Observations focused on organisational practices and procedural compliance, including thawing procedures, use of protective gloves, temperature recording practices, and the cleanliness and layout of the dishwashing area. A total of 70 photographs were collected as visual evidence of system functioning, documenting kitchen infrastructure (12), cold and frozen storage rooms with temperature records (35), defrosting practices (6), and additional elements such as mess rooms and meals served (17). Photographs were treated as qualitative data supporting the verification of observed practices rather than as illustrative material only. Additionally, informal, non-structured interviews were conducted with selected crew members (cook, steward, chief officer, chief engineer, able seaman, and captain). Interviews focused on organisational routines and decision-making processes, including ordering and return procedures, hygiene practices, availability of personal protective equipment, experiences with foodborne illness, and subjective assessments of food quality. Shipboard documentation was analysed as part of the system-level assessment and included temperature control logs, supplier evaluation forms, inventory reports (OSERV Inventory Report), monthly menu plans, purchase orders, and supplier comment sheets.

2.2. Data analysis

Qualitative data analysis followed a thematic categorisation approach, integrating field notes, interview content, photographic records, and documentation. Data were systematically organised into the following analytical categories:

- (i) personal and process hygiene,
- (ii) cold chain safety and thawing procedures,
- (iii) stock management and HACCP documentation,
- (iv) supplier quality and communication,
- (v) crew health symptoms and potential sources of risk.

The analysis was iterative and comparative, allowing for cross-validation between data sources (triangulation). Observations were evaluated against GHP/HACCP requirements, WHO recommendations for ship sanitation (WHO, 2010a, 2010b), and formal inspection criteria included in the Ship Sanitation Control Certificate, such as temperature records, potable water analyses, and food handler certification.

2.3. Responsibilities of Catering Personnel (Catering & galley, 2022; Steward / waiter / messman, 2023; Cook – Duties, 2023)

Clear allocation of responsibilities among catering personnel constitutes a key organisational element of onboard food safety management. Defined roles and formal task descriptions support accountability, procedural compliance, and the effective implementation of GHP/HACCP principles in closed maritime environments.

Chief Cook:

- Prepares meals for both crew and officers.
- Monitors food stocks, forecasts demand, and reports requirements to the captain.
- Ensures compliance with sanitary standards and reports any irregularities.
- Maintains documentation (weekly menus archived for 12 months, temperature records).
- Oversees disinfection of the galley, storerooms, and equipment.
- Implements FIFO principles and separates raw and ready-to-eat foods.
- Holds STCW certification and culinary training; authorised to contact the Designated Person Ashore (DPA) on safety and environmental matters.

Steward (Messman):

- Serves meals and maintains cleanliness of the mess rooms and associated areas.
- Assists the cook in receiving and storing provisions.
- Participates in food labelling and monitoring stock rotation.
- Fulfils EMS/QM 5.10 documentation requirements.
- Holds valid STCW certification and may report directly to the DPA.

In the absence of the chief cook, the captain may appoint another crew member to assume catering duties, provided that certified training in food hygiene and occupational safety has been completed, with the decision documented using form QM 613a.

2.4. Hygiene plan and cleaning schedule

Cleanliness in the galley area is maintained according to a formal document titled “517a Hygiene Plan”, which constitutes part of the food safety management system (Hygiene plan, 2023). The schedule includes four cleaning frequency levels (Table 1), with responsibilities assigned to the relevant departments. Oversight of plan implementation rests with the chief cook and steward, while deviations must be reported to the chief officer. The cleaning schedule functions as an operational control tool within the HACCP system, supporting routine compliance and accountability.

Table 1.
Cleaning schedule

Frequency	Type of work	Example areas	Responsible parties*
Daily	Waste removal; dry and wet cleaning	Mess rooms, cabins, galley, public lavatories	Crew / MM / CC / DD
Weekly	Dry and wet cleaning of surfaces, floors, equipment	All mess rooms, galley, dry provision store	Crew / MM
Monthly	Washing curtains and towels; thorough cleaning of walls and ceilings	Cabins, galley, reefer room, garbage store	Crew / DD
Quarterly	Washing walls and ceilings; cleaning of furniture and appliances	Mess rooms, recreation rooms, reefer room	DD/ED

*Crew = crew member; M-M = steward/messman; C-C = Chief Cook; DD = Deck Dept.; ED = Engine Dept.

Source: own research.

Overall, the hygiene plan and cleaning schedule formalise routine sanitation activities by linking task frequency with clearly assigned responsibilities. From an organisational perspective, this documentation supports accountability and facilitates verification of hygiene compliance during internal and external inspections.

2.5. Procurement system and catering budget

Food procurement is managed primarily under budgetary constraints, with supplier selection driven mainly by economic criteria. The average daily allowance for food and beverages (PMD – Provisions, Messing, Drinks) is €9.35 per person. For a crew of 24 members, this equates to €224.40 per day, or approximately €9425 for a six-week voyage cycle. Main provisioning occurs at the home port in Malta to benefit from wholesale pricing and minimise additional purchases at transshipment ports. Cost pressure favours long-shelf-life products, such as frozen foods and canned goods, which may reduce access to fresh produce during extended voyages. Supplier evaluation focuses largely on compliance at the point of delivery, with sensory quality and transport conditions assessed upon receipt rather than during supplier selection.

3. Results

3.1. Observations of process and hygiene practices

Observations focused on the functioning of routine organisational practices related to hygiene and food handling. Galley personnel (chief cook and messman) had only basic training in HACCP/GHP principles, documented through brief introductory courses. In organisational terms, catering duties were occasionally assigned to personnel promoted internally from deck or engine departments, although the cooks observed on the assessed vessels had prior experience from previous voyages. Despite limited formal preparation, visual management tools recommended by WHO, such as *How to Hand Wash?* and *Five Keys to Safer Food*, were displayed in the galley, together with pictograms (Prevent Cross-Contamination), supporting behavioural standardisation and procedural awareness (figure 1).

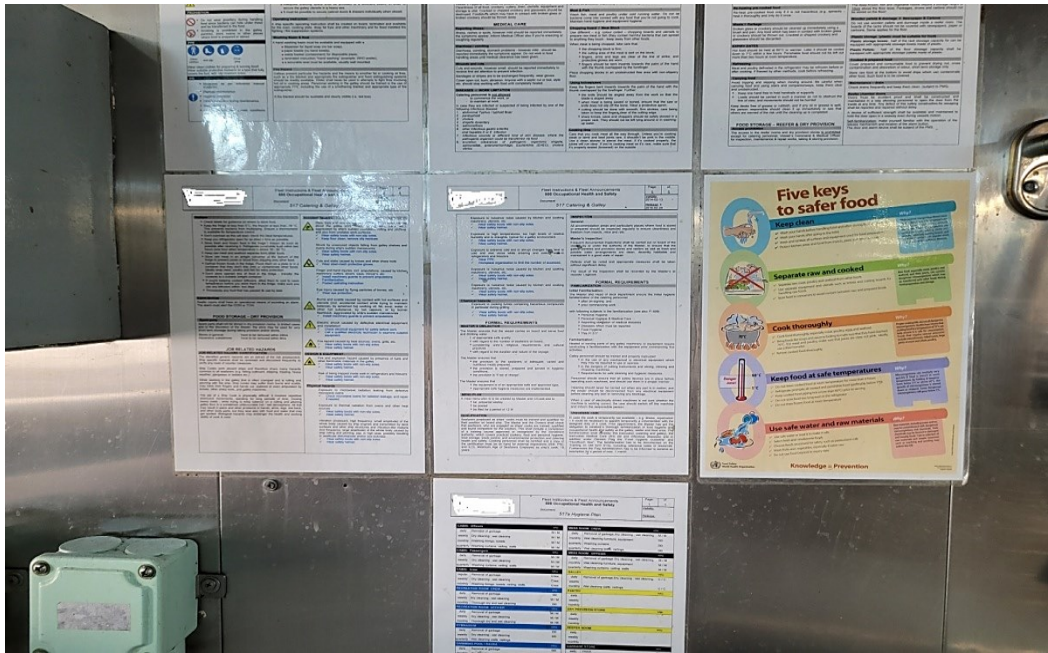


Figure 1. Educational materials.

Source: own research.

Observations confirmed correct handwashing techniques and routine use of disposable gloves; a single temporary lapse in glove use by the messman was immediately corrected, indicating informal peer control mechanisms. In terms of process hygiene, a consistent colour-coded chopping board system was applied (red - raw meat, blue - fish, yellow - poultry, green - vegetables/fruit, brown - cooked meat, white - bread/dairy), serving as an intuitive organisational control tool to minimise cross-contamination risk (figure 2).



Figure 2. Colour-coded cutting boards and knives for food type.

Source: own research.

The dishwashing area followed a linear “dirty-to-clean” layout. Dirty dishes were placed to the left and washed in an industrial dishwasher with a final rinse at 85°C, using detergent and disinfectant specified in the Catering & Galley Manual. Key procedural documents (Hygiene Plan, Catering & Galley Manual, Garbage Management Plan) were visibly displayed, facilitating procedural compliance. Waste was segregated (paper, plastic, metal & glass, food waste) throughout the vessel in accordance with MARPOL Annex V. Food was primarily thawed in refrigerated conditions ($\leq 5^{\circ}\text{C}$); however, ambient-temperature thawing in the galley was also observed as a routine operational shortcut, representing a potential critical control point (figure 3).



Figure 3. Incorrect thawing at ambient temperature, outside recommended safety range.

Source: own research.

Opened shelf-stable products (e.g. oil, peanut butter, jam) were occasionally stored at ambient temperature, reflecting inconsistencies in post-opening storage practices. In contrast, cheese and cold cuts were properly refrigerated after breakfast (figure 4).



Figure 4. Shelf-stable foods (e.g. oil, peanut butter, jam) stored at ambient temperature throughout the day.

Source: own research.

During observation, leftover soup served at 12:00 remained in the serving pot until dinner at 17:00, resulting in prolonged exposure within the microbial danger zone (>2 h) and deviating from WHO recommendations on safe food holding temperatures. Several crew members reported mild gastrointestinal symptoms (diarrhoea, nausea) after consuming seafood. Additionally, crew members aged 37, 50, and 63 recalled previous hospitalisations due to salmonellosis on other vessels, likely associated with raw egg-based desserts or steak tartare. Overall, these findings indicate that while preventive procedures exist, organisational enforcement and corrective documentation remain inconsistent, particularly regarding temperature control, thawing practices, and the mandatory use of protective gloves.

3.2. Monitoring record analysis

Temperature monitoring data covered 25 consecutive operational days on each vessel, with one entry per day recorded in control sheets and verified through thermometer photographs (Table 2).

Table 2.
Temperature monitoring

Area	Target range (°C)	Average (°C)	Limit exceedances*
Meat room	-20 to -5	-18.4	1 (defrost – -5 °C)
Fish room	-18 to -9	-17.6	1 (defrost – -9 °C)
Dairy room	3-8	5.0	3 (> 5 °C)
Vegetable room	3-8	4.6	1 (> 5 °C)
Lobby area	10-12	10.1	1 (> 10 °C)

*Limits adopted: ≤ -18 °C for freezers; ≤ 5 °C for refrigerated rooms; ≤ 10 °C for lobby areas.

Source: own research.

The temperature log contained a complete set of 25 entries per ship ($n = 50$) (Galley fridge..., 2025; Weekly/monthly cleaning..., 2025) (figure 5).

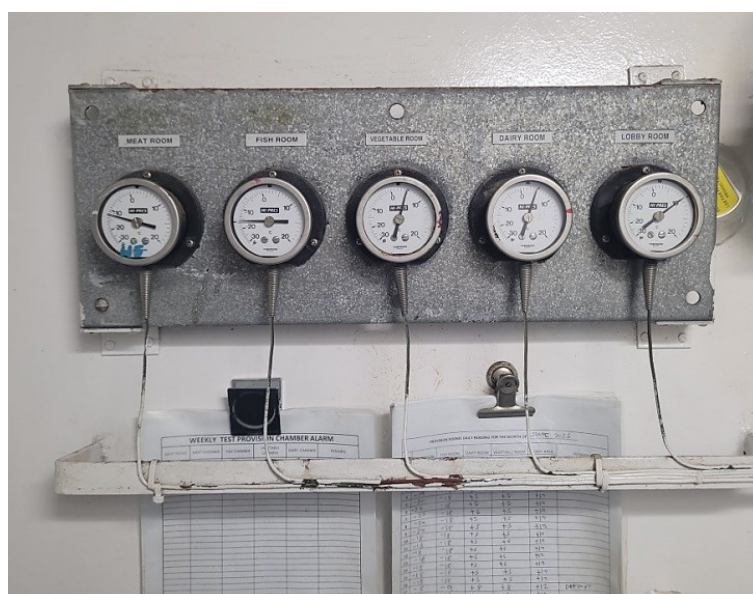


Photo 4. Temperature in individual storage units.

Source: own research.

Recorded temperature exceedances were infrequent and primarily associated with automatic defrost cycles. These short-term deviations did not affect the core temperature of stored products and therefore did not pose an immediate food safety risk. However, the absence of documented corrective or preventive actions following limit exceedances highlights a structural weakness in CAPA implementation, indicating limited feedback between monitoring and management response.

3.3. Communication with the catering company

The shipowner routinely reminds crew members of their obligation to report inventory status and submit the Supplier Evaluation Form within 72 hours after delivery (Reminder on inventory..., 2025). Analysis of two purchase orders from May 2025 showed that supplier communication was largely transactional and reduced to brief technical annotations in the “Comment from Supplier” column. Common entries referred to substitutions, changes in units

of measure, packaging size modifications, or product unavailability. Due to operational time constraints during loading, most deviations were accepted by the crew. However, these changes were rarely documented in the Supplier Evaluation Form, limiting the organisation's ability to assess delivery accuracy, supplier reliability, or cumulative quality deviations. When critical discrepancies were identified (e.g. near-expiry products, thawed ice cream, damaged packaging), immediate returns were initiated and recorded in the receiving log. Nevertheless, the lack of systematic feedback documentation weakened supplier quality management and traceability. These findings illustrate how informal acceptance of deviations can gradually erode control mechanisms within the food supply chain, particularly for perishable products.

3.4. Cost analysis of provisions and consumption

Inventory data for May 2025 indicated an initial food stock value of €10,300 and deliveries totalling €7535. With a final inventory of €10,110, actual consumption amounted to €7725 over 830 man-days, resulting in a daily catering cost (PMD) of €9.30 per person—slightly below the €9.35 budget limit. Budget compliance was primarily achieved through procurement strategies favouring long-shelf-life products, including frozen, canned, and dry goods. While economically efficient, this approach may reduce access to fresh ingredients during longer voyages. Frozen products accounted for 26% of total food expenditure (Table 3), confirming that a substantial share of resources was allocated to temperature-sensitive items, thereby increasing operational reliance on refrigeration systems, as reflected in the monitoring analysis.

Table 3.

Top 5 Cost Categories (May 2025)

Rank	Category	Cost (EUR)	Share (%)
1	Frozen meat	1 950	26 %
2	Dairy	1 200	16 %
3	Fresh vegetables	1 050	14 %
4	Canned goods	900	12 %
5	Soft drinks & juices	750	10 %
	Total (Top-5)	5 850	78 %

Source: own research.

Overall, the observed cost structure highlights a management trade-off between budget control and operational dependence on refrigeration systems, linking economic decisions with food safety requirements.

3.5. Weekly Menu Diversity

Three meals per day were prepared on a seven-day rotational menu. Although individual dishes varied between cycles, the structural composition of the menu remained consistent, as summarised in Table 4. The menu provided at least 14 servings of vegetables or salads per week (≥ 2 per day). Fish or seafood dishes were served three times weekly, accounting for approximately 12% of main meals, while about 70% of animal protein originated from poultry

or beef. Desserts were offered twice weekly, and fresh fruit was routinely available during lunch and dinner. Although dietary diversity was maintained, the relatively low frequency of fish/seafood and dairy-based dishes may limit the intake of omega-3 fatty acids and calcium, indicating a potential nutritional trade-off linked to procurement and cost-management strategies.

4. Discussion

Foodborne disease outbreaks on ships are widely recognised as the result of systemic weaknesses in food safety management, particularly in temperature control, prevention of cross-contamination, staff hygiene, raw material quality, and potable water management (WHO, 2010a; Mouchtouri et al., 2010). In closed organisational environments such as merchant vessels, these risks are amplified by extended supply chains, limited external supervision, and constrained corrective capacity, increasing the importance of effective internal control mechanisms. The assessment of two sister container vessels demonstrated that basic structural elements of GHP/HACCP systems were in place, confirming formal compliance with international requirements. However, the findings indicate a gap between documented procedures and their operational enforcement, a phenomenon frequently described in studies of safety management systems operating under resource and time constraints. The following discussion interprets the results in relation to WHO and EMSA guidance, with a focus on organisational effectiveness rather than procedural description.

4.1. Strengths of the hygiene management system

The presence of clearly defined hygiene routines and visual management tools represents a notable strength of the assessed system. Training in basic infection prevention and hygiene principles, combined with WHO educational materials displayed in the galley, contributed to a baseline level of procedural awareness, consistent with findings by Codreanu et al. (2021), who highlighted the importance of training in mitigating outbreak risks in closed environments. Effective separation of raw materials and the use of colour-coded chopping boards reflect well-established organisational controls designed to reduce cross-contamination through intuitive task allocation, rather than reliance on detailed instructions alone (WHO, 2006). As reported by Starovoytova (2019), such visual systems are particularly effective in confined working environments with limited staff rotation and variable levels of formal training. The structured layout of the dishwashing area and the restricted access to food preparation zones further illustrate the role of physical organisation and access control as risk mitigation measures, supporting earlier observations by Open Textbook BC (2020) that environmental design and

process flow are critical components of effective hygiene management. These practices suggest that even simplified GHP/HACCP tools can provide a functional safety baseline when embedded within clear organisational routines, reinforcing the importance of system design over individual compliance alone.

4.2. Organisational gaps and control weaknesses

From an organisational perspective, the identified shortcomings can be broadly divided into managerial and behavioural control failures. Managerial failures primarily concern enforcement and oversight mechanisms, including incomplete CAPA documentation, limited follow-up after recorded deviations, and insufficient use of feedback loops within monitoring and supplier management systems. Behavioural failures, in contrast, relate to everyday operational practices such as ambient-temperature thawing, inconsistent labelling of opened products, and deviations from recommended food holding procedures, often shaped by time pressure and routine work patterns.

Despite the presence of formal monitoring procedures, the study identified weaknesses in the feedback and corrective response mechanisms, particularly in relation to CAPA documentation. While temperature deviations were recorded, the absence of documented corrective actions indicates a decoupling between monitoring and managerial response, reducing the preventive value of control records. Similarly, deviations from recommended thawing and food holding practices reflect operational shortcuts driven by time pressure, a pattern also reported by Grappasonni et al. (2018). Such behaviours do not necessarily result from lack of knowledge, but from competing operational priorities, underscoring the need for management tools that support decision-making under real working conditions. Inconsistent labelling and storage of opened long-life products further highlight gaps in procedural standardisation and accountability, which may increase exposure to microbiological hazards, as supported by Durack et al. (2012). These findings point to a broader issue of process drift, where informal practices gradually diverge from formal procedures without triggering corrective intervention. Deficiencies in waste container sanitation and supplier communication similarly reflect limitations in cross-functional coordination and documentation, rather than isolated technical failures. As noted by Mafe et al. (2024), inadequate control during storage and transport stages significantly contributes to pathogen proliferation, reinforcing the need for integrated quality management across the supply chain.

4.3. Implications for crew health and operational safety

Reported gastrointestinal symptoms among crew members (diarrhoea, nausea) indicate vulnerabilities in the shipboard food safety management system rather than isolated incidents. Deviations such as improper defrosting, missing date labelling of opened products, and prolonged holding of ready-to-eat foods at ambient temperature increase microbiological

risk, particularly when foods remain within the 5-60°C “danger zone”, which favours rapid pathogen proliferation (*Salmonella* spp., *Staphylococcus aureus*, *Escherichia coli*) (Singh et al., 2019). Inadequate temperature control, improper thawing, and extended storage are recognised as major contributors to foodborne illness risk (Bintsis, 2017). In maritime settings with limited medical access, the consequences of such deviations are amplified. Crew accounts of previous hospitalisations due to salmonellosis linked to raw egg or meat-based dishes are consistent with reports identifying *Salmonella* spp., *Listeria monocytogenes*, *E. coli*, *Clostridium perfringens*, and *S. aureus* as the most common pathogens associated with improper storage and heat treatment (Mafe et al., 2024). Additional risks arise from deficiencies in waste management and sanitation, which may lead to secondary contamination and pest attraction, as highlighted in WHO guidelines. Similar patterns of inadequate temperature control, labelling, and pest management have been reported during ship hygiene inspections by Mouchtouri et al. (2010) and Grappasonni et al. (2013). Although no major outbreaks were observed during the study period, the identified irregularities represent a relevant health and operational risk during long voyages, underscoring the need for consistent application of hygiene procedures and ongoing crew training.

4.4. Managerial and operational implications

Based on the conducted analysis, improvements to the existing GHP/HACCP system on the assessed vessels are deemed necessary. First and foremost, it is recommended to standardise the Corrective and Preventive Actions (CAPA) procedure by mandating the documentation of every intervention taken in response to critical limit deviations - such as cold storage temperatures exceeding 5°C or freezer temperatures above -15°C. The absence of such records weakens the effectiveness of monitoring and hampers trend analysis. According to WHO (2006) guidelines and the recommendations of the European Maritime Safety Agency (EMSA), defrosting procedures should take place either at temperatures below 6°C or in water not exceeding 21°C for a maximum duration of four hours. To ensure compliance with these standards, it is advisable to designate a dedicated defrosting area within the cold storage facility and implement simple time-monitoring tools (e.g., kitchen timers or automated reminders) to control the duration of defrosting and the thermal exposure of foods. Regarding the storage of opened long-life products (such as jams, mayonnaise, horseradish), it is recommended to introduce mandatory labelling of the opening date and to reinforce procedures for storing such items in refrigerated conditions for no longer than five days, in accordance with WHO guidance on high-risk foods. This control should be documented using a simple logbook or dedicated form. To ensure the continuity of personal and workplace hygiene, it is advised to introduce a hygiene supplies checklist including disposable gloves, protective headgear, aprons, cleaning agents, and disinfectants. Ongoing monitoring of this list will help prevent shortages that could compromise adherence to proper hygiene practices. It is also essential to reinforce the procedure

for cleaning waste containers, which - according to WHO - should be washed and disinfected after each emptying. The presence of uncleaned containers increases the risk of biological contamination and pest attraction.

In the area of supplier quality management, the implementation of supplier evaluation forms is recommended to allow systematic assessment of raw material quality, transport conditions, and the sensory status of delivered products. This will also facilitate complaint procedures and decisions regarding supplier rotation. To enhance the accountability of support staff (e.g., messmen), the development of a simplified set of visual instructions (e.g., for product labelling, glove and headgear usage) is suggested, alongside the delivery of a short refresher training session on basic hygiene practices. This should be aligned with WHO's "Five Keys to Safer Food" recommendations.

Conclusions

This study demonstrates that the effectiveness of GHP/HACCP systems on merchant ships depends less on the formal existence of procedures and more on their consistent organisational enforcement. Even under conditions of limited resources, basic food safety controls can provide a functional level of protection when embedded in clearly defined responsibilities and routine practices. The findings highlight that the main challenges arise from gaps in corrective action documentation, process accountability, and operational consistency rather than from a lack of technical knowledge. Strengthening managerial oversight, documentation discipline, and simple control mechanisms may therefore significantly improve food safety performance in closed maritime environments. From a broader organisational perspective, the study contributes to understanding how food safety management systems operate under real-world constraints at sea and offers practical insights applicable to other closed or resource-limited occupational settings. Future research should expand this qualitative approach through comparative studies across different flag states, organisational cultures, and economic conditions to better assess the transferability and long-term sustainability of shipboard food safety management systems.

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QUALITY MANAGEMENT IN THE HEALTH CARE SYSTEMS OF POLAND AND UKRAINE: A COMPARATIVE ANALYSIS OF INSTITUTIONAL DIMENSIONS

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Purpose: The purpose of this article is to compare the institutional frameworks of quality management in the health care systems of Poland and Ukraine.

Design/methodology/approach: The study applies a comparative, system-level desk research design using the Institutional Quality Maturity Model (IQMM) to analyze five dimensions of quality governance based on legal acts, policy documents, and reports from national and international health institutions.

Findings: The results indicate substantial differences in institutional maturity: Poland demonstrates a more integrated and stable quality governance framework, whereas Ukraine remains characterized by fragmented but evolving institutional arrangements shaped by ongoing reforms.

Research limitations/implications: The study is based on desk research and secondary data, which limits the direct assessment of clinical, organizational, and implementation-related outcomes, particularly in the context of ongoing reforms in Ukraine. The analysis focuses on institutional arrangements and provides a basis for future empirical research on quality governance.

Practical implications: The findings underline the importance of strengthening institutional and governance-level frameworks for quality management rather than relying exclusively on organizational or clinical interventions. The IQMM may support policymakers and system-level decision-makers in identifying institutional gaps relevant to the design of quality-oriented health system reforms.

Social implications: The study highlights how institutional arrangements in health care systems influence patient safety, public trust, and equity in access to health services. By informing quality-oriented health policies, the findings may contribute to improved quality of life and greater societal confidence in public health institutions.

Originality/value: The paper introduces the IQMM as a structured analytical framework for system-level comparison of quality governance and provides a basis for comparative research and policy-oriented assessment of institutional conditions supporting quality reforms.

Keywords: quality management, health care systems, Poland, Ukraine, institutional governance.

Category of the paper: Research paper.

1. Introduction

The quality of health care services constitutes one of the fundamental pillars of contemporary health care systems, shaping patient safety, the efficiency of resource utilization, and public trust. The literature emphasizes that improving quality requires not only the implementation of managerial tools at the organizational level of health care providers, but above all stable and coherent system-level frameworks encompassing regulation, supervision, financing mechanisms, and organizational culture (WHO, 2020; OECD, 2019).

From a global perspective, the achievement of high-quality health systems has been identified as a critical prerequisite for improving population health outcomes and for attaining the Sustainable Development Goals, particularly in low- and middle-income and transforming health systems, where patient safety and system-level approaches to error prevention constitute integral components of quality improvement (Kruk et al., 2018; Leape, Berwick, 2005).

Both Poland and Ukraine are implementing reforms aimed at strengthening the quality and safety of health care. Poland has established institutional oversight mechanisms, including the CMJ accreditation system and quality monitoring instruments, while Ukraine has been developing the foundations of a quality system for over a decade in the context of ongoing institutional and financial transformation (Anufriyeva et al., 2022). These two countries represent different stages of quality system development, making a comparative analysis particularly relevant for understanding their institutional capacities and structural limitations.

In studies concerning Poland and Ukraine, organizational-level analyses predominate, focusing on the implementation of standards, certification processes, or organizational culture within individual health care providers (Maczuga, 2013b, 2018). In contrast, there is a lack of research addressing the institutional level, which defines the framework conditions for quality across the health care system as a whole. This gap hampers a comprehensive assessment of the effectiveness of quality-oriented reforms and limits the formulation of policy-relevant recommendations for countries undergoing systemic transformation.

The study addresses the following research question: “How do differences in institutional arrangements related to the quality of health care services in Poland and Ukraine influence the direction and effectiveness of ongoing reforms?”

The article contributes to the literature by:

- proposing a structured framework for the institutional analysis of quality management,
- providing a synthesized comparison of key quality dimensions in the health care systems of Poland and Ukraine,
- identifying developmental gaps and systemic barriers relevant to countries undergoing systemic transformation.

The subsequent sections of the article present a review of the literature, the analytical model, the research methodology, the results of the comparative analysis, the discussion, and the conclusions along with practical recommendations.

2. Literature Review

2.1. Concepts of Quality in Health Care

In the management science literature, the Donabedian model (1988) is widely acknowledged as a foundational analytical framework for structuring quality assessment, distinguishing between structural conditions, managerial processes, and performance outcomes. In this perspective, the model serves not as a clinical tool, but as a conceptual basis for designing and evaluating system-level quality management and governance arrangements. Its application is evident in contemporary quality governance frameworks developed by international organizations, including the World Health Organization (WHO) and the OECD, as well as in regulatory and supervisory practices implemented by national health authorities.

This perspective is strongly rooted in the conceptual framework developed in response to the Institute of Medicine's Crossing the Quality Chasm report, which emphasized patient safety, effectiveness, efficiency and system-wide responsibility for quality improvement (Berwick, 2002).

From a managerial standpoint, quality improvement has been supported by a range of management-oriented approaches, such as Total Quality Management (TQM), Lean Management, Six Sigma, the EFQM Excellence Model, and ISO standards. These frameworks are designed to enhance organizational effectiveness, support process optimization, and improve strategic alignment between operational activities and quality objectives (Berwick, Fox, 2016). However, research increasingly demonstrates that the performance effects of such management tools are contingent upon the broader institutional context, particularly the coherence of regulatory frameworks, the integration of quality-related data into managerial decision-making, and the maturity of organizational culture and leadership practices (Maczuga, 2015).

2.2. Systemic approaches to quality

From a system-level perspective, the quality of care is not viewed as the sole outcome of actions undertaken by individual health care providers, but rather as the result of the proper design of the entire institutional ecosystem. The World Health Organization (WHO, 2020) identifies several key elements in this regard, including:

- coherent quality-related regulations,
- a clear allocation of institutional responsibilities,
- oversight and supervision mechanisms,
- integration of quality-related data,
- a culture of patient safety.

The OECD (2019) emphasizes the importance of governance stability, understood as the capacity of a system to design, implement, and monitor quality policies, which is particularly critical in countries undergoing health system transformation. The concept of patient safety as a core dimension of quality has been extensively elaborated in the literature, emphasizing system learning, organizational responsibility and the prevention of adverse events as key mechanisms of quality improvement (Hughes, 2008).

Earlier analyses of patient safety reforms highlighted that sustainable improvement requires a shift from individual blame toward systemic approaches to error prevention and organizational learning (Leape, Berwick, 2005).

2.3. Pro-quality tools and solutions in selected countries

In the international literature, quality oversight systems in countries with a high level of institutional development have been widely described, including the Care Quality Commission (CQC) in the United Kingdom, the Australian Council on Healthcare Standards (ACHS), clinical audit models developed by the Healthcare Quality Improvement Partnership (HQIP), and the concept of the “10 Building Blocks of High-Performing Primary Care” (Bodenheimer et al., 2014). These systems serve as reference points for quality-oriented reforms in Central and Eastern Europe, including Poland and Ukraine. Systematic reviews also indicate that business excellence models are increasingly used as supplementary frameworks for quality assessment in health care organizations, although their applicability depends on organizational maturity and governance capacity (Kamal, 2023).

Comparative analyses of health system improvement initiatives demonstrate that successful quality reforms are highly context-dependent and rely on adaptive governance, leadership capacity and sustained institutional learning rather than on the mechanical transfer of best practices. Evidence from international case studies across diverse health systems confirms that quality improvement is a complex, non-linear process shaped by national institutional conditions (Braithwaite et al., 2017).

However, their direct transfer to transforming health care systems is limited by differences in institutional stability, governance capacity, financing mechanisms, and data infrastructure, which require context-sensitive adaptation rather than straightforward replication. Beyond traditional clinical and organizational indicators, patient-reported outcome measures have been increasingly recognized as an important component of quality assessment, as they capture patients’ perspectives on health outcomes and the effectiveness of care (Black, 2013).

2.4. Quality management in Poland – research findings

Since the early 2000s, the Polish health care system has progressively developed institutional arrangements for quality management, integrating regulatory instruments, supervisory mechanisms, organizational solutions, and digital tools within a coherent governance framework. A key milestone in this process was the establishment of the Centre for Monitoring Quality in Health Care (CMJ), which introduced a nationwide accreditation system functioning as a system-level management instrument rather than solely an evaluative mechanism. The development of institutional quality arrangements in Poland has been guided by national health policy priorities, including the National Health Programme for 2021-2025, which defines quality improvement, patient safety and organizational effectiveness as key objectives of health system performance (Ministerstwo Zdrowia, 2021).

Empirical evidence from national and international studies indicates that CMJ accreditation contributes to the strengthening of quality governance by formalizing management structures, standardizing quality-related processes, and supporting internal coordination and communication within health care organizations (Chojnacka, 2023; Maczuga, 2021). In this sense, accreditation operates as an institutional lever that aligns organizational practices with system-wide quality objectives and enhances managerial capacity for quality-oriented decision-making.

The introduction of the Act on Quality in Health Care and Patient Safety in 2023 established a formal framework for reporting adverse events, monitoring quality indicators, and developing internal patient safety management systems. According to reports issued by the Ministry of Health and the National Health Fund (NFZ), these regulations are intended to enhance transparency and strengthen system-level oversight of quality governance (NFZ, 2023; OECD, 2019).

An important component of Poland's quality-oriented policy is the gradual linkage of health care financing with quality-related activities. The National Health Fund (NFZ) has introduced incentive mechanisms that reward the fulfillment of quality requirements, such as obtaining accreditation or developing patient safety management systems. Although these mechanisms remain partial in scope, the literature indicates their positive impact on work organization, error reduction, and the strengthening of a quality-oriented organizational culture (Dahl, 2022).

Previous research suggests that higher levels of digital maturity are associated with the development of formal quality management structures and more systematic quality-oriented activities in health care organizations (Maczuga, 2025).

In summary, the Polish health care system has developed institutional foundations for quality management, including the operation of a central supervisory body (the Centre for Monitoring Quality in Health Care – CMJ), the gradual linkage of quality with financing mechanisms, the development of digital infrastructure, and the strengthening of a patient safety culture. However, the literature emphasizes that further system development requires a greater

integration of quality-related data into managerial decision-making processes and a stronger alignment between quality outcomes and financial incentives (OECD, 2019; NFZ, 2023).

At the policy level, the World Health Organization has emphasized the need for coherent, system-wide strategies for quality improvement that integrate governance arrangements, data infrastructures and accountability mechanisms. The Pathways to Quality framework developed for the WHO European Region highlights quality of care as a core component of health system performance and resilience, particularly in countries undergoing institutional transformation (World Health Organization Regional Office for Europe, 2021).

2.5. Quality management in Ukraine – findings from previous research

Ukraine has been implementing quality-related reforms under conditions of broad systemic transformation, encompassing changes in financing mechanisms, service delivery organization, and institutional oversight. The establishment of the National Health Service of Ukraine (NHSU) in 2017 introduced greater transparency in contracting arrangements; however, international analyses indicate that quality-related issues remain largely fragmented (World Bank, 2020; WHO, 2020). The legal framework underpinning these reforms is defined by statutory and executive regulations adopted in 2017-2018, which established state financial guarantees for health care services, created the National Health Service of Ukraine, and regulated the provision of primary health care (Verkhovna Rada of Ukraine, 2017; Cabinet of Ministers of Ukraine, 2017, 2018).

The literature emphasizes that the absence of a unified accreditation system and a central institution responsible for quality oversight is associated with significant regional variation in standards and practices, particularly in transitional health systems such as Ukraine (Maczuga, 2012).

Limitations in the development of quality also concern information infrastructure. Reports by the World Health Organization and the National Health Service of Ukraine indicate that the interoperability of medical data systems remains limited, and the reporting of adverse events is irregular, which hinders the monitoring of quality outcomes at the system level (WHO, 2020; NHSU, 2022). Research also highlights the significance of cultural barriers, including hierarchical management styles and staff concerns about the consequences of error disclosure, which contribute to a low level of patient safety culture (Artemenko et al., 2020). Differences in motivation, work engagement and perceived efficiency among medical staff have also been identified as an important institutional factor influencing the performance of health care systems in Poland and Ukraine, particularly in contexts characterized by significant disparities in system efficiency (Goncharuk, Lewandowski, 2020).

The results of the author's previous studies confirm that quality-oriented initiatives in Ukraine are often local in nature and are not fully supported by coherent regulatory frameworks, which limits their sustainability and scalability (Maczuga, 2015, 2018). International literature indicates that the Ukrainian health system remains at an early stage of quality

institutionalization, characterized by fragmented regulations, limited oversight, and partial solutions in the area of quality-related data systems (WHO, 2020; OECD, 2019; Maczuga, 2012).

At the same time, the financing reform implemented by the National Health Service of Ukraine creates a foundation for the gradual strengthening of a system-level approach to quality, which in the literature is described as a potential direction for the further institutional development of the Ukrainian health care system. In cooperation with international partners, including the World Bank, the Ministry of Health of Ukraine identified priority areas for the restoration and modernization of the health care system, emphasizing infrastructure, financing mechanisms and institutional coordination (Ministry of Health of Ukraine, 2022, 2023). Recent policy-oriented analyses emphasize that strengthening institutional capacity, governance coherence and international cooperation will be critical for building a resilient and quality-oriented health care system in Ukraine in the post-crisis period (Slobodian, 2025).

2.6. Research gap and the relevance of the PL–UA comparative analysis

In the literature on quality in health care, analyses focused at the organizational level predominate, encompassing the implementation of standards, certification systems, continuous improvement tools, and patient safety culture. These studies provide valuable insights into internal organizational practices; however, they address only to a limited extent the institutional conditions that determine the capacity to implement quality-oriented interventions (Berwick, Fox, 2016; WHO, 2020).

In the context of countries undergoing systemic transformation—such as Poland and Ukraine—this gap is particularly significant. There is a lack of comparative studies that examine regulatory stability, oversight structures, the linkage between quality and financing, or the level of data digitalization as factors influencing the effectiveness of reforms. Existing publications focus primarily on selected quality tools (e.g., accreditation, ISO, Lean), without incorporating a coherent institutional perspective.

The author's research on quality in medical institutions in both countries indicates the existence of differences resulting not only from organizational practices, but also from distinct institutional conditions, such as oversight structures, financing mechanisms, and patient safety culture (Maczuga, 2013a, 2015, 2018, 2021). This gap points to the need for a system-level analysis that encompasses regulatory and institutional frameworks as well as cultural and technological determinants.

In light of the above, there is a need to develop a structured framework for comparative analysis that enables the identification of differences and similarities in the institutional dimensions of quality in Poland and Ukraine. Such an approach allows for a better understanding of how systemic conditions influence the direction and sustainability of quality reforms.

These considerations justify the application of the institutional analytical model presented in the subsequent section of the article.

3. Methods

3.1. Assumptions and logic of the model

Based on a review of the literature and findings concerning the determinants of quality in Poland and Ukraine, the Institutional Quality Maturity Model (IQMM) was developed. The model serves as an analytical tool enabling a comparative assessment of the level of development of institutional quality mechanisms in health care systems. Its structure reflects the assumptions of Donabedian's framework (the relationships between structure, process, and outcomes), the concept of quality governance as articulated by the WHO and the OECD, as well as the body of research on maturity models in the public sector.

The IQMM assumes that the quality of care results from the configuration of five key institutional dimensions:

1. regulatory stability,
2. oversight institutions and accreditation systems,
3. the linkage between financing and quality,
4. patient safety culture and communication,
5. the interoperability of quality-related data.

The level of development of these dimensions determines the degree of institutional quality maturity, which influences the capacity of the health care system to implement sustainable quality-oriented reforms. The model adopts a system-level perspective, enabling the analysis of structural determinants of quality that extend beyond individual health care providers and encompass the institutional framework of the state.

3.2. Model structure

The logic of the model is presented in Figure 1. The five institutional dimensions are positioned at the foundational level as elements defining the framework conditions of the health care system. They are then linked to an intermediate level—*institutional quality maturity* (IQMM), which serves as a synthetic indicator of the system's readiness to implement reforms. The final component of the model is the outcome level, reflecting the effectiveness of quality reforms.

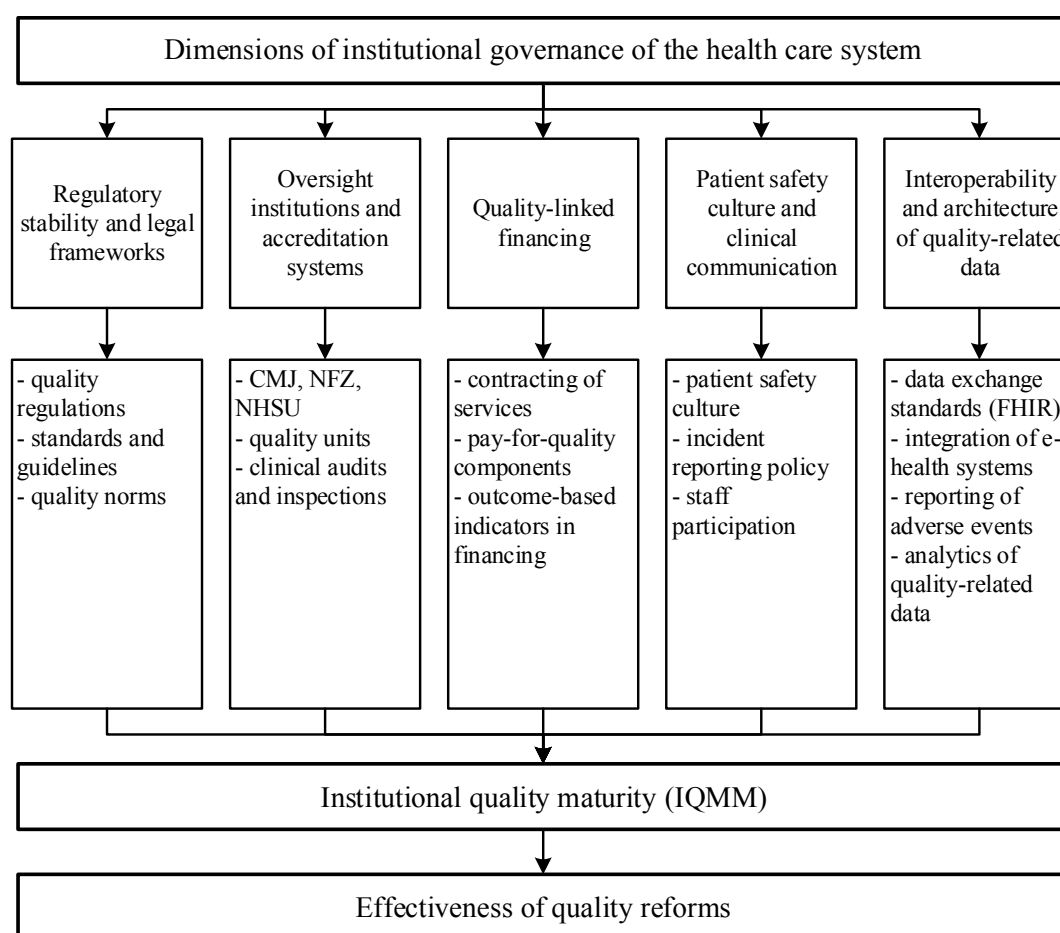


Figure 1. Institutional model of comparative analysis of quality management in health care.

Source: Author's own elaboration.

3.3. Relevance of the model for comparative analysis

The application of the IQMM enables a structured and multidimensional assessment of differences between the health care systems of Poland and Ukraine. The model makes it possible to identify which institutional elements facilitate the implementation of quality reforms and which constitute systemic barriers. As a result, both similarities and differentiating mechanisms between the two systems can be captured in a more comprehensive manner than in approaches based solely on organizational tools (e.g., accreditation or certification).

The IQMM provides the basis for the operationalization of research variables and the construction of the comparative procedure used in the analysis. The subsequent section of the article presents the data coding method, the selection of sources, and the approach to building the comparative matrix aligned with the structure of the model.

3.4. Data sources

A mixed-method approach based on the analysis of secondary data (desk research) was applied in the study. Triangulation was conducted using four groups of sources:

- legal acts and regulations related to quality in health care in Poland and Ukraine (including the quality act, implementing regulations, standards, and guidelines),
- reports of national and international institutions such as the WHO, OECD, CMJ, the National Health Fund (NFZ), and the National Health Service of Ukraine (NHSU),
- strategic and analytical documents (e.g., digitalization strategies, e-health reports, and accreditation-related documents),
- findings from the author's previous research on patient safety culture, internal communication, and institutional determinants in the health care systems of Poland and Ukraine (Maczuga, 2012, 2013a, 2015, 2018, 2021, 2025).

Such an approach made it possible to capture both the formal institutional frameworks and the practical mechanisms underlying the functioning of the health care systems.

3.5. Operationalization of the IQMM dimensions

Based on the Institutional Quality Maturity Model (IQMM), five analytical categories corresponding to the key systemic dimensions were developed:

- regulatory stability,
- oversight institutions and accreditation systems,
- quality-linked financing,
- patient safety culture and communication,
- interoperability of quality-related data.

For each category, a definition, assessment criteria, and exemplary indicators were specified, as presented in Table 1. This structure enabled a systematic analysis of the documents and a comparison of Poland and Ukraine across the five institutional dimensions.

Table 1.

Operationalization of the dimensions of the Institutional Quality Maturity Model (IQMM)

Institutional dimension	Definition	Assessment criteria	Exemplary indicators	Data sources
Regulatory stability and legal frameworks	The degree of coherence, continuity, and enforceability of regulations related to quality and patient safety	– the presence of national quality-related regulations, – the mandatory or voluntary nature of the requirements, – clarity of institutional responsibilities, – the degree of harmonization of legal frameworks	– Is there a legal act regulating the quality system? – Is the reporting of adverse events mandatory? – What central quality standards are in place?	Legal acts, regulations, WHO (2020), OECD (2019), and ministerial regulatory documents
Oversight institutions and accreditation systems	The scope of operation of central institutions responsible for quality assessment,	– the existence of oversight institutions, – the degree of formalization of their competencies,	– Is there a central accreditation institution in operation? – Does accreditation have a legal basis?	Reports of the CMJ and the NHSU, WHO and OECD publications, and accreditation-related documents

	oversight, and standardization	– the functioning of the accreditation system, – the role of oversight in quality monitoring	– What quality control mechanisms are in place?	
Quality-linked financing (Pay for Quality, P4Q)	Mechanisms through which the financing of health care services is linked to quality outcomes or patient safety standards	– incentives linked to accreditation, – the use of quality indicators in contracting, – transparency of financing rules, – linkage between financing and outcomes	– Does the contracting system incorporate quality indicators? – Are Pay for Quality (P4Q) components in place? – How is quality improvement financially incentivized?	Reports of the National Health Fund (NFZ) and the National Health Service of Ukraine (NHSU), OECD (2019), and HQIP (2020)
Patient safety culture and communication	The integration of information systems and the capacity to collect, process, and analyze quality-related data at the system level	– openness to reporting, – the existence of quality-related structures, – the level of internal communication, – practices of interdisciplinary collaboration	– Are formal quality-related structures in place? – Do staff members report adverse events? – Are internal communication channels in operation?	The author's own research (Maczuga, 2012; 2013a; 2015; 2018; 2021; 2025), literature on patient safety culture, and WHO (2020)
Interoperability and architecture of quality-related data	The integration of information systems and the capacity to collect, process, and analyze quality-related data at the system level	– data integration, – the existence of national registries, – interoperability of ICT systems, – availability of quality indicators	– Does the e-health system support quality reporting? – Which indicators are centrally available? – Are national registries in place?	CEZ, P1, the National Health Service of Ukraine (NHSU), e-health reports, OECD, and WHO

Note. IQMM – Institutional Quality Maturity Model; CMJ – Centre for Monitoring Quality in Health Care; NFZ – National Health Fund (Poland); NHSU – National Health Service of Ukraine; P4Q – Pay for Quality; ICT – Information and Communication Technologies; WHO – World Health Organization; OECD – Organisation for Economic Co-operation and Development. The table presents an analytical operationalization of the IQMM dimensions used for the comparative assessment of the health care systems of Poland and Ukraine. The data are based on secondary sources, including legal acts, institutional reports, strategic documents, and the author's previous research (desk research approach). Symbols and qualitative descriptors are used for comparative purposes and do not represent quantitative measurements.

Source: Author's own elaboration based on WHO (2020), OECD (2019), CMJ, NFZ, NHSU, and national regulatory documents.

The presented operationalization of the five dimensions of the Institutional Quality Maturity Model (IQMM) provides the foundation for the subsequent analytical procedure. The following section outlines the stages of the comparative analysis, including thematic coding of the source material, profiling of the health care systems of Poland and Ukraine, and the synthesis of results in the form of a comparative matrix.

3.6. Analytical procedure

The analysis was conducted in three stages:

Stage 1. Thematic coding

Documents were coded according to the five IQMM dimensions presented in Table 1. Each legal act, institutional report, and analytical document was assigned to one or more categories, depending on its substantive scope. This made it possible to identify both dominant and missing institutional elements.

Stage 2. Profiling of the PL–UA systems

Based on the coded data, institutional profiles of Poland and Ukraine were developed for each dimension. The analysis accounted for strengths and weaknesses of the respective solutions, the level of formalization, the degree of implementation, and the scope of available data.

Stage 3. Comparative synthesis

To consolidate the results, a comparative matrix was developed (Table 2), reflecting similarities and differences in the institutional quality maturity of the two systems. The matrix provides the basis for the interpretation presented in the results section.

Table 2.

Comparative matrix of institutional quality maturity (IQMM) in Poland and Ukraine

Dimension	Poland	Ukraine	Comparative commentary (synthetic interpretation)
Regulatory stability	Developed quality-related regulations; quality act in place; mandatory reporting requirements	Partial regulations; lack of central coordination; regional variation	Poland has a coherent regulatory architecture, which supports the stability of reform implementation. Ukraine remains at the stage of developing legal frameworks, which limits the uniform application of quality standards.
Oversight institutions and accreditation systems	CMJ – accreditation system in place; oversight exercised by the National Health Fund (NFZ)	Lack of a unified accreditation institution; the NHSU is primarily responsible for financing	Poland has a stable oversight infrastructure that supports the implementation of standards. Ukraine requires consolidation of institutions responsible for quality.
Quality-linked financing	Partial Pay for Quality (P4Q) mechanisms; incentives linked to accreditation	Predominantly volume-based financing; lack of linkage to quality	Poland is undergoing a transition toward Pay for Quality (P4Q) mechanisms. Ukraine remains within a volume-based financing model, which limits quality-oriented incentives.
Patient safety culture and communication	Development of patient safety systems; higher readiness for reporting	Low level of patient safety culture; irregular reporting	Patient safety culture is more firmly established in Poland, whereas Ukraine requires further development of transparency practices and communication competencies.
Data interoperability	Progressing digitalization; integration of NFZ/CEZ data	Limited interoperability; lack of comprehensive quality registries	Poland has achieved a higher level of data integration, enabling system-level monitoring. Ukraine requires further investment in data architecture and the standardization of reporting processes.

Note. IQMM – Institutional Quality Maturity Model; CMJ – Centre for Monitoring Quality in Health Care (Poland); NFZ – National Health Fund (Poland); NHSU – National Health Service of Ukraine; P4Q – Pay for Quality; CEZ – Central e-Health System (Poland). The table presents a qualitative, comparative assessment of institutional quality maturity in the health care systems of Poland and Ukraine. Descriptive categories are used to indicate the relative level of development of each dimension and do not represent quantitative measurements. The analysis is based on secondary data and expert interpretation within a desk research framework.

Source: Author's own elaboration based on legal acts, institutional reports, and analytical documents of WHO (2020), OECD (2019), CMJ, NFZ, NHSU, and national regulatory sources.

The presented comparative matrix synthesizes the key differences and similarities in the institutional quality maturity of Poland and Ukraine. This approach organizes the collected data within the five dimensions of the IQMM and provides a direct basis for the interpretation of results presented in the subsequent section of the article.

4. Results

The results of the comparative analysis based on the IQMM reveal clear differences in the level of institutional quality maturity between Poland and Ukraine. The comparison of data across the five institutional dimensions makes it possible to identify both well-developed areas and those requiring further strengthening. The comparative profile is presented in a synthetic form in Table 2.

4.1. Regulatory stability

In Poland, a high level of formalization of quality-related regulations can be observed, encompassing the quality act, implementing regulations, standards of practice, and a well-developed system of requirements for reporting adverse events. These regulations form a coherent legal structure and establish clear institutional frameworks.

In Ukraine, regulations are less standardized and more fragmented. There is no unified system of quality norms or centralized legislative oversight, which results in regional variation in the application of quality and safety principles. Regulatory reforms are being implemented gradually, primarily in the area of health care financing.

4.2. Oversight institutions and accreditation systems

In the Polish system, a distinguishing feature is the operation of the Centre for Monitoring Quality in Health Care (CMJ), which administers the national hospital accreditation system. Accreditation is embedded in the regulatory framework, and its role in quality oversight is confirmed by institutional reports and the literature. In addition, the National Health Fund (NFZ) performs a supervisory function through monitoring the provision of services and by partially linking contracting mechanisms to quality.

In Ukraine, there is no central institution responsible for quality accreditation. The National Health Service of Ukraine (NHSU) primarily acts as a payer and does not operate a unified accreditation system. Oversight functions remain fragmented and largely dependent on the regional level. As a consequence, this hampers the implementation of uniform standards and the monitoring of quality at the national level.

4.3. Quality-linked financing

In Poland, a gradual implementation of quality components in the contracting of health care services can be observed. Pay-for-quality (P4Q) mechanisms remain partial; however, they include, among others, incentives linked to accreditation and selected outcome indicators.

In Ukraine, the financing of health care services is primarily based on service volume, and quality elements do not directly affect the level of contracts. The absence of a linkage between financing and quality outcomes limits the ability to create system-level quality-oriented incentives.

4.4. Patient safety culture and communication

In Poland, the development of patient safety culture is supported by regulations on adverse event reporting, initiatives undertaken by public institutions, and the implementation of quality management systems in medical facilities. Research indicates that accredited organizations more frequently have formal structures responsible for quality and engage in regular reporting (Maczuga, 2021, 2025).

In Ukraine, patient safety culture remains one of the least developed areas. The reporting of adverse events is inconsistent, and cultural barriers—such as fear of sanctions and hierarchical management styles—hinder the creation of an environment conducive to transparency and shared responsibility. These differences are reflected in the literature and in WHO reports.

4.5. Interoperability of quality-related data

Poland is developing central health data systems (NFZ, CEZ, the P1 platform), which enable the integration of information on health care services, quality indicators, and clinical events. These systems support quality reporting and monitoring at the national level.

In Ukraine, data infrastructure is fragmented, and the interoperability of information systems remains limited. The absence of a unified data architecture hampers quality analyses, outcome monitoring, and the development of clinical registries.

4.6. Summary of results

The analysis indicates that Poland is characterized by a higher level of institutional quality maturity, particularly in the areas of regulatory stability, accreditation oversight, the linkage between financing and quality, and data digitalization. Ukraine, by contrast, remains at an early

stage of institutionalization, with fragmented oversight structures and a partially developed system of financing and quality monitoring.

The identified differences, presented in Table 2, provide the basis for the interpretation of the results and for the discussion of systemic determinants of the effectiveness of quality reforms, which is addressed in the subsequent section of the article.

5. Discussion

The findings indicate that the level of institutional quality maturity constitutes a key mechanism differentiating the capacity of health care systems to implement quality-oriented reforms. In particular, the analysis confirms that regulatory stability, centralized quality oversight, the integration of financing with outcomes, and a well-developed data infrastructure have a direct impact on the sustainability and effectiveness of quality improvement initiatives. These results are consistent with the WHO's findings on the development of governance-based quality systems (WHO, 2020) and with OECD analyses demonstrating that the effectiveness of reforms depends on the interaction between regulations, financing, and data availability (OECD, 2019).

At the same time, the comparative analysis shows that the differences between Poland and Ukraine do not stem solely from the level of development of individual tools (e.g., accreditation, standards, or digitalization), but primarily from differences in the configuration of institutional conditions for implementation. This finding extends previous research that has focused mainly on organizational-level analyses, while overlooking the influence of systemic determinants on the effectiveness of quality reforms in countries undergoing systemic transformation.

5.1. The role of the regulatory dimension

The results indicate that regulatory stability constitutes the foundation of a well-functioning quality system. Poland, with its extensive regulations concerning quality and patient safety, creates conditions conducive to the standardization of practices and increased transparency of activities. The literature emphasizes that coherent regulatory frameworks play a stabilizing and guiding role in system development (Berwick, Fox, 2016).

The situation in Ukraine, where regulations are less integrated, confirms the WHO's (2020) argument that the absence of strong legal foundations leads to the fragmentation of implemented solutions. The findings of this analysis indicate that regulatory stability is one of the most significant factors differentiating the two systems.

5.2. The role of oversight institutions and accreditation systems

The Polish CMJ accreditation system, as an institutionally embedded instrument of quality oversight, is strongly supported by the literature on quality governance (OECD, 2019). The results confirm that the existence of a central oversight structure promotes the uniform application of standards, enhances patient safety, and enables the monitoring of outcomes at the national level.

The absence of an analogous institution in Ukraine results in fragmented oversight mechanisms and limits the application of uniform quality practices. This finding is consistent with the author's previous research and with WHO reports, which indicate that systems lacking centralized oversight require a longer time to build a quality culture and to implement quality reforms effectively.

5.3. Quality-linked financing as a determinant of institutional behavior

International literature emphasizes that financing based on quality outcomes (Pay for Quality, P4Q) can stimulate the development of quality-oriented practices (OECD, 2019; HQIP, 2020). The findings of this study indicate that in Poland, although such mechanisms remain partial, they support the development of quality systems by incentivizing accreditation and selected outcome indicators.

In Ukraine, the absence of these mechanisms constitutes one of the main barriers to the implementation of quality-oriented initiatives. The analysis therefore confirms the thesis that a system-level linkage between financing and quality is essential for enhancing the effectiveness of reforms, which is consistent with the conclusions of Berwick and the OECD.

5.4. Patient safety culture and communication as conditions for the sustainability of reforms

The results of the analysis indicate that patient safety culture and internal communication are factors that strongly differentiate the health care systems of Poland and Ukraine. By developing regulations on reporting and supporting open communication practices, Poland creates an environment conducive to engaging staff in quality improvement activities.

In Ukraine, by contrast, cultural barriers—described in the WHO literature and in the author's research—limit the development of mature quality structures. The findings of this analysis confirm that without cultural change, regulatory and organizational mechanisms have limited sustainability.

5.5. The importance of interoperability of quality-related data

According to the WHO and OECD literature, data interoperability constitutes a key prerequisite for the development of quality systems in health care. The results of the analysis show that Poland has a more advanced data architecture, enabling quality monitoring at the

national level. Ukraine, although developing digital solutions, continues to face challenges related to fragmented infrastructure.

Limited availability of integrated data hinders the implementation of outcome-based practices and constrains the system-level assessment of quality—a conclusion consistent with WHO reports (2020).

5.6. The significance of the IQMM for system-level analysis

The findings confirm the usefulness of the IQMM as an analytical tool enabling a synthetic assessment of quality maturity at the institutional level. The model made it possible to identify elements that facilitate the implementation of reforms (in Poland) as well as those that constrain them (in Ukraine).

The application of the IQMM in a comparative context adds new value to the literature, as there has previously been a lack of models capable of capturing the complex relationships between regulations, oversight, financing, organizational culture, and quality-related data in countries undergoing systemic transformation.

These findings indicate that institutional analysis provides a more comprehensive understanding of the determinants of quality reforms than approaches focused exclusively on the organizational level.

5.7. Comparative reflections

The comparison between Poland and Ukraine reveals that differences in quality management do not stem solely from the level of implementation of individual quality improvement tools, but rather from distinct institutional configurations that shape their effectiveness and sustainability. Poland represents a model of gradual quality institutionalization, in which regulations, accreditation oversight, elements of outcome-based financing, and developing data systems form a coherent architecture conducive to the implementation of reforms. Ukraine, by contrast, remains at an early stage of systemic consolidation, where regulatory, organizational, financial, and digital components are developing in parallel but without a shared governance framework.

The results of the analysis confirm the observations of the WHO and the OECD, according to which the effectiveness of quality reforms depends on the level of institutional readiness, that is, the extent to which a health care system is prepared to absorb new solutions. Poland, with a stable regulatory base and central oversight institutions, creates favorable conditions for scaling quality improvement tools. In Ukraine, the absence of a unified accreditation system, limited data interoperability, and the uneven development of patient safety culture hinder the full implementation and monitoring of reforms.

The application of the IQMM makes it possible to demonstrate that quality in health care is not the result of individual tools operating in isolation, but rather the outcome of interactions among multiple institutional dimensions. The differences between Poland and Ukraine illustrate

that reforming systems require the parallel strengthening of regulations, oversight, financing, organizational culture, and data infrastructure in order to achieve sustainable outcomes. While the analysis focuses on institutional configurations, it should be noted that the effectiveness of quality reforms may be influenced by implementation-related risks at the organizational level, such as reporting practices, administrative burden, and enforcement capacity, which were beyond the scope of this study.

6. Summary

This summary synthesizes the key findings of the study, highlights its limitations, and outlines the contribution of the proposed Institutional Quality Maturity Model (IQMM) to research on quality governance in health care systems.

The aim of the article was to conduct a comparative analysis of the institutional determinants of quality management in the health care systems of Poland and Ukraine using the Institutional Quality Maturity Model (IQMM). The analysis made it possible to identify key differences in the areas of regulation, oversight, financing, patient safety culture, and data infrastructure, which shape the capacity to implement quality-oriented reforms.

6.1. Limitations of the study

The study is based on a desk research approach, which means that it relies on available documents, institutional reports, and the relevant literature. This approach allows for the identification and comparison of institutional determinants of quality; however, it does not capture the organizational perspective or the behaviors of health care providers. The analysis also does not account for regional differences in the implementation of reforms or for the perceptions of system stakeholders. Consequently, the findings reflect configurations of regulations, institutions, and financing mechanisms rather than the experiences of practitioners or patients. Future research should extend the analysis to primary data, including interviews and survey-based studies, which would enable a deeper interpretation of the results and support the validation of the IQMM at the organizational level. In particular, the study does not assess implementation-related risks at the organizational level, including underreporting incentives, administrative burden, or enforcement capacity.

6.2. Summary of results

The analysis indicates that Poland is characterized by a higher level of institutional quality maturity, particularly in the areas of regulatory stability, accreditation oversight, the linkage between financing and quality, and data digitalization. Ukraine, by contrast, remains at an early

stage of institutionalization, with fragmented oversight structures and a partially developed system of financing and quality monitoring.

The identified differences, presented in Table 2, provide the basis for the interpretation of the results and for the discussion of systemic determinants of the effectiveness of quality reforms, which is addressed in the subsequent section of the article.

6.3. Implications for policy and future research

For this reason, an institutional approach may serve as a useful reference point for other countries in Central and Eastern Europe facing similar transformational challenges. First, the results indicate that regulatory stability constitutes the foundation of quality development. Poland operates within coherent legal frameworks, whereas Ukraine implements reforms under conditions of regulatory fragmentation, which affects the uneven adoption of quality-oriented solutions.

Second, the existence of central oversight institutions and accreditation systems—such as the CMJ—facilitates the standardization of practices and the monitoring of quality at the national level. The absence of analogous structures in Ukraine confirms the thesis that the institutionalization of oversight is a key element in building quality systems.

Third, the linkage between financing and quality constitutes one of the main factors differentiating the two countries. The Pay for Quality (P4Q) mechanisms implemented in Poland strengthen quality-oriented incentives, whereas their absence in Ukraine limits the sustainability of implemented solutions.

Fourth, patient safety culture and internal communication function as reinforcing mechanisms that condition the effectiveness of reform implementation. The findings confirm that institutional actions must support the development of an organizational culture conducive to reporting and shared responsibility.

Fifth, data interoperability proved to be one of the key factors determining the capacity of health care systems to conduct quality monitoring. Poland has reached a higher level of data integration, whereas Ukraine requires substantial investment in information architecture.

6.4. Theoretical implications

The findings indicate the need to develop systemic quality models that account for interactions among regulations, oversight, financing, culture, and data. The application of the IQMM confirmed its usefulness as an analytical tool that can be applied in comparative studies of countries undergoing systemic transformation. The article contributes to the development of the quality governance literature by emphasizing the importance of institutional quality maturity as a factor conditioning the effectiveness of reforms.

6.5. Practical implications

The findings of the study may serve as guidance for policymakers in Poland and Ukraine. In Poland, the further development of the quality system should include:

- strengthening the role of quality-related data in decision-making processes,
- expanding the linkage between financing and quality outcomes,
- deepening the integration of information systems.

In Ukraine, the key priorities include:

- strengthening quality-related regulations,
- establishing a central institution responsible for quality oversight,
- integrating health data and developing uniform monitoring standards,
- building a patient safety culture that supports openness and reporting.

6.6. Directions for future research

The article is based on the analysis of secondary data, which creates opportunities for further empirical research. In particular, the following areas require further development:

- quantitative analyses covering quality indicators in medical institutions,
- studies on organizational culture and internal communication across different types of health care providers,
- comparative research including a broader range of countries in the Central and Eastern European region,
- longitudinal testing of the IQMM to assess the dynamics of institutional change over time.

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THE SIGNIFICANCE AND PERCEIVED ECO-FRIENDLINESS OF THE GRÜNER PUNKT SYMBOL AMONG CONSUMERS IN POLAND AND ITS INFLUENCE ON PURCHASING DECISIONS

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Purpose: The purpose of this article is to present the results of an empirical study examining the meaning, perceived environmental character, and influence of the Grüner Punkt (Green Dot) symbol on consumer purchasing decisions.

Methodology: The study employs a quantitative approach based on an online survey conducted among 500 respondents. The questionnaire focused on three main areas: the level of recognition and understanding of the symbol, perceptions of the environmental character of labels, and the declared influence of the symbol on purchasing choices. The analysis relied on descriptive statistics and comparative analysis of response distributions.

Findings: The results indicate a moderate level of visual recognition of the symbol combined with a low level of understanding of its actual meaning. A substantial proportion of respondents attribute environmentally positive characteristics to the Grüner Punkt, particularly in relation to packaging, despite the fact that such interpretations do not reflect its real function. At the same time, the symbol does not exert a significant influence on consumer purchasing preferences.

Research limitations/implications: The study is based on a survey questionnaire, which may not fully reflect actual purchasing behaviour. Future research could incorporate experimental designs, consumer observations, or comparative studies conducted in different national contexts.

Practical implications: The findings highlight the need to improve the clarity of environmental communication and to reduce the risk of unintentional greenwashing. They may provide a reference point for market actors and policymakers when designing clearer environmental labels and communication practices.

Social implications: Improving consumer understanding of environmental symbols may support the development of more informed consumer attitudes and strengthen trust in pro-environmental initiatives undertaken by companies.

Originality/value: The article provides empirical evidence of the discrepancy between the formal meaning of the Grüner Punkt symbol and its social perception as an environmentally oriented label. In doing so, it contributes to research on the quality of environmental communication and consumer education.

Keywords: environmental labelling; green claims; consumer perception; sustainability communication.

Category of the paper: research paper.

1. Introduction

In recent years, growing attention has been paid to issues related to sustainable development, responsible consumption, and the transparency of environmental information addressed to consumers. This trend reflects both increasing environmental awareness and the expanding formal and legal requirements imposed on companies, particularly with regard to packaging management, waste handling, and responsibility for product life cycles (European Commission, 2020). As a result, environmental labelling—including symbols, labels, and claims referring to the environmental characteristics of products and their packaging—has become an important element of market communication and a potential factor shaping consumer purchasing decisions.

Alongside this development, the problem of label proliferation and ambiguity has intensified. Environmental labels differ in their prevalence, scope, interpretation, and perceived credibility. Research shows that consumers often struggle to distinguish between symbols, assign them accurate meanings, and assess their reliability (Grunert et al., 2014; Testa et al., 2021). This situation contributes to *label fatigue*, understood as exhaustion caused by an excess of labels, and increases the risk of unintentional greenwashing—situations in which consumers attribute environmental qualities to products that they do not actually possess (Delmas, Burbano, 2011). From a marketing communication perspective, this is a particularly sensitive area, as environmental labels frequently influence consumers not only through factual information, but also by creating intuitive and positively charged associations with ideas such as environmental protection or responsibility, especially when their visual form clearly suggests such a connection.

Within this context, the Grüner Punkt (Green Dot) symbol, developed in Germany and in use since the late 1980s, deserves particular attention. The symbol indicates a producer's participation in financing a packaging recovery and recycling system. According to its original definition, it does not confirm the recyclability of packaging or its environmental friendliness, but solely the producer's financial contribution to the system (Der Grüne Punkt – Duales System Deutschland GmbH, 2021). Despite this clearly defined function, market observations and international studies suggest that consumers frequently associate the symbol with explicitly environmental attributes of products or packaging (Thøgersen, 2002). This means that the Grüner Punkt may exert an unintended influence on perceptions of packaging environmental performance, potentially leading to misinterpretation and purchasing decisions based on incorrect assumptions.

In Poland, the issue of consumer perception of the Grüner Punkt symbol remains relatively underexplored in academic literature. Although environmental product labels—such as the EU Ecolabel, FSC certification, or recycling-related symbols—have been widely analysed in terms of consumer recognition and trust, there is a lack of studies focusing on the discrepancy

between the formal meaning of the Green Dot and its social interpretation. This gap also applies to research on the influence of the symbol on purchasing decisions and consumer attitudes toward environmental claims made by producers. International literature indicates that incorrectly understood labels may reinforce mechanisms such as the *halo effect* or *eco-halo*, leading consumers to over-attribute pro-environmental qualities to products (Schuldt et al., 2011). In this sense, the Grüner Punkt represents an interesting case of a symbol “imported” from a country positioned as a leader in pro-environmental policy, which—despite its technical and financial nature—functions in consumer perception as a marker of environmentally friendly packaging.

The Polish context further intensifies this issue. The symbol has not been, and still is not, widely explained to consumers by producers or distributors, and its role within the waste management system remains largely unfamiliar outside expert circles. At the same time, the symbol appears on products available on the Polish market, including domestically produced goods. As a result, many consumers rely on intuitive visual cues, such as the use of arrows arranged in a loop—similar to official recycling symbols—which further increases the likelihood of misinterpretation. Consequently, the Grüner Punkt may operate as a quasi-environmental label, even though it does not formally belong to this category.

These observations point to the need for empirical research aimed at determining:

1. the level of recognition of the Grüner Punkt symbol in Poland,
2. the degree of consistency between consumers’ declared understanding of the symbol and its actual function,
3. the extent to which the symbol influences consumer purchasing decisions; and
4. the potential risk of unintentional greenwashing resulting from incorrect ecological interpretation.

Such research is particularly important in light of planned legal changes within the European Union, including initiatives related to the Green Claims Directive and forthcoming regulations on environmental declarations. Understanding how consumers in Poland interpret the Grüner Punkt symbol may provide valuable insights for companies, regulatory authorities, and non-governmental organisations, supporting the development of more transparent, effective, and responsible environmental communication.

The aim of this article is therefore to present the results of an empirical study examining the meaning, perceived environmental character, and influence of the Grüner Punkt symbol on consumer purchasing decisions. By doing so, the article seeks to address an existing research gap and to provide empirical evidence focused on this issue.

2. Literature Review

Environmental labels (*eco-labels*) are currently among the key instruments used in communication between producers and consumers. Their main purpose is to convey information about the environmental aspects of products or services in a concise form that is easy to notice, recognise, and compare. The literature shows that environmental labels may influence purchasing decisions in two ways: by providing concrete information and by exerting a symbolic effect that reinforces the perception of a product as more “green” (Grunert et al., 2014; Testa et al., 2021).

Research also confirms that consumers often rely on labels as cognitive heuristics, particularly in situations characterised by low involvement or limited access to detailed information (Thøgersen, 2002). In such cases, eco-labels may effectively replace a more thorough evaluation of product attributes. While this mechanism simplifies decision-making, it simultaneously increases the risk of misinterpretation and the excessive attribution of pro-environmental qualities to products.

The contemporary market is characterised by a growing number of symbols and labels referring to environmental protection, sustainability, or ethical production. The proliferation of such messages contributes to the phenomenon known as *label fatigue*, which leads to a declining ability among consumers to correctly distinguish and interpret individual symbols (Delmas, Burbano, 2011). As a consequence, ambiguity in environmental labelling may foster unintentional greenwashing situations in which consumers assign environmental benefits to products that are not supported by their actual characteristics.

At the same time, the literature highlights the relevance of the *halo effect* (Schuldt et al., 2011). This mechanism occurs when a single positive attribute of a product or a symbol associated with it leads consumers to infer additional, unjustified positive qualities. In the context of environmental labelling, this means that the mere presence of a symbol associated with ecology may cause a product or its packaging to be perceived as more sustainable and responsible than it actually is.

The Grüner Punkt symbol was introduced in Germany in the late 1980s as part of a financial system for the recovery and recycling of packaging waste, implemented within the framework of Duales System Deutschland. Its primary function was to indicate that a producer pays a fee to support the packaging waste management system (Der Grüne Punkt – Duales System Deutschland GmbH, 2021). The symbol does not refer to the material composition of packaging, does not provide information on recyclability, and does not guarantee any environmental properties of the product or its packaging. The fees paid by system participants are used to maintain and develop the system and to support the design of packaging solutions that are less burdensome for the environment, for example in terms of weight or material composition.

Despite this formal definition, international studies indicate that consumers frequently assign ecological or pro-recycling meanings to the symbol that do not stem from its actual function (Thøgersen, 2002; Wiedmann et al., 2014). In the literature, this phenomenon is described as *perceived eco-friendliness*: a form of environmental perception driven primarily by intuitive associations rather than factual knowledge. It tends to occur particularly when the graphic design of a symbol refers visually to ecology or recycling. This issue becomes especially relevant in countries where the role of a given symbol is not widely communicated to consumers.

In response to the broader problem of misleading environmental claims, the European Commission proposed the Green Claims Directive (COM(2023) 166), aimed at limiting greenwashing by introducing requirements for clear justification and verification of environmental claims. The proposal assumed that every communicated environmental attribute of a product should be substantiated by objective, comparable, and scientifically grounded evidence (European Commission, 2023). A particularly important element of the directive was the prohibition of using symbols or labels that suggest environmental friendliness if their meaning cannot be verified or if they may lead to consumer misinterpretation. In this context, the discussion surrounding the Grüner Punkt symbol—often incorrectly associated with the environmental performance of packaging gains particular relevance. One of the key objectives of the Green Claims Directive was to bring order to the symbolic landscape and to eliminate labels that could mislead consumers (EPRS, 2023).

However, on 20 June 2025, the European Commission announced the withdrawal of the proposed Green Claims Directive, which had been intended to address greenwashing understood as false or misleading environmental declarations by companies. This decision sparked controversy. Supporters of the withdrawn regulation warned that it represents a step toward deregulation, potentially weakening consumer protection and undermining efforts to combat greenwashing. Critics, in contrast, argued that simplification was necessary in order to reduce the regulatory burden on companies, particularly in challenging economic conditions. At the same time, the Directive *Empowering Consumers for the Green Transition* (Directive (EU) 2024/825), adopted in 2024 and scheduled to enter into force in 2026, is currently being prepared for implementation. This regulation aims to protect consumers against misleading environmental claims, including those related to CO₂ offsetting, which are often vague or confusing. Its broader objective is to improve the quality of information available to consumers so that purchasing decisions can better support sustainable development and the transition toward a circular economy.

3. Methodology

The aim of the study was to assess the level of awareness, understanding, and perceived environmental character of the Grüner Punkt symbol among consumers in Poland, as well as to identify how the symbol influences declared purchasing decisions. The study also sought to determine whether consumers attribute pro-environmental meanings to the symbol that do not result from its actual systemic function.

The research was conducted using an original online survey questionnaire distributed via an internet platform (CAWI). Data collection took place in the first half of 2025 and resulted in a sample of 500 complete and valid responses. Participation in the survey was anonymous and voluntary, and respondents were informed about the purpose of the study prior to completion.

The sample consisted of 500 adult consumers in Poland. Given the exploratory nature of the study and its analytical objectives, no weighting procedures or additional representativeness adjustments were applied. The size of the sample was sufficient to identify dominant tendencies and perceptual patterns related to awareness and interpretation of the Grüner Punkt symbol.

The questionnaire included 17 questions grouped into four thematic areas:

1. Visual awareness (recognition of the symbol);
2. Understanding of the symbol's meaning (both declarative and intuitive knowledge);
3. Perception of environmental character and related associations (halo effect, eco-assumptions);
4. Influence of the symbol on purchasing behaviour (declared preferences).

Due to the exploratory character of the study and the absence of demographic variables enabling the construction of predictive models, inferential statistical tests were not applied. The analysis focused on identifying prevailing perception patterns and their implications for consumer behaviour.

The study has several limitations. It is based on a convenience sample, which restricts the generalisability of the findings to the entire population of consumers in Poland. In addition, the declarative nature of the methodology may lead to discrepancies between reported and actual purchasing behaviour. Nevertheless, a sample of 500 respondents allows for a reliable assessment of dominant trends and interpretations related to the Grüner Punkt symbol.

4. Results

The results indicate that the Grüner Punkt symbol is relatively well recognised visually, while its actual meaning remains poorly understood. A total of 69.4% of respondents declared that they had seen the symbol before, whereas 11.0% stated that they had never encountered it.

At the same time, only 11.0% of respondents reported that they “know exactly” what the symbol means. A further 58.8% indicated that they have only a general idea of its meaning, while 30.2% admitted that they do not know what the symbol stands for.

A clear majority of respondents (61.4%) were not aware that the Green Dot does not indicate that packaging is environmentally friendly, but merely that the producer participates financially in a packaging recycling system. Only 17.6% of respondents declared prior knowledge of this fact.

Respondents frequently attributed ecological meanings to the symbol that do not correspond to its actual function. More than half of the participants (56.2%) believed that the symbol indicates that the packaging is recyclable, while 42.8% interpreted it as meaning that the packaging is environmentally friendly. In contrast, only 27.6% of respondents correctly identified the symbol as indicating the producer’s financial contribution to the waste management system (Table 1).

Table 1.

Interpretations of the meaning of the Grüner Punkt symbol (multiple responses possible)

Interpretation	Number of responses	Percentage
Packaging is recyclable	281	56.2%
Packaging is made from recycled materials	219	43.8%
Packaging is environmentally friendly	214	42.8%
Product comes from a company applying environmentally responsible practices	145	29.0%
Producer contributes financially to the waste management system	138	27.6%

Most respondents do not pay attention to the symbol while shopping. As many as 59.0% declared that they never notice it, and only 1.4% stated that they always do so.

The study also shows that the Grüner Punkt symbol has a limited influence on purchasing behaviour. A total of 41.0% of respondents indicated that the symbol has no significance for them, while 33.4% reported that they do not pay attention to it at all. Only 19.2% declared that the symbol has any influence on their purchasing decisions (Table 2).

Table 2.

Influence of the symbol and consumer attitudes

Response	Number of respondents	Percentage
The symbol has no significance	205	41.0%
I do not pay attention to it	167	33.4%
Rather yes – it signals producer responsibility	85	17.0%
I often choose products with this symbol	11	2.2%

Survey results further indicate that most respondents agree with the statement that the “Green Dot” symbol performs primarily a marketing rather than an informational function. A large majority of participants (81%, combining the responses “strongly agree” and “rather agree”) perceived the symbol as a tool for building an environmentally friendly image of a product, rather than as a reliable source of information about its environmental impact.

Respondents tended to view the symbol as an element of marketing strategy rather than as a source of information on material composition, production processes, or recycling possibilities.

In addition, 69.4% of respondents stated that the “Green Dot” symbol requires changes, either in terms of graphic modernisation or its communicative function. Participants indicated that the current form of the symbol does not fulfil its informational role and that its message is ambiguous and often misleading for the average consumer. As many as 88% of respondents expressed the view that producers should provide more information explaining the meaning of such symbols.

In summary, the study reveals a high level of visual recognition combined with a low level of knowledge regarding the actual meaning of the symbol. The results clearly point to an overinterpretation of its environmental character, despite the absence of such meaning in its formal definition. The findings suggest that the Grüner Punkt may function as a carrier of general ecological value associations. At the same time, the study confirms its limited influence on purchasing decisions and the prevailing belief that the symbol primarily serves a marketing function. Respondents also highlighted the need for greater transparency and reliability in environmental labelling.

It should also be noted that the Grüner Punkt symbol plays a significantly smaller role in Poland than in Germany, where it was originally introduced as part of the Dual System. This contextual difference further explains why the symbol is interpreted primarily through intuitive associations rather than through knowledge of its actual systemic function.

5. Discussion

The conducted study confirms the existence of a substantial gap between the visual recognition of the Grüner Punkt symbol and consumers’ actual understanding of its meaning in Poland. The results indicate that mere visual exposure to the symbol not only fails to support correct interpretation, but may in fact reinforce positive yet erroneous environmental associations. This finding is consistent with the ecological overinterpretation effect discussed in the literature, whereby specific graphic elements, colour schemes, and naming conventions lead consumers to attribute environmental qualities to products or packaging that they do not actually possess (Taufique, Polonsky, 2019; Jóźwik-Pruska et al., 2022).

The findings further suggest that the Grüner Punkt functions in consumer awareness primarily as an “eco” symbol, despite its original role being purely systemic and financial in nature. The fact that only a small proportion of respondents were able to correctly identify the meaning of the symbol indicates that, for most consumers, it no longer serves an informational function. Instead, it has become part of an intuitive, visually driven interpretative process.

Similar mechanisms of misinterpretation of eco-labels have been identified in previous studies focusing on environmental communication on packaging (Wojnarowska et al., 2020).

Another important outcome of the study is the limited influence of the Grüner Punkt symbol on declared purchasing decisions. Despite its relatively high level of recognition, the symbol rarely operates as a decisive criterion in product choice. At the same time, the dominant belief among respondents that the symbol plays a marketing rather than an informational role significantly weakens its persuasive potential. Skepticism toward the communicative intentions of producers translates directly into consumer behaviour, reducing the effectiveness of even widely recognised labels. Similar conclusions have been reported in studies examining the relationship between consumer perceptions of eco-labels and purchasing intentions (Kolović et al., 2023).

The results gain additional significance in the context of ongoing debates on greenwashing and the growing number of regulatory initiatives aimed at increasing transparency in environmental communication. From this perspective, the Grüner Punkt may be seen as an example of a symbol that—despite the absence of explicit environmental claims generates associations that extend beyond its actual function. This suggests that the risk of misleading consumers does not apply solely to explicit “green claims”, but also to symbols with a long history and an established market presence. Such an interpretation is consistent with findings in the literature on perceived greenwashing (Lyon, Montgomery, 2015; Gosselt et al., 2019).

It is also important to highlight the specific context of the present study. Although the Grüner Punkt has been present in Poland since the early 1990s, it has never been embedded in a widely recognised and practically functioning waste management system comparable to that in Germany. The lack of strong institutional anchoring of the symbol, combined with limited consumer education regarding environmental labelling, may encourage simplified and intuitive interpretations. In this sense, the symbol operates largely detached from its original meaning, becoming a carrier of general ecological associations rather than a source of precise information. This observation is supported by previous research on consumer awareness of eco-labels (Żuchowski et al., 2023).

In summary, the findings indicate that, in its current form, the Grüner Punkt symbol does not fully fulfil its informational function among Polish consumers. Its perception is largely based on visual and intuitive cues, which leads to systematic ecological overinterpretation. This raises questions about the appropriateness of continuing to use such symbols without additional explanation, as well as about the need to enhance the transparency of environmental communication at the packaging level. Importantly, the original purpose of the symbol was not to communicate environmental attributes of product packaging to consumers, but to ensure the effective functioning of a packaging recovery and recycling system. In this sense, the critical perception identified in this study concerns primarily the symbol’s contemporary communicative role, rather than the legitimacy of the underlying systemic solution itself (Wojnarowska et al., 2020).

6. Conclusions

This study provides important insights into how the Grüner Punkt symbol is perceived by consumers in Poland and into its role in contemporary environmental communication. The findings confirm the existence of a clear gap between the recognition of the symbol and consumers' actual understanding of its meaning. The Grüner Punkt is commonly associated with ecology, recycling, or the pro-environmental character of a product, even though its real function is purely systemic and financial in nature. As a result, the symbol does not fully perform an informational role for consumers, and its interpretation is largely based on intuitive visual associations.

The results also show that consumers' level of knowledge significantly affects how the credibility of the symbol is assessed. Limited awareness tends to sustain simplified and often positive perceptions, whereas greater knowledge leads to a more critical and reflective approach. At the same time, the Grüner Punkt symbol demonstrates a limited influence on declared purchasing decisions, suggesting that its persuasive power is relatively weak particularly among consumers who express scepticism toward environmental marketing communication.

From a practical perspective, these findings may be relevant for producers and for actors responsible for designing and applying labels on packaging. The study indicates that the absence of clear and understandable information encourages overinterpretation and may result in a loss of trust in environmental symbols as communication tools. It therefore appears justified to supplement such symbols with additional explanations or to rely on labels whose meanings are more transparent and unambiguous to consumers, while also reconsidering the use of markings that clearly risk misleading audiences.

These conclusions are particularly important in light of current and planned European Union regulations concerning environmental communication, including efforts to counter greenwashing and to strengthen consumer protection against misleading environmental messages. The case of the Grüner Punkt demonstrates that the risk of misinterpretation does not apply solely to explicit environmental claims, but also to symbols with an established market position that operate in consumer awareness independently of their original meaning.

At the same time, it should be emphasised that the Grüner Punkt symbol has played a significant role in the development of extended producer responsibility systems and the financing of packaging waste management in Europe. The critical assessment presented in this study relates primarily to its contemporary communicative function rather than to the legitimacy of the systemic solution itself. In this sense, the findings point to the need for a clearer separation between the systemic and informational functions of symbols used on packaging, as well as for adapting environmental communication to the current expectations and competencies of consumers.

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GRAPH DATABASE AS A TOOL FOR REPRESENTING DOMAIN KNOWLEDGE – A CASE STUDY

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Purpose: To present graph databases as an effective tool for representing and exploring domain knowledge. A graph database was designed as an implementation of a semantic model to demonstrate the feasibility of mapping comprehensive relationships within a single, coherent database system. The case study examines dog breeding as an industry with a high degree of interconnection among genetic, health, and behavioural data.

Design/methodology/approach: A graph knowledge database model was designed and implemented in the Memgraph environment, drawing on prior studies. The implementation included identification of knowledge units and semantic relations, construction of a graph in the Cypher language, and experimental data mining through queries and result consistency analysis. The study is conceptual and application-oriented and is based on a case study methodology.

Findings: The proposed solutions confirmed that the graph model allows natural mapping of links in domain knowledge. The developed database enables adequate data storage and interactive exploration, including analyses of disease occurrence, links between breeds, and relationships between symptoms and treatments. The graph model facilitates inference and integration of various data types within a single system.

Research limitations/implications: The model is a prototype verified on a limited dataset (two dog breeds) and does not include complete genealogical or statistical data. Future research will extend the model with recommendation modules and machine learning integration.

Practical implications: The database may support decision-making in breeding and veterinary practice by enabling analysis of relationships between diseases, symptoms, and treatment methods.

Social implications: Improved knowledge representation in animal breeding may contribute to more responsible practices and better health management.

Originality/value: The study's innovative approach is the use of a graph model in zootechnics and its potential for decision support systems. The paper demonstrates the feasibility of applying graph database technology to dog breeding, a domain relatively underrepresented in the literature.

Keywords: graph databases, domain knowledge, knowledge representation, NoSQL, Memgraph.

Category of the paper: Research paper.

1. Introduction

The current development information technology development are connected with a continuous increase in diverse data – comprehensive, multidimensional and derived from a multitude of sources. Data collection itself is becoming increasingly important, as is its interpretation in the context of interdependencies. Relations between data units are a key element of analysis in numerous areas of science and economy (Groth, 2020). In such cases, classic relational databases, based on a rigid tabular structure, prove insufficient.

Non-relational systems have emerged in response to these limitations and are collectively referred to as NoSQL. (*Not only SQL*) – allowing for flexible modelling of data structures. One of their variations include graph databases, which allow for natural mapping of the links between objects (Sadalage, Fowler, 2012).

Graph databases, such as Memgraph, are increasingly widely used in analytical systems, where relationships among data are crucial. They are used, among other applications, in the analysis of social networks, recommendation systems, biological research, genetic relationships, and specialist areas such as animal breeding. The use of a graph structure enables effective modelling of dynamic and complex relationships that are difficult to capture with classical relational models (Robinson, 2015).

This article aims to analyse the possibility of using graph databases as an effective tool for representing and exploring domain knowledge. An example of the analysed are is the breeding of purebred dogs, in particular Amstaffs and German Shepherds. Knowledge in this area includes information on the origin of animals, their health status, characteristics, behaviour, genealogy and breeding relationships. These data do not exist in isolation – they form an extensive network of connections, which is ideal for mapping as graphs.

The current state of research on graph databases indicates their growing importance in the analysis of semantic knowledge. According to Hogan (2021) and Groth and Moreau (2020), knowledge graphs form the basis of modern information systems, enabling the integration of data from various sources and their processing in meaningful contexts. Studies by Angles and Gutierrez (2018) have shown that the graph model is particularly effective at mapping complex cause-and-effect relationships, while Franconi and Tessaris (2002) have highlighted its usefulness in conceptual and biological systems. In practical applications, Memgraph and Neo4j are examples of tools that combine real-time visualization and analysis of relations, as evidenced by Mansfeld (2020) and Robinson (2015). Building on these studies, this paper contributes by applying graph theory to model knowledge in dog breeding. This area had been poorly represented in the scientific literature.

The work is conceptual and application-oriented and presents a case study of the design and implementation of a graph knowledge database using the Memgraph system. The article presents a data structure model, sample queries in Cypher, and an analysis of the practical possibilities for knowledge exploration.

The following research hypotheses were verified:

H1: The graph structure allows for a practical and intuitive exploration of knowledge based on semantic relations.

H2: As a graph platform, Memgraph may serve as a foundation for decision support systems in specialist areas, such as breeding purebred dogs.

The article combines a literature review, conceptual design, and experimental implementation of a graph model in the context of domain knowledge.

The subsequent sections of the article present:

- a review of NoSQL literature and technology,
- a description of the graph construction and analysis of the technology used,
- contextual knowledge obtained from the database under experimental queries,
- a discussion of results in the context of existing research,
- conclusions and recommendations on the possibility of further development of the system.

This work is based on a case study, as recommended by Yin (2018), in which a graph database was used to represent domain knowledge in dog breeding. The research methodology covers: an analysis of the literature on graph databases and representation of knowledge (Groth, Moreau, 2020; Hogan et al., 2021), a design of a semantic graph model based on domain-specific relations, the implementation of the Memgraph model using Cypher, and the operationalization of queries about real analytical problems in animal breeding.

2. Literary and technological review

With the development of information technology and the rapid growth in data volume, traditional relational databases (RDBMS) have faced significant limitations, particularly in scalability, flexibility, and the processing of complex data structures. The growing demand for systems capable of handling large, dynamic and heterogeneous sets of data has led to the development of a new class of databases – NoSQL systems. (Not only SQL) (Peng, 2018).

NoSQL databases differ from traditional relational databases in that they do not rely on rigid tabular structures. Instead, they use flexible data models that better reflect real-world relationships and enable efficient information processing in highly volatile environments. The main types of

NoSQL databases include:

1. Document databases – storing data in documents, often in formats such as JSON or BSON. Each document constitutes a separate unit of information, containing both the data and its structure. Examples of such databases include MongoDB and CouchDB. Their application is primarily in systems that require high structural flexibility, e.g., websites and e-commerce applications (Sadallage, 2012).
2. Column bases – they store data in columns instead of rows, which allows for high performance analysis of large data sets, in particular in analytical applications. Examples of such systems include Apache Cassandra and HBase, which are used, among other applications, for real-time analysis of transaction data.
3. Key-value databases – the simplest type of NoSQL databases where data is stored in pairs: a unique key and its corresponding value. Examples include Redis and DynamoDB. Such databases are characterized by exceptionally high efficiency for read and write operations and high scalability.
4. Graph databases – they store data as nodes and edges, which map the relations between objects. Each node represents a specific entity (e.g., a person, an organization, an animal), whereas edge describes their mutual relationship (e.g., “belongs to”, “suffers from”, “is a parent”). This model allows the natural representation of the comprehensive connections that occur in reality (Graph Foundation, 2021).

2.1. Development of NoSQL approach and graph concepts

The concept of non-relational databases is not new; it originated in the 1960s, when IBM developed the IMS (Information Management System), which operated on a hierarchical structure. The breakthrough came in the 70s, when Edgar Codd proposed a relational model which dominated the database market for multiple decades. The emergence of large-scale, dynamic data (Big Data) and distributed systems has necessitated more flexible solutions (Sadallage, Fowler, 2012).

NoSQL systems introduced four key features (Sadallage, Fowler, 2012):

- schema flexibility – the lack of need to define the data structure in advance,
- horizontal scalability – the ability to disperse data between multiple nodes of the system,
- support for unstructured data – the ability to integrate data from different sources in various formats,
- high performance – optimized support for reading and writing data,
- one of the critical design assumptions of NoSQL databases is the CAP theory (Hogan et al., 2021), which describes a compromise between three system properties (see Figure 1):
 - consistency,
 - availability,
 - partition tolerance.

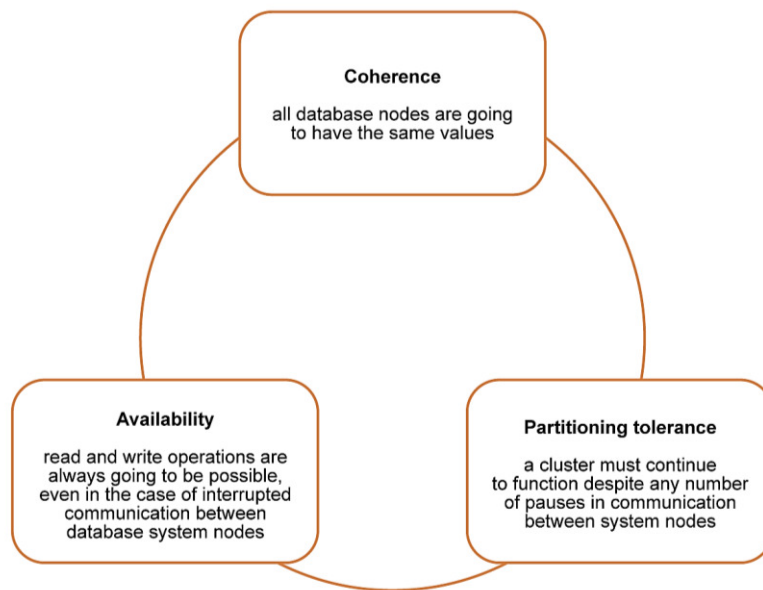


Figure 1 CAP theory diagram.

Source: Own elaboration.

CAP theory states that a database can provide only two of those three features simultaneously. In practical terms, this means that NoSQL systems often abandon complete consistency in favour of greater availability and resiliency (Microsoft, 2021).

2.2. Graph databases and their applications

Graph databases occupy a critical position among NoSQL databases, as they allow modeling relationships between objects in a manner that is closest to human understanding of relationships. Data are stored as nodes and edges, and each edge may contain attributes describing the nature of the relationship (Sadalage, Fowler, 2012).

In practice, graph databases are used, among others, to (Hogan et al., 2021):

- analyse social networks (e.g., relations between users),
- detect frauds,
- analyse biological and genetic links,
- represent expert knowledge in decision-making systems,
- manage relations in animal breeding and genetics.

As noted by Hogan (2021), a graph representation of knowledge enables not only data storage but also the mapping of the meaning and hierarchy of concepts, making it highly useful in semantic applications.

2.3. Memgraph – a tool for analysing and exploring graphs

Memgraph, a modern graph database system, was used for implementation. This system combines high performance (because it operates in the operating memory) with full support for ACID transactions. Its main advantages include:

- support for Cypher query language,
- real-time data analysis,
- integration with data streams,
- easy visualization of graphs,
- scalability and flexibility in modelling knowledge structures.

The use of this tool was justified by its intuitive syntax, high efficiency, and advanced analytical capabilities, which enable the exploration of complex relationships between objects (Angles, 2018; Memgraph Ltd., 2021). Memgraph, as an implementation tool, was identified following a comparative analysis of available graph engines, including Neo4j, ArangoDB, and OrientDB. The final decision was made based on its high performance in processing data in operational memory, which also ensures the portability of queries.

Memgraph – a modern graph engine supporting the Cypher query language, compliant with the principles of ACID transactions (Angles, 2018; Memgraph Ltd., 2021), which meets four basic requirements:

- **A** (atomicity) – each transaction is indivisible.
- **C** (consistency) – a transaction leads the database from one consistent state to another.
- **I** (isolation) – parallel transactions do not affect each other.
- **D** (durability) – once a transaction is approved, the data is durable, even in the event of a failure.

This principle guarantees the correctness of the operation and the reliable operation of the database (Sadalge, 2012).

The advantages of Memgraph include:

- high efficiency due to operation in the operating memory,
- complete support for transactions,
- the ability to perform real-time data analysis,
- integration with data streams,
- simple visualization of query results.

Memgraph allows the creation of dynamic knowledge structures in which data is not stored linearly but rather as links between nodes. This feature makes it particularly useful for modeling areas in which relationships play a dominant role, as in breeding purebred dogs.

In the scientific context, graph databases are part of a broader concept of knowledge graphs, which, as emphasized by Groth and Moreau (2020), enable the integration of data from various sources into a coherent semantic structure.

A graph database was designed as an implementation of a semantic model to demonstrate the feasibility of mapping comprehensive relationships of meaning within a single, coherent database system.

3. Methods

3.1. Project concept

A prototype graph knowledge database, Canis, was created using the Memgraph framework. The area of application chosen for the case study was the breeding of purebred dogs. This example was used for illustrative purposes as a model depicting how graph databases may support knowledge mining and inference processes in domains with complex information structures. The project aimed to create a data structure that not only stores information about objects and their properties but primarily maps their complex interrelationships.

The following methodological assumptions were adopted in the design process.

- the base must be semantic in nature, i.e., relations between nodes must not only combine the data technically, but also reflect their logical meaning (e.g., *a dog suffers from a disease, the disease manifests itself as a symptom*);
- the structure must be extensible and scalable, allowing for easy addition of new types of nodes (e.g., new breeds, diseases, care elements);
- the database is designed to support knowledge exploration through queries in Cypher language, including analytical and comparative queries;
- the project aims to reflect realistic data, based on generally known characteristics of exemplary breeds of Amstaffs and German Shepherds, their typical diseases, and methods of care.

The study employed qualitative methods to analyze the structure of domain knowledge and the design methods used in knowledge engineering (Sowa, 2000; Brachman, Levesque, 2004). The data were sourced from publications on dog diseases, breed patterns, and breeding recommendations, official FCI breed standards, and sample descriptions of veterinary cases. These data have been transformed into unified knowledge units (graph nodes). The criteria for model validation included: semantic consistency of relations, ambiguity of relations between entities, and the correctness of results obtained via test queries. The research hypothesis was verified by applying a set of diagnostic, comparative, and exploratory queries, consistent with the analytical triangulation method recommended in studies on knowledge graphs (Hogan et al., 2021).

The research methodology included three stages:

1. design of the knowledge graph structure, identifying the key knowledge units and relationships,
2. implementation of the model in the Memgraph environment,
3. experimental exploration – covering query tests and analysis of results consistency.

The selection of dog breeding as an application domain was justified by the availability of semantic relationships (genetic, health, behavioural), thus making this area an excellent test case for verifying research hypotheses.

3.2. Knowledge graph structure design

The basic unit of the knowledge base is a node representing a particular real entity – in this case, a dog. This node is the central point of the graph, and the relations from other nodes stem from it.

The project defines the following main types of nodes:

- *dog* – contains information on a particular specimen, such as race, name, body weight, colour, growth, and character traits,
- *disease* – represents a disease entity, e.g., hip dysplasia, food allergy,
- *symptom* – describes a clinical symptom of the disease, e.g., limping, mobility issues, falls,
- *treatment* – describes a therapeutic method, e.g., rehabilitation, surgery, supplementation,
- *care* – applies to care treatments, e.g., combing, bathing, and cleaning the ears,
- *nutrition* and *dog food* – contains information on diet, type of food, and feeding frequency.

Relations between nodes reflect logical dependencies typical of the breeding industry:

- $(Dog)-[:SUFFERS\_FROM]\rightarrow(Disease)$.
- $(Disease)-[:SYMPTOM]\rightarrow(Symptom)$.
- $(Disease)-[:TREATMENT]\rightarrow(Treatment)$.
- $(Dog)-[:CARE]\rightarrow(Care)$.
- $(Dog)-[:Feeding]\rightarrow(Food)$.

These relations are semantic in nature; each carries meaning and enables interpretation of data within the field, not only in technical terms.

Genealogical relations are planned for future development of the database, such as *IS_PARENT* and *DERIVED_FROM*, which will enable analysis of trait and disease inheritance across genetic lines. The database structure has been designed to support expansion with additional data types, such as genealogical relations (*IS_PARENT*, *DERIVED_FROM*) or statistical indicators of disease frequency.

3.3. Implementation – exemplary Cypher queries

The database creation began with the definition of nodes and relations in Cypher. The following code snippets present examples of commands for creating nodes and relationships in the Canis graph knowledge base (figure 2).


```

CREATE (p:Dog {
  race: "Amstaff,"
  weight: "30 kg,"
  colour: "brindle,"
  height: "45 cm"
})
CREATE (cz:Care {type: "Combing"})
CREATE (p)-[:CARE {
  frequency: "once per week,"
  tools: "rubber brush, glove, comb."
}]->(cz)

```

Nodes and relations on diseases have been created similarly, as illustrated in Figure 2:

```

CREATE (ch:Disease {name: "Hip dysplasia"})
CREATE (obj:Symptom {symptom: "Limping"})
CREATE (p)-[:SUFFERS_FROM]->(ch)
CREATE (obj)-[:SYMPTOM]->(ch)

```



Figure 2. Concept of nodes and their mutual connections in the Canis database.

Source: Own elaboration.

The structure is designed to allow flexible expansion of the database; adding a new dog, disease, or symptom does not require modifying the diagram. This makes the model scalable and dynamic, a key advantage of graph databases.

3.4. Principles of knowledge exploration

The developed model allows the formulation of queries of varying degrees of detail. Users – breeders, veterinarians, students – can explore data intuitively and flexibly, thus obtaining answers to practical and analytical questions.

Sample queries:

- Which dog breeds are registered in the database?
MATCH (r:Dog) RETURN DISTINCT r.breed
- Which diseases occur in specific breeds?
MATCH (p:Dog)-[:SUFFERS_FROM]->(c:Disease) RETURN p.breed, c.name
- Which symptoms are associated with a specific disease?
MATCH (c:Disease)-[:SYMPTOM]-(o:Symptom) RETURN c.name, o.symptom
- What diseases are common among the two breeds (Amstaffs and German Shepherds)?
MATCH (:Dog {breed: "Amstaff"})-[:SUFFERS_FROM]->(c:Disease)-[:SUFFERS_FROM]-(o:Dog {breed: "German Shepherd"})
RETURN DISTINCT c.name

4. Results

4.1. Characteristics of the developed database

Exploring the *Canis* database. A graph domain knowledge base was created in the Memgraph environment as a result of the project, including data on selected dog breeds: Amstaffs and German Shepherds. Each Dog node has been associated with a set of properties describing its physical characteristics (body weight, height, colour) and with other nodes representing components of the domain knowledge, such as diseases, symptoms, treatments, care, and nutrition.

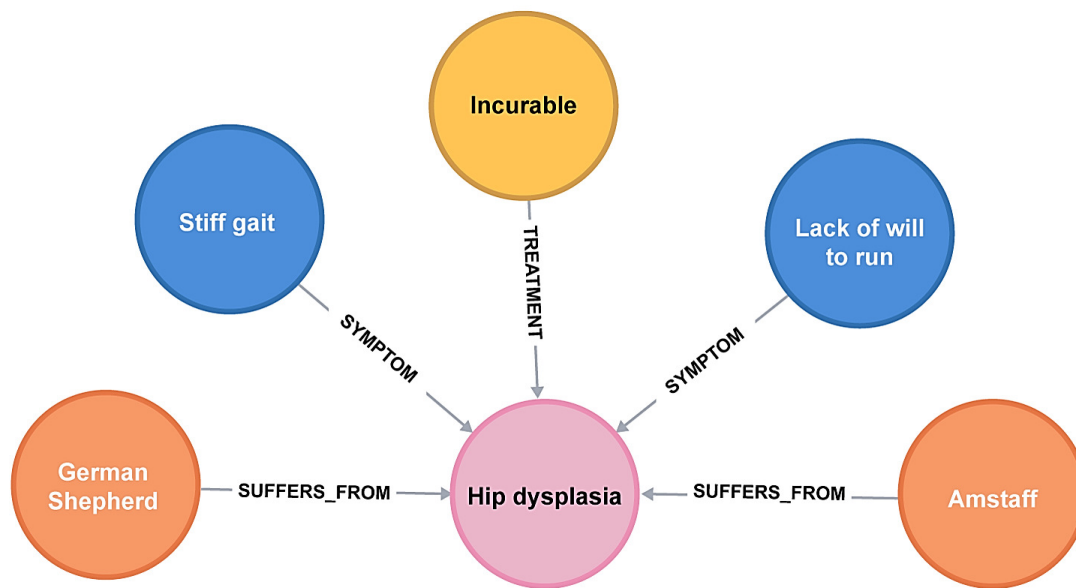


Figure 3. Representation of the case study graph database – detail.

Source: Own elaboration.

The developed graph enables movement across varying levels of information, from a single individual to general relations. For instance, Figure 3 presents a condition shared by both breeds, i.e. *hip dysplasia*. Symptoms may include limping and mobility issues. The treatment methods include Surgery and Exercise. The MATCH command generates the diagram.

4.2. Results of exploratory inquiries

This chapter presents the results of exploratory Cypher queries, illustrating how knowledge can be obtained from the Canis graph database and the practical analytical possibilities enabled by the applied data structure.

Example 1. Summary of dog breeds registered in the database

Query:

```
MATCH (r:Dog) RETURN DISTINCT r.breed
```

Result:

Amstaff

German Shepherd

The results indicate that two dog species, representing different breeding lines, were introduced into the test version of the database. The query enables users to identify available breeds and serves as a starting point for further data exploration.

Example 2. A list of diseases attributed to specific breeds

MATCH (p:Dog)-[:SUFFERS_FROM]->(c:Disease) RETURN p.breed, c.name

Result:

Breed	Disease
Amstaff	Hip dysplasia
German Shepherd	Hip dysplasia
German Shepherd	Food allergy

The resulting list indicates the links between disease units and dog breeds recorded in the database. The result provides a basis for further analysis of the relationship between genetic factors and disease frequency.

Example 3. Identification of dogs suffering from a selected disease entity

Query:

MATCH (p:Dog)-[:SUFFERS_FROM]->(c:Disease {name: "Hip dysplasia"})

RETURN p.name, p.breed

Result:

Name	Breed
Rex	Amstaff
Luna	German Shepherd

This query allows the identification of individuals affected by a particular disease. The data may serve as the basis for further analyses, e.g., epidemiological or breeding analyses.

Example 4. A list of disease symptoms and treatment methods

Query:

MATCH (p:Dog)-[:SUFFERS_FROM]->(c:Disease {name: "Hip Dysplasia"})<-[:rel]-(info)

WHERE type(rel) IN ["SYMPTOM", "TREATMENT"]

RETURN type(rel), info

Result:

Relationship type	Name/description
SYMPTOM	Limping, mobility issues, falls
TREATMENT	Rehabilitation, surgery, supplementation
SYMPTOM	Limping, mobility issues, falls

The results reflect how knowledge units are linked in the graph—each disease has a set of relationships describing its symptoms and potential treatments.

Example 5. Diseases common to the two breeds

Query:

```
MATCH (:Dog {breed: "Amstaff"})-[:SUFFERS_FROM]->(c:Disease)<-  
[:SUFFERS_FROM]-(:Dog {breed: "German Shepherd"})  
RETURN DISTINCT c.name
```

Result:

Hip dysplasia

The query results indicate that hip dysplasia occurs in both breeds under analysis. This allows further research into its genetic condition.

Example 6. Potential disease based on symptoms

Query:

```
MATCH (c:Disease)<-[:SYMPTOM]-(o:Symptom)  
WHERE o.symptom IN [  
  "Mobility issues,"  
  "Limping,"  
  "Falls,"  
  "Difficulty maintaining balance and turning"]  
RETURN DISTINCT c.name
```

Result:

Hip dysplasia

Arthritis

Pelvic limb injury

This type of query allows for the identification of potential disease units based on defined symptoms. It is an example of the application of the database in veterinary diagnostic processes.

4.3. Graph result structure

The actions performed yielded a complete knowledge graph structure, including nodes of the following types: Dog, Disease, Symptom, Treatment, Care, and Feed, connected by appropriate semantic relations.

Figure 4 presents a general representation of the relationship between knowledge units in the *Canis* database.



Figure 4. A representation of a portion of the Canis graph database.

Source: Own elaboration.

5. Discussion

Exploring the *Canis* database graph not only allows the storage of information on dogs and their characteristics, but also enables the acquisition of knowledge dynamically through queries based on inter-node relationships. The database may serve as a support for decision-making in breeding and veterinary medicine. Similar conclusions were drawn in the research by Angles and Gutierrez (2018), in which graph models of knowledge enabled the analysis of cause-and-effect relationships in biological systems. The applied model has potential for implementation and education. It may serve as the basis for systems supporting breeding, clinical, or didactic decisions. In the future, the database could be integrated with expert systems or machine learning algorithms, enabling automatic inference from the relational structure.

The application of Memgraph database in this project confirmed the practical advantages of the environment – e.g., the ability to execute queries in Cypher, support for ACID transactions, and integration with data streams. As pointed out by Mansfeld (2020), such features make graph databases handy for analysing dynamic data, where relationships are more important than values themselves.

In the context of the subject literature, it should be noted that the presented model is consistent with the stream of research on the ontological representation of domain knowledge. Brachman (2004) and Sowa (2000) point out that effective representation of knowledge requires tools that allow for the association of facts with their semantic meaning. The graph knowledge base presented in the article implements the assumption.

Compared to other works, the project stands out for its attempt to apply the concept of graph modelling of knowledge in the area of animal husbandry, which has been relatively poorly represented in computer science literature to date. Typically, graph databases are used in social network analysis, natural language processing, and biological data analysis (Hogan, 2021). This paper demonstrates that the same concept can be successfully applied in the zootechnical context for modeling and exploring breeding data.

The results confirm H1, which states that exploring knowledge using Cypher queries proved intuitive and practical, consistent with observations by Robinson (2015) and Angles (2018). Compared to previous studies on expert systems in medicine (Franconi, Tessaris, 2002), the presented model shows greater structural flexibility while maintaining relational semantics. The results support H2: the Memgraph database could serve as the foundation for future decision support systems. In the context of dog breeding, such a system can provide breeders with information on genetic links, behavioural characteristics, and health predispositions, thereby supporting breeding selection and planning. For veterinarians, the system enables analysis of the relationships among diseases, symptoms, and treatment modalities, supporting diagnostics, monitoring animal health, and planning therapies. The graph structure enables quick, intuitive link searches and the generation of recommendations based on complex relationships among data.

It should be noted that the developed model is a prototype and has been verified on a limited dataset (two breeds of dogs). Therefore, its full implementation would require expanding the database to include additional cases and integrating it with real breeding and veterinary records. In addition, the visual graph analysis, as specified in the original project assumptions, was not fully implemented due to constraints of the presentation environment.

The results obtained indicate that graph databases are an effective tool for representing and analyzing domain knowledge. In the context of the presented case study – breeding purebred dogs – the application of a graph structure allows for the combination of data from various areas: health, genealogical, and behavioural. Unlike traditional relational databases, which store information in tables with a fixed schema, a graph approach allows for more natural and

semantically accurate representation of relations among individuals (Robinson, 2015; Groth, Moreau, 2020).

The project results align with the observations of other authors on graph knowledge modelling. Hogan (2021) emphasizes that knowledge graphs enable a transition from static information storage to dynamic association, thereby increasing the analytical value of the data. Similarly, Memgraph, used in this work, enabled interactive exploration of the relations among units of knowledge.

Similar applications have been reported in the bioinformatics literature (Franconi, Tessaris, 2002), in which graphs are used to represent metabolic networks and gene-to-gene relationships. This project uses a similar approach: the relationships among diseases, symptoms, and treatment modalities constitute a logical network, enabling multidimensional knowledge analysis.

6. Conclusions and summary

This article aimed to examine the feasibility of using graph databases to represent and explore domain knowledge. Based on the case study concerning the breeding of purebred dogs, it was shown that the graph data model enables a natural and semantically accurate representation of reality.

The results of the conducted analyses confirmed that the graph databases – in particular the Memgraph environment – allow:

- represent multidimensional relationships between knowledge units,
- integrate data at various structural levels (e.g., race, disease, symptoms, treatment, nutrition),
- real-time exploration of connections through Cypher queries,
- easy scaling and expansion of the database without the need to modify its schema,
- building a coherent semantic model reflecting the domain logic.

From a practical perspective, the designed graph knowledge base is a functional tool for collecting and analyzing breeding information, supporting decision-making processes in health prevention, planning crossbreeding, and genetic risk assessment. This system may also be used in veterinary and zoological education as an example of the implementation of the ontological knowledge model. From a scientific point of view, the project shows several important innovative features:

1. Application of the graph knowledge base in the dog breeding domain, which has not been described in detail in the literature.
2. Integration of many aspects of knowledge (health, care, nutrition, genetics) into a single, coherent semantic model.

3. The potential to extend the model with statistical and genealogical data, allowing for the analysis of the inheritance of diseases.
4. The possibility of using the base as a component of the recommendation system – e.g., in advisory services related to breeding and veterinary care.

The research carried out brings new value to the literature of the subject through:

1. Application of graph database technology to the domain of animal husbandry, which is a new field of its use.
2. Integration of multiple types of information – health, care, behavioural, and genealogical – into a single, coherent system.
3. Demonstration of the potential of a practical graph model of knowledge, which can provide the basis for future expert systems or decision support tools.
4. Proposing a universal graph structure which may be adopted in other domains, such as biology, medicine, or education.

It should be emphasized that the presented model is a prototype and requires further verification on larger real datasets. The database contained a limited number of units and lacked complete genealogical data or veterinary records.

The research conducted confirmed that graph databases are among the most promising solutions for modern knowledge management systems. Their ability to combine information in a relational context and to continuously expand their scope make them suitable for use in the life sciences, medicine, education, or the agricultural industry.

The model used in the work, despite the limitations in terms of its scale, proves that even in a small thematic domain – such as breeding purebred dogs – it is possible to effectively develop a coherent knowledge graph which not only collects data, but also supports their interpretation and practical application.

The results are consistent with Robinson's observations (2015), which emphasize that graph data models make it easier to navigate complex relationship structures than relational databases. Similarly, Hogan et al. (2021) indicate that graph databases facilitate the representation of knowledge in which semantic relations are as relevant as the objects themselves, as confirmed by the results of this study on the possibility of a complete interconnection among dogs, diseases, symptoms, and treatments. The results of our study are therefore consistent with the trends reported in the literature on the subject.

In conclusion, the discussion confirms that the use of graph databases, such as Memgraph, is a modern and effective tool for processing domain knowledge. The project adds scientific value, demonstrating the feasibility of practical mapping of complex semantic relations in animal husbandry.

In result, the developed system may be considered a prototype of an intelligent graph knowledge base, providing a starting point for further research on the use of graph data models in the automation of cognitive and decision-making processes.

The application of the model in the zootechnical domain is a novel approach that has not been the subject of extensive analysis to date. Our research shows that the graph structure can be extended to include a statistical and genealogical layer, enabling applications in predictive analyses.

Research plans include developing recommendation modules and integrating them with machine learning tools, enabling automated inference based on graph structure. Future work will consist of recommendation modules and integration with ML to automate inference.

The planned directions of further research include:

- Expansion of the database to include quantitative data (frequency of occurrence, effectiveness of treatment).
- Implementation of a recommendation module using logical rules and semantic links.
- Integration with a web interface allowing for the exploration of the graph by non-technical users.
- Transferring the model to other domains, such as horse breeding, cat breeding or genetic analysis in medicine.

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KITCH AND ITS USE IN BUSINESS COMMUNICATION. AN EXAMPLE OF PERSONAL BRANDING AND ADVERTISING USING AI

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Purpose: The main research problem was formulated in the form of a question: In what areas of business communication is kitsch dominant and what are the ways of building social sensitivity in order to eliminate or limit it? The purpose of this article is to discuss the category of kitsch in business communication, in areas such as personal branding and artificial intelligence (AI) advertising. It also aims to clarify the state of knowledge about kitsch in business, which is a vivid and widespread phenomenon, though perceptually subjective, and therefore eludes rigid definitional rules.

Design/methodology/approach: Humanities research, essential in marketing, PR, HR, UX/UI, as well as project management and strategy development in creative industries, was conducted. Non-reactive methods were employed: desk research and descriptive analysis. Full-text databases, including EBSCO, ProQuest, ISI SSI Reuters/Thomson, were also used, along with the leading website scholar.google.com. Data were selected based on final results, inclusions, and exclusions.

Findings: Kitsch is part of the phenomenon of modern consumerism. In business, it is primarily used for marketing purposes to appeal to the tastes of a wide audience. Examples include online activities utilizing artificial intelligence, such as personal branding and advertising campaigns.

Research limitations/implications: This article is of a theoretical nature. New trends that fit into the phenomenon of digital kitsch and serve business communication, such as personal branding and advertising using artificial intelligence (AI), as well as trends in the use of artificial intelligence in this area, were identified.

Practical implications: It was concluded that AI is not enough in business practice, but that a human factor will always be needed: supervisors, experts and connoisseurs who, with the sensitivity typical of homo sapiens, will manage advertising campaigns and ensure the proper personal branding of employees.

Social implications: The article contributes to building social sensitivity to the negative features of kitsch, which lead to the trivialization of culture, undervaluation and creation of illusions, which is already visible in the new version of the forms of personal branding and advertising described in the article using artificial intelligence (AI), as well as in commercial products.

Originality/value: The approach to the category of kitsch in business communication presented in the article organizes this area and identifies opportunities for better use of the potential of knowledge in this area in business practice.

Keywords: kitsch, AI-powered advertising, personal branding, business communications.

Category of the paper: research paper.

1. Introduction

A retrospective analysis of the concept of kitsch leads to the conclusion that it has existed in various historical periods (Broch, 1998). However, the word itself appeared only in the late 19th century in the Munich art trade to describe cheap goods (Banach, 1968). Critics used the term kitschen (“scraping mud”) to refer to landscape paintings devoid of artistic merit, favored by the upstarts of the time, represented by rapidly growing wealthy industrialists. Today, with the spread of colloquial culture, the dominance of simultaneous visual messages, and the emergence of new-generation technologies, including artificial intelligence (AI), kitsch is taking over new spaces, also entering the sphere of business communication.

The internet, where various social, aesthetic, and emotional needs are increasingly being met, serves as a rudiment and a breeding ground for its spread. In business communication, kitsch refers to the use of tacky aesthetics, primarily for marketing purposes, that pander to the tastes of mass audiences. In this context, the aim of this article is to theoretically organize the state of knowledge about the kitsch phenomenon, and to discuss, on a practical level, the identified business areas in which it appears, such as personal branding and artificial intelligence (AI) advertising. The final section of the paper presents conclusions and recommendations regarding the discussed issue.

2. Methods

This article is theoretical in nature. Non-reactive methods were used in the research: desk research and descriptive analysis. Following a systematic literature review methodology, secondary sources related to the concepts of kitsch and camp were analyzed, including online forums, news, and media content related to image management and artificial intelligence-generated advertising. Full-text databases were used, including EBSCO, ProQuest, ISI SSI Reuters/Thomson, and the scholar.google.com search engine. The obtained materials were selected based on keywords and inclusion and exclusion criteria (Czakoń, 2011). The content of the documents, updated continuously, was compared with previously obtained materials. An inductive scientific reasoning approach was employed.

3. The category of kitsch in the light of a literature review

In the context of clarification, kitsch defies any attempt at unambiguous definition, as it is a connotative, contextual, and subjective concept (Jaworski, 2013). Its perception reflects the level of cultural competence, which varies depending on the individual's social environment. Therefore, kitsch "is always in the eye of the beholder, and all intellectual constructions are secondary to this fact" (Czaja, 1997). As an aesthetic category, or—metaphorically speaking—"the art of happiness" (Moles, 1978), it is commonly associated with exaggeration, an excess of decoration and embellishment, exaggerated and overly saccharine colors, as well as with mediocrity, mediocrity, and inept imitation. It applies to works of questionable artistic quality (paintings, sculptures, visual art, literary works, music, and films), but also applies to objects and gadgets (toys, jewelry, decorative and utilitarian objects) that look nice but are of low quality and give the impression of cheapness. Researchers agree that kitsch manifests itself most fully through the distortion of function and an excess of decorativeness. It combines the characteristics of novelty and excess with those stemming from tradition. Its main characteristics are:

- a) inadequacy (exceeding functionality),
- b) accumulation (accumulation of various functions in one object),
- c) synesthesia (multi-sensory interaction with many senses simultaneously),
- d) mediocrity (fluidity between what is previously accepted and what is new),
- e) comfort (striving for well-being by avoiding what is difficult and uncomfortable) (Moles, 1978).

Kitsch, which is mass-market and rooted in stereotypes, mental simplifications, and fairground sentimentalism, shows no signs of disappearing today; on the contrary, it is taking over various spheres of life, becoming, one must agree, "a phenomenon not only in aesthetics, but also in social life. It is commonly associated with something banal, sentimental, vulgar, tacky, ultimately ugly and bad, a manifestation of tastelessness and talentlessness. And, most importantly, this does not bother its enthusiasts" (Mikołajczyk, 2018). It should be added that it cannot be a nuisance because it is assigned to things that people like, that they purchase, watch, read, listen to, and use, deriving pleasure from them. Moreover, it could "neither come into being nor survive if there were no man who likes kitsch and, as an art producer, wants to produce it, and as an art consumer, is ready to buy it and even pay well for it" (Broch, 1998).

Kitsch, as mentioned above, is characteristic primarily of works of art, but it evolves, transforming from an aesthetic dilemma, tantamount to a denial of the creator's skill and the work's originality and uniqueness, into a sociological phenomenon (a favorite of the masses), as well as a psychological one—understood as an immanent element inherent in each of us. In the contemporary world, kitsch seems ubiquitous, though "it is something vague, intuitive,

but also extremely nuanced" (Maciejewski, 2018). It is not art, but its distortion, manifested in the devaluation of its value. The researcher is right that "kitsch is universal, it is at the level of the average person, unlike art, which transcends them" (Drożdż-Szczybura, 2023).

Since 1964, thanks to the book *Notes on Camp* by American intellectual Susan Sontag, the term camp has gained popularity. It is similar in meaning to kitsch, but differs in its provenance and the social context from which it originated. Kitsch is generally considered a plebeian concept, while camp refers to the homosexual community and the excluded. As the researcher explains, in the 19th century, the word camper was used as an adjective to mean "homosexual", and in homosexual slang, it meant "something tasteless, distasteful" (Drożdż-Szczybura, 2023).

Camp, like kitsch, defies attempts at objectification and unambiguous definition. If we assume that "kitsch draws solely on the resources of beauty and goodness, whereas camp often combines exaggerated beauty with ugliness" (Malinowska-Petlenz, Petlenz, 2007), then the thought arises that works and artworks whose creators deliberately and artistically introduce elements of turpism in order to evoke aesthetic shock fall under the category of camp, not kitsch.

The statement that "kitsch denotes sensitivity, while camp denotes a specific attitude" (Booth, 2012) is certainly correct. Camp is not only an aesthetic category, but also an "unruly cultural phenomenon" (Drożdż-Szczybura, 2023), validated by lifestyle and an uninhibited way of perceiving the world. What connects both concepts, according to researchers, is a "critical attitude towards what is traditional and established, regardless of whether they toy with the ideas of fine art or clumsily strive to imitate them" (Maciejewski, 2018). One should also agree with the assessment that "the areas of the nefarious activity of both phenomena are increasingly overlapping, whether in the field of fighting for the rights and interests of excluded people, including sexual minorities (camp), or in the field of discussion about what actually is art and what is not? (kitsch)" (Maciejewski, 2018).

In the literature to date, the phenomenon of kitsch/camp has most often been analyzed in relation to real life. Cyberspace, where various social, aesthetic, and emotional needs are met, provides a new location for the persistence of these categories. The entire virtual space is now becoming a sphere susceptible to kitsch, or, as a YouTube researcher put it, the "internet kitschosphere" (Maćkowiak, 2016). This is facilitated by the rules governing the internet, such as universal accessibility, anonymity, atterritoriality, and abstraction. It is not without reason that cyberspace is synonymously referred to as the "Tower of Babel or Cyber Thermopylae" (Marczyk, 2018). It is replete with examples of poor taste and saccharine, artificial stylistic conventions, to which artificial intelligence (AI) plays a significant role. We discuss this below.

4. Doll in a box – personal branding marked with kitch

One pop culture trend that began gaining popularity in early 2025 (Madan, 2025) is personalizing self-images in the form of the popular Barbie doll or other superheroes, housed in virtual packaging similar to those found on store shelves and in which toys are sold in the real world. From a business perspective, this trend aligns with personal branding. The idea is to stand out and build a personal brand to enhance perception. Using animation and ChatGPT, you can create a viral doll-in-a-box image of yourself and showcase it seamlessly on social media, such as TikTok, Instagram, or Facebook. These AI-generated portraits are meant to symbolize the real world and idealize an individual's profession, personality, and interests.

The first step is to choose the color of the virtual box, imitating the packaging of the doll representing us. Then, we select the appropriate accessories—miniature additions we consider most aptly characterize us. For example, people who consider themselves intellectuals might include books, glasses, or a laptop; others who care about their fitness might include gym equipment or a container resembling a boxed diet; and pet owners won't forget to visualize their pet. Once the desired image with the new doll-in-a-box image, generated from an authentic photo, is ready, log in to the appropriate website to upload and obtain the existing video. As Times Now World notes, "you can request additional elements such as a logo, a made-up name, or even fake power statistics. If you don't like the first result, you can modify the image and try again until it looks just right" (Madan, 2025). This way, you achieve a perfect character, free of any flaws.

The doll-in-a-box trend is widespread, despite its low-brow representation. However, it demonstrates that kitsch is colonizing various spaces today, including those previously considered eminent, such as academia and business. Educated and ambitious adults with professional aspirations, specialized knowledge, and a strong desire for goodwill and respect from their surroundings are succumbing to the need for this illusory, childish play. However, they are unaware that the image created, while essentially false, is a manifestation of hedonistic kitsch, a lack of good taste, and, above all, evidence of the dominance of the "utopian culture of the world of perfect people" (Gromysz, 2016). An artificial, manipulated image is not the highest-quality way to define one's self or build a reputation. This is not a technique, as the internet user-businesswoman claims, for self-irony (<https://www.instagram.com/p/DIQ6F5qAxGe/>).

On the contrary, the created image is devoid of any flaws, which demonstrates a lack of self-distance. It is a manifestation of a certain immaturity and a "massive drive towards narcissistic body cultivation" (Giddens, 2010), and in extreme cases, a sign of body dysmorphia. It also confirms the collective fascination with the Barbie doll, promoted through effective advertising campaigns. The researcher is right that "the famous doll is no longer just a passive instrument illustrating desired ideas. It has become a factor in creating reality independent of

its creators" (Woźniak-Czech, 2023). It is "a thing that governs its owner", the researcher adds, illustrating her statement with an example of surgical procedures undertaken to resemble the American puppet (Woźniak-Czech, 2023). The fictional image of a "beauty" in a box does not require such sacrifices, but the psychological mechanism of the actions taken remains the same.

5. Some thoughts on AI-powered advertising

It's no secret that some advertisements, not only in terms of ethical standards (Pabian, Pabian, 2024), but also aesthetically, leave much to be desired. One must agree with researchers that "advertising is the most ubiquitous and intrusive of cultural messages" (Baumann, 1993), and the advertising texts themselves are "simple, understandable, precise, persuasive, and often imbued with kitsch" (Stefaniak, 2016). While researchers emphasize that "advertising has been considered an art form on a par with sculpture or painting, the most artistic advertisements are not considered works of art, primarily because of their commercial dimension" (Chęć-Małyszek, 2015). Equally important is the fact that advertisements appeal to a mass audience, which means that "by their very nature they feed on kitsch" (Plesnar 1997). Scientific analyses also indicate that the existence of kitsch in advertising is determined by stylistic persuasive devices. Lexical indicators of kitsch include: shortening the distance by directly addressing the recipient of the message (using the second-person singular and personal pronouns, e.g., "Your", "You"), the imperative mood, the use of all-caps letters, the use of foreign words, the pursuit of brevity, including word shortening, and the succumbing to linguistic trends, triviality, and the repetition of words and messages (Stefaniak, 2016).

To strengthen their commercial arguments, companies producing advertising campaigns are increasingly using artificial intelligence, which is used systematically for "planning, analyzing, designing, producing, shaping the characters in the spots, and implementing the entire film creation" (Kończak, 2024). The first Polish audio-video ad entirely generated by AI, titled "Max – the Seduction Trainer", appeared in early 2024 (Drynko, 2024). Artificial intelligence as an independent tool has therefore been used in marketing communications for a relatively short time, but it has significant development potential.

Advertisements generated by AI are already generating moral and artistic controversy. For example, some of them contain elements of so-called shockvertising, the inclusion of risky content intended to provoke extreme reactions, even disgust, in viewers. Another challenge is what the authors of this article call the kitschification of masterpieces. In this case, the idea is to exploit the resources of classical and modern art for bold parodies of outstanding originals, employing altered means of expression. Such alterations most often take the form of paraphrases, replacing the conventions of seriousness with verbal or situational humor, thus altering the work's character and reception. An example is the commercial titled "Coca-

Cola – Masterpiece" (Keystory, 2023). This is a dynamic story about characters from famous canvases by renowned painters (including Johannes Vermeer's "Lady with a Pearl Earring", William Turner's "Shipwreck", van Gogh's "Room in Arles", Edvard Munch's "The Scream", and other emerging artists from far-flung corners of the Earth) who come to life at the sight of a Coca-Cola bottle from Andy Warhol's artwork and, delighted by the taste, toss it back and forth from painting to painting in the exhibition hall. In the finale, the bottle of the famous drink is given to a young artist, presumably an art student, who, after drinking its contents, gains creative inspiration to sketch. Another example is an advertisement titled Tourist attractions, in which characters from outstanding works of art (including the Mona Lisa, Vincent van Gogh from his self-portrait, Lady with a Pearl Earring by Johannes Vermeer, a farming couple (a farmer and his daughter) from the painting "American Gothic" by Grant Wood, etc.) come to life thanks to artificial intelligence and verbally encourage tourists to visit Denmark (YouTube).

These types of ads are modern and can be appealing to audiences because they represent a brilliant novelty. However, their aesthetic and emotional impact can, in some people, evoke what Roger Scruton calls "semi-physical disgust—a feeling of yuck!" (Scruton, 1999), or a sense of kitsch. Experts on the subject point out this problem, writing, among other things, that "brands are aware of technical limitations and that audiences are offended by the characters' unnatural movements, facial expressions, and lack of proportion, as well as the lack of realism and caricaturality". Some try to get around this, for example by changing conventions, deliberately exaggerating the artificiality of the effects to give the ad a satirical dimension, which is much harder to criticize" (Kończak, 2024). Arguably, this approach won't eliminate the problem. The fact that, as we already know, artificial intelligence algorithms can learn is also not encouraging. Unfortunately, this is machine learning, devoid of human sensitivity, feelings, and finesse, and therefore resistant to emotion or making distinctions at the intersection of aesthetics and ethics, beauty and truth.

Finally, it's worth adding that advertising campaign creators have long been leveraging the potential of classical art to promote various products. Perhaps the most common parodies involve Leonardo da Vinci's portrait of the Mona Lisa (e.g., BIC stationery, PANTENE hair cosmetics), and BLISTEX lip balms and lipsticks (Łuc, Bortliczek, 2014). Works by Impressionists Edouard Manet and Pierre-Auguste Renoir have also been used to promote the McDonald's restaurant chain, for example, a paraphrase of the painting "Bar at the Folies-Bergère", in which a woman in a Parisian nightclub serves the company's chicken nuggets instead of drinks, or the beachgoer from Renoir's "Figures on the Beach", who holds a company takeout bag (Pabian et al., 2024). These parodied travesties, however, were made by people with greater or lesser sensitivity and sense of taste, who were capable of being moved and were susceptible to emotions. The exclusive use of AI in advertising elevates the category of kitsch to a technological, completely dehumanized, electronic level. Its limitation or elimination is only possible with human intervention.

6. Conclusions

The research findings confirm previous findings that the development of cyberspace is impoverishing the realm of reality by shifting everyday life—personal and professional—to the virtual dimension. Kitsch is also migrating to the internet, as it thrives on what is sensational, surprising, and "pretending to be innovative" (Dróżdż-Szczybura, 2023). In business communication, kitsch refers primarily to the use of tacky aesthetics for marketing purposes that pander to the tastes of mass audiences. Examples include online activities using AI, such as the creation of idealized images (dolls in a box) and advertising campaigns that lead to the kitschification of masterpieces. The resulting images can be viewed as a celebration of the extraordinary and a certain absurdity. They are inauthentic, manipulated, exaggerated, distorted, and distorted, yet simultaneously eye-catching, colorful, often dynamic, and easy to perceive.

Kitsch is present on the Internet and will take over more and more space, if only because it is "an element of the generic code used by Internet users to communicate" (Gumkowska, 2016). The situation is not improved by the boundless and unprecedented infatuation with new generation technologies and the resulting practice of entrusting all artistic activities to artificial intelligence, which lacks human sensitivity, artistic elegance and even a shadow of lyricism. The messages obtained so far are fed by kitsch and bear the hallmarks of dehumanization. Artificial intelligence undoubtedly relieves the burden of intellectual work and increases human productivity (Rheingold, 2003). It also supports artistic creativity, but "it will not replace it, because a human has a soul, emotions and sensitivity" (Garwol, 2024). The researcher is right that we will probably soon see the times when "the value of works made by humans, and not by a machine will increase precisely because of their authenticity, the amount of work and the time needed to complete them" (Garwol, 2024).

The conclusion is that business communication will always require a human element: supervisors, experts, and art connoisseurs who, with the sensitivity of a human being, will manage advertising campaigns and ensure proper employee branding. This requires an exchange of experiences and dialogue between creators, art connoisseurs, managers, and everyday internet users. Systematic training for managers and advertising creators in terms of cultural knowledge would also be useful.

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AI-ENHANCED ORGANIZATIONAL RESILIENCE

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Purpose: The article identifies and analyzes a new theoretical construct — AI-enhanced organizational resilience. The study explains how employees utilize AI capabilities to support their own behavioral flexibility, thereby strengthening their organization's ability to cope with unpredictable threats.

Design/methodology/approach: A mixed-methods approach was applied, combining a literature review with empirical research. The research was conducted using an original survey questionnaire comprising 65 variables grouped into 19 categories, with a sample of $n = 614$ respondents. The results were analyzed using exploratory factor analysis (EFA) and linear regression.

Findings: A statistically significant construct of AI-enhanced resilience was identified, comprising two dimensions: behavioral flexibility and adaptability, as well as openness to collaboration with AI. The multidimensional nature of the studied phenomenon was confirmed, and key predictors were identified.

Research limitations/implications: The cross-sectional design limits our ability to infer causality, and we limited the sample to the Polish organizational context.

Practical implications: The results emphasize that organizations should invest in developing employee digital competencies and fostering an organizational culture that supports experimentation with new technologies.

Social implications: The study contributes to discussions about the future of work organization in the AI era and highlights the need for organizations to prepare their employees to collaborate with intelligent systems as part of socio-economic resilience.

Originality: This work introduces an innovative construct of AI-enhanced resilience and provides the first empirical contribution to understanding how individual AI-supported behaviors can strengthen organizational resilience to unpredictable threats.

Keywords: organizational resilience, artificial intelligence, adaptive behaviors.

Article category: Research paper.

1. Introduction

In the VUCA/BANI world, the ability of organizations to cope with events that are sudden, surprising, and highly destructive, yet simultaneously unclear or unknown, is becoming increasingly important. Put more simply, contemporary organizations must be able to quickly

and effectively deal with the impact of sudden, unforeseen phenomena of an incompletely recognized nature. This sketches the role of organizational capabilities and action strategies that constitute organizational resilience (Salun, Zaslavskaya, 2024, p. 186). Within this article, resilience is understood as an organizational process that enables achieving outcomes in the form of resilient organizational actions and behaviors (Hillmann, Guenther, 2021, p. 8). This approach has its advantages, as it allows for the development of resilience theory as well as the assessment and improvement of this aspect of organizations. In this way, it is possible to consciously increase an organization's chances of success when confronting unknown and unpredictable scenarios of situational changes. The article discusses a specific organizational resource that, potentially, in the face of sudden exposure to unknown and strongly destructive factors, can constitute a source of resilient behaviors.

2. Organizational Resilience as Outcome and Process

The concept of organizational resilience began with assessing how organizations face difficulties that (1) threaten vital company interests, (2) leave little time to respond, and (3) are unexpected (Williams et al., 2017, p. 735). Resilience means the organization can respond adequately to these difficulties. This usually involves maintaining or improving efficiency, or quickly returning to normal (Sutcliffe, Vogus, 2003, p. 96; Williams et al., 2017, p. 740). Organizational resilience is thus a process leading to resilient reactions (Sutcliffe, Vogus, 2003 p. 96). Some views reduce resilience to just the reaction's outcome (Gibson, Tarrant, 2010, p. 9), but studying its sources is more common. Most definitions focus on the organization's capacity to absorb disruptions or on its ability to return to a previous state. Based on the classification developed by Hillman and Guenther (2021), six strategies for understanding and defining resilience can be characterized:

1. The behavioral approach, the oldest, focuses on specific behaviors of resilient organizations: Coutu (2002), Hamel and Välikangas (2003), Horne and Orr (1998). Ishak and Williams (2018) developed this approach into a two-dimensional model encompassing a typology of resilient behaviors.
2. The integrative approach combines resilient behaviors with organizational resources necessary for their occurrence. Resources are activated and combined in various ways, as noted by Lengnick-Hall, Beck (2005) and Sutcliffe, Vogus (2003), through processes defined as social mechanisms (Vogus, Sutcliffe, 2007).
3. The systems engineering approach emphasizes the role of proper organizational design as a hierarchical system and equipping it, through technology, coordination, and integration of subsystems, with the capacity for resilient response: Chewning et al. (2013), Erol, Sauser & Mansouri (2010), Patriarca et al. (2018).

4. The capabilities-based approach treats resilience as an organizational capability. It focuses on developing organizational response capacities, understood in terms of abilities, potential, or skills: Duchek (2020), Parker and Ameen (2018), Williams et al. (2017).
5. The typological approach proposes typologies and dimensions of organizational resilience, enabling the classification and comparison of organizations based on their resilience (Limnios et al., 2014).
6. The ecological approach combines various aspects of organizational activity in its understanding of ecology. It adapts earlier conceptualizations of the notion of resilience, developed in the natural sciences, to organizational considerations (Linnenluecke, Griffiths, 2012).

The concept of organizational resilience is clearer when we note what it is not. Resilience research does not overlap with crisis management, which studies crises—namely, their causes, dynamics, and consequences—not how organizations protect themselves from their impacts (Williams et al., 2017, p. 740). Resilience also differs from flexibility, agility, or adaptability. These concepts are related but not identical (Legnick-Hall et al., 2011). Resilience is not just about predicting the future. Some view prediction as one aspect of resilience (Duchek, 2020, p. 223), particularly in a strategic context (Hepfer, Lawrence, 2022, p. 15). Still, resilience mainly concerns coping with the unforeseen, which sets it apart. The distinction between prediction—attempting to forecast future events using available information—and resilience—coping with unforeseen phenomena—is necessary due to the fallibility of prediction (Vogus, Sutcliffe, 2007, p. 3419).

3. Modeling Resilience

This research uses the integrative approach (number 2 above). Resilience is seen as either the ability to return to pre-disruption operations or as a way to create and exploit new opportunities (Lengnick-Hall et al., 2011, p. 245). Lengnick-Hall sees this capacity arising from the combined knowledge, skills, and abilities of key employees (2011, p. 246). The first definition stresses quickly fixing the disruption effects. The second view sees difficulties as an opportunity to utilize resources and skills more effectively. Each definition points to different abilities as sources of resilience. Gittell et al. (2006) emphasize the importance of returning to normal quickly, focusing on both financial and relational resources. Richtnér and Löfsten (2014) stress transformation and the ability to spot new opportunities. They focus on organizational creativity as a vital source of resilience, based on the following resources (Richtnér, Löfsten, 2014, pp. 140-141):

1. Structural - structure, vision, and action plans shared by employees, financial resources, distribution of power, and core values.
2. Cognitive - skills, knowledge, and competencies, access to expert knowledge, experienced mentors, and experts.
3. Relational - external partners and collaborators, such as subcontractors, consultants, clients, or policymakers.
4. Emotional - friendship, support, trust, respect, camaraderie.

These resources create potential that allows organizations to generate solutions characterized by a significant level of creativity and, consequently, effectiveness in coping with difficulties. Organizations achieve the outcome of organizational resilience by engaging the above resources in action. The models presented by Hillman and Guenther (2021) and Hepfer and Lawrence (2022) share a similar vision of organizational resilience. Hillman and Guenther, summarizing their original integrative model, defined organizational resilience as *the ability of an organization to maintain functions and recover fast from adversity by mobilizing and accessing the resources needed. An organization's resilient behaviour, resilience resources and resilience capabilities enable and determine organizational resilience. The result of an organization's response to adversity is growth and learning* (2021, p. 31). Meanwhile, Hepfer and Lawrence state: *(o)ur review of research on organizational resilience suggests a nested, recursive model that connects the foundations, dynamics and outcomes of organizational resilience through processes of application, transformation and learning* (2022, p. 17).

In both models, the threat or difficulty is identified and interpreted, and then the process of constructing a response begins, utilizing all available organizational resources. Its structure and dynamics depend on how the threat was understood - how its structure, dynamics, and potential impact on the organization were interpreted, as well as on resource availability. The organization's response mitigates the negative factor and alters the consequences of its occurrence. The effectiveness of neutralizing potentially dangerous or undesirable impacts constitutes organizational resilience. The cyclical nature of the process allows for its improvement through organizational learning. Improvement encompasses the recursive relationship between organizational resources and managerial cognitive capabilities, as well as processes of shaping organizational response and expanding their repertoire.

4. The Role of AI in Developing Organizational Resilience

Based on the above-cited literature review results, organizational resilience can be defined as the outcome of a process of transforming organizational resources into actions aimed at neutralizing difficulties or threats affecting the organization, or changing their nature to a favorable one. The effectiveness of these actions is difficult to determine *ex ante*, but remains

directly related to the level of organizational capability development. As demonstrated in the earlier part of the study, key capabilities conditioning organizational resilience include:

1. Cognitive capabilities of managerial staff, including the ability to interpret events, phenomena, processes, and trends in the environment. These capabilities are conditioned by both knowledge and experience, as well as the ability to work effectively in the face of information overload.
2. Organizational cognitive resources in the form of knowledge records and the employment of experts.
3. Relational resources in the form of people possessing knowledge, experience, and other resources.
4. Creative capabilities - allowing the creation of original responses to threats. Creativity constitutes a key source of organizational resilience (Richtnér, Löfsten, 2014; Weick, 1993).
5. Decision-making capabilities - necessary in the face of time pressure characteristic of crisis situations.

The cognitive nature of these resources, the role of information and decisions in their transformation into action, as well as the conditions for using networks of relationships to acquire needed resources, draw attention to, in each case, the role of information, informatics, and communication technologies (ICT - Information and Communication Technology, or increasingly DT - Digital Technology). In the case of resilience as a means to quickly restore the organization's state before the occurrence of a disruptive factor, communication plays an important role (Chewing et al., 2013; Zaskórski, Woźniak, 2024). Seeking innovative responses requires the engagement of creative processes, as the resilient organizational state in this case is distinct from those in previous instances. Comprehensive support for resilience processes is provided by dynamically developing artificial intelligence (AI). This technology serves as a means for comprehensive improvement of information processing capabilities (Li, Li, He, 2025, p. 5), and consequently positively affects generally understood organizational performance (Yu et al., 2024, p. 3). In terms of resilience:

1. AI allows for effective environmental monitoring. The capabilities of current data processing enable the monitoring of trends in the environment and the estimation of the risk of phenomena threatening the organization based on them (Li, Li, He, 2025, p. 5).
2. Generative AI can support the creative process by nature of creating potential organizational behaviors, that is, the process of transforming organizational cognitive resources (Kmieciak et al., 2024).
3. AI's analytical and predictive capabilities enable the support of decision-making processes aimed at selecting and implementing the developed solution most effectively (Badmus et al., 2024).
4. Organizational learning is a component of organizational resilience (Hepfer, Lawrence, 2022, p. 8), which can also be effectively supported by AI.

5. Empirical Research Design

The empirical research design incorporated the following conclusions from the literature review:

1. The area of organizational resilience is not clearly and strictly defined. It is a category that encompasses a wide range of diverse concepts and research areas (Williams et al., 2017, p. 743).
2. The core of resilience is the ability to improvise and respond effectively to unexpected events.
3. Resources are cognitive, and AI is currently the organizational core of transforming resources of this type.
4. Investments in technological innovations increase organizational resilience (Jiang et al., 2024, p. 2).

It may happen that the threat arises from an improper interpretation of the environment. Therefore, cultivating organizational routines in the interpretation of situations, implementation of solutions, and decision-making may hinder the ability to find an effective response. It would be a mistake to rely on organizational knowledge, as it formed the basis of previous interpretations, decisions, and actions. Another argument for abandoning existing decision-making processes and resources is the time pressure accompanying threats. Organizational decisions may not only be erroneous but also delayed. Therefore, it was assumed that the study would concern individual responses to threats, undertaken to protect the organization, but against organizational routines and procedures. This provides an opportunity to identify responses to unexpected threats that extend far beyond predicted scenarios of situation development. Thus, resilient behavior may involve ignoring both routines and procedures as well as organizational shared notions regarding the acceptable scope of actions. However, they are undertaken in the organization's interest, which allows them to be classified as Pro-Social Rule Breaking (PSRB) behaviors (Miao, Chen, Yao, 2024, p. 1).

The rejected knowledge, routines, and organizational procedures are worth replacing with other cognitive resources - those that are more quickly available and facilitate a different perception of the situation than those cultivated within the organization. This is enabled by the development of mobile, cloud, and AI technologies. A competent person can significantly support their decision-making process by using their assistance.

In the discussed context, among digital technologies, artificial intelligence gains particular significance (Zheng et al., 2017, p. 155), which, unlike traditional ICT tools, not only processes information but also supports creative thinking and decision-making. AI provides exceptionally effective support for decision-making processes under time pressure, which aligns with the specificity of crisis situations that require resilient responses.

These unique properties of AI, combined with individual employee initiative, create a new type of organizational potential, which has been adopted as an area of empirical research. This studied potential can be termed AI-enhanced resilience.

6. Research Method

The empirical research concerns exploring the structure of the network of organizational resources that condition the occurrence and intensity of resilient action. The research aims to identify the determinants influencing the level of AI-enhanced resilience, which can be understood as a component of organizational resilience, characterized by an employee's tendency to take independent action utilizing AI support. Therefore, the dependent variable of the research consists of two items:

1. Behavioral flexibility and adaptability, understood as readiness to take action for the good of the organization, even in situations of risk where this activity may be interpreted as breaking applicable rules.
2. Openness to collaboration with AI, understood as readiness to consider AI as a useful partner offering useful support in implementing cognitive processes.
3. The analysis of survey results consisted of two phases, whose content determines the research tool used:
4. Exploratory Factor Analysis (EFA) - allowing verification of whether theoretically selected variables actually create a factor (Grabowski, 2014, p. 251).

Linear regression - allowing examination of relationships between the explained variable - dependent, and a set of explanatory variables - independent (Biecek, 2013, p. 1; Hair et al., 2019, p. 265). Results were refined using the Akaike criterion (Akaike Information Criterion - AIC). This criterion aims to minimize the number of explanatory variables (Yamashita et al., 2007, pp. 2395-2396), which enables the identification of key explanatory variables influencing the level of AI-enhanced resilience, represented by two factors that group a total of 14 dependent variables (explained). Linear regression was applied twice, examining the influence of substantive variables and the influence of demographic variables separately.

The research was conducted using an original online survey in February 2025. It was carried out by an external research company. The author adopted the condition for including responses in the research set was meeting two requirements: current professional activity performed at a dimension of at least $\frac{3}{4}$ full-time equivalent and length of service at the current place of employment of no less than two years. Imposing these limitations resulted from our effort to obtain responses from people whose experiences in organizational participation are current and have been shaped under conditions of continuity for at least two years. Among the 1000 responses delivered by the company conducting the research, 614 met the above criteria.

Respondents were individuals of diverse genders, ages, and occupations, employed in various industries, at different positions, and in organizations of varying sizes. The following list presents in detail the structure of the studied sample:

- Respondent gender: female: 370 (60,3%); male: 244 (39,7%).
- Age (categories): up to 30 years: 114 (18,6%); 31-40 years: 213 (34,7%); 41-50 years: 168 (27,4%); 51-60 years: 90 (14,7%); over 60 years: 29 (4,7%).
- Education: higher than master's: 73 (11,9%); master's: 243 (39,6%); bachelor's, engineering: 68 (11,1%); secondary: 199 (32,4%); vocational: 31 (5,0%).
- Position: board member: 18 (2,9%); managerial: 141 (23,0%); independent/specialist: 223 (36,3%); executive: 232 (37,8%).
- Length of service at current place of employment: from 2 to 5 years: 223 (36,3%); from 5 to 10 years: 214 (34,9%); over 10 years: 177 (28,8%).
- Industry: manufacturing: 160 (26,1%); market services: 283 (46,1%); public services: 117 (19,1%); other: 54 (8,8%).
- Organization size: up to 9 people: 97 (15,8%); between 10 and 49 people: 171 (27,9%); between 50 and 249 people: 178 (29,0%); over 250 people: 168 (27,4%).
- Organization location: city over 300 thousand inhabitants: 222 (36,2%); city 100-300 thousand inhabitants: 136 (22,1%); city 20-100 thousand inhabitants: 143 (23,3%); city below 20 thousand inhabitants: 62 (10,1%); rural area: 51 (8,3%).

The principal part of the survey consisted of 65 questions divided into nineteen categories. Some of these variables (14 in total, categorized into 4 categories) were incorporated into the factors and are presented in Table 2. The remaining categories, along with the number of variables assigned to them, are presented in Table 3. Respondents provided answers by selecting one option on a five-point Likert scale. In the process of processing results, the following weights were assigned to individual response options: definitely not: -2; rather not: -1; hard to say: 0; rather yes: +1; definitely yes: +2.

The 614 responses meeting the adopted conditions are sufficient for conducting the planned research. In the case of linear regression, the minimum sufficient ratio is 10:1 (Austin, Steyerberg, 2015, p. 632). In this research, it is nearly 12:1. Moreover, the quality of the research set is significantly enhanced by the inclusion of criteria for minimum length of service and current employment (Memon et al., 2020, p. xiv).

7. Results

At the literature review stage, a series of factors were constructed that could serve to build the research model; however, some of them obtained negative results in empirical assessment using Cronbach's alpha reliability coefficient or factor verification using EFA. Factors whose reliability was confirmed empirically are presented in Table 1. Table 2 presents the set of parameters used in assessing factor reliability.

Table 1.

Factor names and indicators

Factor name	Indicators
dependent variable items	
Behavioral flexibility and adaptability	(1) readiness to break procedures when in the employee's opinion it is worth doing; (2) readiness to break procedures for the good of the organization; (3) readiness to break procedures for the good of the organization - even in face of misunderstanding from superiors; (4) experimenting with application of new methods and tools even against rules
Openness to collaboration with AI	(1) readiness to accept AI as a partner in task implementation; (2) acceptance of AI's influence on work flow; (3) readiness to accept plans prepared by AI
independent variable items	
Organizational innovation in the digital sphere	(1) striving for the widest possible application of DT in the organization; (2) continuous search and testing of digital tools; (3) existence of plans regarding AI application development; (4) growth of digital component in offered products and services
Personal digital competencies of employee	(1) programming skills; (2) ability to train AI models; (3) ability to create websites

Source: own elaboration.

Table 2.

Selected parameters for assessing factor reliability

Factor name	Cronbach's alpha	Range of factor loadings	Explained variance	RMSEA	Tucker-Lewis Index (TLI)
Behavioral flexibility and adaptability	0,85	0,72-0,85	60%	0,032	0,997
Openness to collaboration with AI	0,87	0,82-0,86	69%	0,000	-
Innovation in the digital sphere	0,84	0,70-0,81	58%	0,113	0,953
Personal digital competencies of employee	0,81	0,67-0,86	59%	0,000	-

Source: own elaboration.

Only in the case of one variable (concerning the ability to create websites), the factor loading was 0,67 and was lower than the recommended 0,7; however, due to the substantive value of the variable, it was retained in the factor structure. All factors achieved low RMSR values ($< 0,03$), which confirms good model fit. The highest correlation coefficient value between the factors is 0,512, indicating no problems with multicollinearity.

The dependent variable was the sum of two factors: (1) behavioral flexibility and adaptability, and (2) openness to collaboration with AI. Its predictors are two independent factors characterized above: organizational innovation in the digital sphere and personal digital competencies of the employee, as well as a series of fifty-one individual variables representing selected issues considered as potentially influencing the level of AI-enhanced resilience. Aspects of the organizational situation, as well as those concerning the employee, are represented by individual variables in Table 3. As can be seen, some aspects were assigned more than one variable. However, as determined empirically, they do not form reliable factors.

Table 3.

Selected aspects of the organizational situation, concerning the employee, along with the number of assigned individual independent variables

Group	No.	Aspect	Number of variables
Aspects of organizational situation	1.	formalization	6
	2.	IT infrastructure	1
	3.	AI use in practice	1
	4.	AI implementation plans	1
	5.	knowledge sharing practices in organization	9
	6.	employee preferences regarding work organization forms	3
	7.	organization's advancement in IT	1
	8.	leadership	1
Aspects concerning the employee	9.	basic digital competencies of employee	5
	10.	employee competencies regarding IT equipment	1
	11.	employee competency development practices in IT field	2
	12.	sources of employee digital competencies	5
	13.	self-assessment of one's digital competency level	3
	14.	employee attitude toward digitalization	10
	15.	employee attitude toward digital threats	2

Source: own elaboration.

The model prepared in this way showed a high quality of fit to the data. The model is globally statistically significant ($F(23, 590) = 34,930$, $p < 0,001$) and characterized by a high coefficient of determination ($R^2 = 0,577$), which indicates that it explains 57,766% of the variance in AI-enhanced organizational resilience. The value of the adjusted coefficient of determination (adjusted $R^2 = 0,560$) confirms the model's stability after accounting for the number of predictors. The AIC variable selection procedure reduced the initial set of 53 predictors to 24 most significant for the model.

Table 4.

Significant predictors of AI-enhanced organizational resilience from the group of substantive variables

Group	No.	Predictor	Aspect	B	p
Predictors concerning organizational situation	1.	factor: organizational innovation in the digital sphere	-	-0,190	0,043 *
	2.	high degree of work proceduralization	formalization	-0,103	0,049 *
	3.	team meetings occur according to schedule	formalization	-0,123	0,005 **
	4.	internal cooperation occurs via digital tools	knowledge sharing practices in organization	-0,139	0,012 *
	5.	using support of IT-proficient colleagues	knowledge sharing practices in organization	0,125	0,008 **
	6.	implementation plans for AI and machine learning systems	AI implementation plans	0,218	< 0,001 ***
	7.	organization is a digitalization leader in its field/industry	organization's advancement in IT	0,168	0,002 **
Predictors concerning the employee	8.	factor: personal digital competencies of employee	-	0,309	< 0,001 ***
	9.	belief that one should strive for the most far-reaching digitalization of work	employee attitude toward digitalization	0,139	0,017 *
	10.	own ideas regarding development of work digitalization	employee attitude toward digitalization	0,172	0,001 **
	11.	belief that concerns about AI are exaggerated	employee attitude toward digitalization	0,140	0,005 **
	12.	concern about security of digital records	employee attitude toward digital threats	-0,130	0,010 **
	13.	image as an IT enthusiast	self-assessment of one's digital competency level	0,129	0,011 *
	14.	belief in colleagues' superiority in digital competencies	self-assessment of one's digital competency level	0,092	0,038 *
	15.	plans for professional involvement with IT industry	employee competency development practices in IT field	0,116	0,018 *

Notes: B - unstandardized regression coefficient; p - significance level: ***p < ,001, **p < ,01, *p < ,05.

Source: own elaboration.

In the next step, the collected demographic variables were used as predictors of the dependent variable. Their list, values, and distributions are presented in the earlier part of the article. To examine their influence, linear regression was used again. The obtained model proved to be statistically significant ($F(10, 603) = 5,653$, $p < 0,001$), explaining 8,572% of the variance in AI- enhanced organizational resilience. Significant variables are presented in Table 5.

Table 5.

Significant predictors of AI-enhanced organizational resilience from the group of demographic variables

No.	Predictor	B	p
1.	gender: female	-1,291	0,008**
2.	position	1,472	< ,001***
3.	industry: manufacturing	1,730	0,049*
4.	industry: market services	1,611	0,053

Notes: B - unstandardized regression coefficient; p - significance level: ***p < ,001, **p < ,01, *p < ,05, p < ,01; The category "market services" at the borderline of significance ($p = 0,053$) includes trade, transport, and IT services.

Source: own elaboration.

8. Discussion

Two elements stand out in the research results. First, the model explains 57.7% of the variance in AI-enhanced resilience and shows high stability, indicating reliable and credible results. Second, the findings empirically confirm that organizational resilience is multidimensional: eight of the 15 analyzed aspects significantly affect resilience. Therefore, organizations aiming to strengthen crisis resilience should invest holistically in competencies, culture, structures, and technologies.

The research defines resilience in a distinct way, focusing on individual actions that may diverge from established procedures. In this context, decision-making involves collaboration with AI rather than consultation with superiors, colleagues, or formal regulations, promoting faster and often substantively valuable outcomes. This approach aligns with approaches that emphasize the role of creative organizational threads and also relates to the realities of the VUCA/BANI world, where the possibility of sudden and dangerous phenomena occurring completely outside considered scenarios of future development exists. It was precisely this vision of resilience that was operationalized as a dependent variable, and the conducted analysis allowed for the identification of factors that increase the chances of this form of organizational resilience occurring.

The compilation of factors influencing the level of the dependent variable in a significant and positive way includes both organizational and individual factors. Individual factors comprise an image of a high-class specialist (Table 4, items 8 and 15) in the field of DT. Personal digital competencies of the employee (Table 4, item 8) constitute the strongest predictor of AI-enhanced organizational resilience ($B = 0,309$, $p < 0,001$). This statistically significant effect, with a high level of explained variance ($R^2 = 0,577$), confirms the fundamental role of individual capabilities in building organizational resilience in the digital era. Competencies such as programming skills, ability to train AI models, or create websites form a foundation upon which an organization can build its adaptive capacity. The level of competencies is also influenced by the dynamics of knowledge processes, as this specialist works in an environment with other high-level IT specialists, as indicated by item 14 in Table 4 ($B = 0,092$, $p < 0,05$).

High personal competencies and even higher ones, those of colleagues, go hand in hand with an enthusiastic attitude toward digitalization, as expressed in employees' attitudes and behaviors (Table 4, items 9, 10, 11, 13). The belief in the need for maximum digitalization of work (Table 4, item 9: $B = 0,139$, $p < 0,05$) and own ideas regarding the development of digitalization (Table 4, item 10: $B = 0,172$, $p = 0,001$) show that AI-enhanced resilience is not solely a function of technical skills, but also of a proactive attitude and readiness to initiate changes.

The model also confirmed the significance of concrete AI implementation plans as a predictor of resilience (Table 4, item 6: $B = 0,218$, $p < 0,001$). This suggests that mere openness to technology is insufficient; concrete, planned implementation actions are necessary. Similarly, the organization's position as a digitalization leader in the industry (Table 4, item 7: $B = 0,168$, $p < 0,01$) proved to be a significant predictor, suggesting that being at the forefront of digital transformation brings measurable advantage in terms of organizational resilience.

The second component of the dependent variable is readiness to break applicable rules. It turns out that readiness for such behavior is closely linked to a lack of concern about data record security (Table 4, item 12, with a negative regression coefficient $B = -0,130$, $p = 0,01$) and trust in AI (Table 4, item 11: $B = 0,140$, $p < 0,01$). Such a relationship between an attitude of indifference to particular data security issues and readiness to undertake rule-breaking behaviors causes the studied component of organizational resilience to be considered a high-risk resource.

Among the predictors related to the organizational situation, substantive factors have a positive influence on the value of the dependent variable, similar to those related to the person. This is superiority in DT over other organizations operating in the same industry (Table 4, item 7) and striving to maintain, and perhaps strengthen, this superiority, expressed by the presence of plans to implement systems based on AI and machine learning (Table 4, item 6).

A certain organizational approach negatively affects the value of the dependent variable. The inhibiting impact of highly formalized work organization (Table 4, items 2 and 3, with negative regression coefficients) on actions exceeding applicable regulations is consistent with intuition.

Intriguing, however, is the negative regression coefficient for organizational innovation in the digital sphere ($B = -0,190$, $p = 0,043$). This seemingly paradoxical result can be explained in several ways:

1. A statistical suppressor effect is possible. Digital innovation may act as a suppressor variable, controlling variance shared with personal digital competencies and revealing the true relationship between individual capabilities and organizational resilience. Given the high regression coefficient for employee competencies ($B = 0,309$), intensive organizational innovation may indicate a phase of digital transformation in which the organization has not yet fully absorbed the introduced changes.
2. Organizations that intensively innovate in the digital sphere may experience temporary destabilization (Cyfert et al., 2025). Continuous testing of new tools and searching for the latest solutions may lead to a transient weakening of operational stability. Employees may be overwhelmed with changes, and organizational routines may be disrupted.

3. Organizational innovation may not only disrupt routines but also change their architecture. This means that in innovative organizations, a much wider range of behaviors fits within accepted organizational norms, not meeting the criteria for deviation. Colloquially speaking, in innovative organizations, employees "are allowed more".
4. This relationship may be nonlinear or moderated by other variables. This hypothesis requires verification in future research using nonlinear models (e.g., quadratic regression) or analysis of interaction effects. Longitudinal studies would have great value in explaining the dynamics of the relationship between innovation and resilience.

On the basis of empirical material collected in the presented research procedure, it can be stated that the more clearly marked the form of work organization is, the more strongly it contributes to limiting deviant behaviors. Regardless of whether it is directed at inspiring innovation or maintaining work processes within the framework of procedures and regulations, it has the same effect.

Demographic analysis reveals an additional finding: these variables, while explaining less than 9% of the variability in resilience, have a statistically significant effect. Women show less inclination toward the behaviors under study, while a tendency for AI-supported, non-regulation-conforming behaviors increases with organizational rank. Such behaviors are most prevalent in manufacturing, trade, transport, and IT services.

9. Conclusion

Perceiving readiness to break regulations without coordinating actions with superiors or colleagues, while only using AI assistance as an organizational resource, may raise justified doubts. However, three arguments can be indicated for such perception:

1. Resilience is a response to surprising and atypical situations. Describing today's world using the acronym VUCA/BANI, i.e., volatility, uncertainty, complexity, ambiguity, and brittleness, anxiety, non-linearity, incomprehensibility, does not testify to the effectiveness of forecasting tools used in business, nor to the lack of problems with controlling selected processes. It testifies to something quite opposite.
2. Actions classified within the studied category lie outside the formalized organization. Rules and hierarchical dependencies are broken, as are processes of social knowledge sharing, customs of action, and decision-making.

3. When, due to the specificity of the situation, all rules that allowed the organization to function fail, breaking them may prove to be the only chance for survival. All the more so, as this is not a random action. Its direction takes into account the value of the organization's goods, utilizing employee competencies and AI capabilities. Therefore, it is the realization of values in a new way, possessing the highly desirable quality of creativity (Panasiewicz 2021; Richtnér, Löfsten, 2014).

The research demonstrated that AI-enhanced resilience exists, as indicated by the statistical significance of the developed models, and is a complex, multidimensional construct. The previously discussed research results indicate both factors that contribute to the development of this specific organizational potential and factors that limit its level. On the one hand, thanks to this, it is possible to choose the direction of purposeful and effective influence at this level, depending on the degree of acceptance of the arguments cited above. On the other hand, a significant factor in the development of the studied potential is organizational digitalization and the development of employees' and teams' digital competencies. Currently, there is no alternative to the development of organizational digitalization. Therefore, one must reckon with the fact that progress in this area may inspire behaviors of a PSRB nature.

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HOW ORGANIZATIONAL CITIZENSHIP BEHAVIOR SHAPES EMPLOYEE WELLBEING IN MODERN WORKPLACES

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Purpose: The aim is to examine the relationship between Organizational Citizenship Behavior and employee Psychological Well-Being in modern workplace. The study investigates the conditions under which OCB enhances or diminishes well-being and addresses a research gap by combining theoretical framework with empirical data. The analysis focuses on how voluntariness, recognition, managerial support and workload shape employees' experience of OCB.

Design/methodology/approach: A qualitative, multi-sources research design was applied. The study includes a systematic literature review, document analysis of annual reports and disclosures from companies listed in the Forbes' Best Employers 2024 ranking and semi-structured interviews with employees from a selected large corporation in Poland. The triangulation of these methods provides a comprehensive perspective on OCB and PWB, integrating employee narratives, organizational policies and theoretical framework.

Findings: Impact of OCB on well-being is conditional as when OCB is recognized and correctly resourced, employees report benefits such as satisfaction, learning and motivation for further development. Imposed or unrecognized OCB, especially under time constraints, led to stress, demotivation and overall fatigue. Employees during the interviews emphasized lack of recognition and difficulty in setting boundaries as key stressors. Organizational reports reinforced these observations, showing that companies with structured recognition systems and well-being initiatives create more favorable conditions.

Research limitations/implications: The qualitative nature and small interview sample limit the ability to generalize the findings. Document analysis focuses on high-ranking employers, potentially excluding less supportive environments. Future research should include more diverse organizations, larger samples and longitude approaches.

Practical implications: The paper shows that organizations should protect voluntariness of OCB, ensure recognition of extra-role efforts and manage workload to reduce hidden labour and stress-related risks, such as burnout. Well-being programs, feedback mechanisms and clear role expectations support healthier OCB engagement and improve the team's performance.

Social implications: The study highlights the importance of psychologically safe and supportive workplaces. Promoting responsible management practices can improve employees' well-being and contribute to broader societal expectations for human-centered leadership and sustainable work environments.

Originality/value: The paper offers a unique multi-source analysis that links employee perspectives, organizational reports and theoretical framework. Together it demonstrates that OCB's effects on well-being are not uniform but depend on managerial support, recognition

and resource availability. The findings provide value for both scholar and practitioners seeking to design sustainable workplaces.

Keywords: Organizational Citizenship Behaviour, Employee Well Being, Psychological Wellbeing, Employee Engagement, Workplace Sustainability.

Category of the paper: Research paper.

1. Introduction

Understanding the factors that can contribute to an employee well-being and organizational success has become a priority for both researchers and professionals in recent times (Prasad et al., 2024; Peña et al., 2024). Among these notions, Organizational Citizenship Behavior, further referred to as OCB, and its impact on employee well-being stands out as particularly important. OCB, as defined by Organ in 1988 involves discretionary behaviors that are not formally rewarded but they collectively enhance organizational effectiveness (Organ, 1988). These behaviors often expand beyond employees' formal job descriptions - they are fostering collaboration, trust, and a supportive workplace environment which is crucial for the development of a healthy organization (Organ, 1988).

The importance of employee well-being, in particular psychological well-being (PWB) cannot be overlooked in modern business arrangements as it involves concepts of six dimensions: self-acceptance, autonomy, environmental mastery, purpose in life, personal growth, and positive relationships (Ryff, Keyes, 1995). This multidimensional framework highlights the broader significance of well-being as a state that gives a chance for to employees to thrive both personally and professionally. Research is highlighting this connection, demonstrating that employees with higher levels of PWB are more productive and demonstrate stronger organizational commitment (Robertson, Cooper, 2010). These findings point out the key role of well-being in sustaining a high-performing and engaged workforce (Wright, Cropanzano, 2004).

Discretionary efforts, such as those included by OCB, are linked to improved teamwork, innovation, and resilience, which are important for businesses facing complex and quickly changing environments (Podsakoff et al., 2009). By cultivating and nurturing a culture that encourages OCB and prioritizes employee well-being, organizations not only enhance individual employee outcomes but also create a foundation for long-term success (Dávila de León, Finkelstein, 2013).

This article aims to explore how OCB influences employee well-being, emphasizing their combined impact on organizational performance and sustainability; as it is important to add to existing body of research, theory and evidence (Peña et al., 2024). With the newest research available it is as present as ever that the importance of OCB and PWB are emerging, and their relationship understanding is critical for further development of the subject (Prasad et al., 2024).

By connecting theoretical perspectives and practical applications, this article seeks to provide actionable insights for managers and leaders who are striving to create thriving workplace environments.

2. Conceptual foundations of Organizational Citizenship Behavior and Psychological Well-Being

This section reviews key theoretical and empirical perspectives on Organizational Citizenship Behavior and Psychological Well-Being, with particular attention to stress, work engagement, leadership, and motivational mechanisms shaping this relationship.

To identify appropriate literature on the topic of Organizational Citizenship Behavior and employees' Psychological Well-Being, the review of existing studies related to the subject was conducted. Determination of suitable keywords was based on extensive review of available research papers and current problems that are being discussed. Determined keywords included: OCB, Organizational Citizenship Behavior, Employee Well-Being, Psychological Well-Being, and PWB - they were utilized in searches through SCOPUS and ScienceDirect databases. The author took into consideration research articles written in English, covering publications from the earliest available studies up to 2024. Due to the large number of papers available on ScienceDirect (over 13,000 articles) and specificity of filtering criteria, the author applied inclusion and exclusion criteria in SCOPUS database to refine the selection and gain a clearer overview of the available research. After identifying relevant articles that met the subject criteria, the author used the snowballing technique to further explore and expand knowledge on the topic in Table 1.

Table 1.

Literature search strategy summary

Criterion	Number of papers
Search terms: Organizational Citizenship Behavior, language: English	5343
Search terms: Organizational Citizenship Behavior AND employee well-being, language: English	42
Search terms: Organizational Citizenship Behavior AND employee well-being and PWB, language: English	1
duplicates	1
Total of chosen articles	42

Source: own elaboration.

After conducting a review of the chosen articles, 27 papers have been selected. Selection was based on systematic review and synthesis of the most accurate and needed information on the subject needed for this article. One of the major criterion was for the articles that were to be used in the literature review to be as representative as possible for the research that is to be conducted throughout this work by the culture in which the research has been done as well as

by the type of organization in which they took place, for example by excluding research done in hospital setting due to its high complexity and specificity that is beyond author's knowledge nor capacity to discuss.

Organizational Citizenship Behavior refers to discretionary actions by employees that go beyond their formal job requirements to enhance organizational effectiveness (Organ, 1988). These are actions not mandated by job roles but contribute significantly to organizational success, such as helping colleagues or volunteering for extra tasks (Organ, 1988). Such actions may vary from watering the plants in the office to helping the fellow team members during high demand periods. These behaviours are not directly recognized by organizational reward systems, as they are also not included in the job description but are essential for fostering a collaborative and positive work environment (Podsakoff et al., 2000). OCB includes dimensions such as altruism, courtesy, conscientiousness, sportsmanship, and civic virtue, each contributing uniquely to workplace dynamics (Farh, Podsakoff, and Organ, 1990). As a good example one might think about altruism – it can be as such as assisting colleagues with work related tasks, while conscientiousness reflects a dedication to go beyond basic job expectations. Together these dimensions illustrate the complex nature of OCB and its potential to improve organizational and individual outcomes.

Close to OCB is Psychological Well-Being which reflects an individual's emotional and cognitive evaluation of their life, including factors like life satisfaction, positive emotions, and the absence of negative emotions (Ryff, Keyes, 1995). PWB is vital to employee well-being, influencing motivation, performance, and engagement at work. Employees with higher PWB are more likely to engage in OCB, as their positive mental state fosters a willingness to support organizational objectives (Wright, Cropanzano, 2004). Furthermore, PWB enhances resilience against occupational stress, enabling employees to navigate workplace challenges effectively (Ryff et al., 2006). Expanding on the broader concept of employee well-being, this construct encompasses physical, psychological, and social health within the workplace (Grant et al., 2007). It reflects an employee's overall quality of work life and ability to thrive professionally. Efficient Human Resource Management (HRM) practices offer flexible work arrangements, wellness programs, and supportive leadership, which are vital for promotion of well-being (Guest, 2017). Research consistently demonstrates that higher levels of employee well-being are linked to greater job satisfaction, improved productivity, and reduced turnover (Robertson, Cooper, 2010). These findings highlight the strategic importance of prioritizing employee well-being within organizations.

The behaviors shown in the workplace, whether they are task-related or discretionary, profoundly influence organizational dynamic. Workplace behavior includes actions such as OCB and is often shaped by factors such as job satisfaction and employee engagement (Borman, Motowidlo, 1993). Positive behaviors enhance organizational performance and promote a culture of collaboration (Christian et al., 2011). In opposition negative behaviors, such as absenteeism or workplace deviance, can undermine effectiveness. Identifying and

understanding these determinants is crucial for designing interventions that foster a supportive and productive work environment (Robinson, Bennett, 1995). Within this spectrum, discretionary workplace behavior plays a pivotal role (Organ, 1988) as it aligns closely with OCB and reflects employees' intrinsic motivation to support organizational goals (Bolino, Turnley, 2003). Key factors influencing these behaviors include employee engagement, organizational commitment, and workplace culture (Macey, Schneider, 2008). Encouraging such behaviors requires supportive leadership and recognition of employees' contributions beyond formal duties. Employee engagement, a positive and fulfilling work-related state of mind, is another foundation of workplace success. Defined by dedication and interest (Schaufeli et al., 2002), engaged employees are more likely to exhibit OCB and contribute to productivity by committing to organizational goals (Harter et al., 2002). Factors such as job resources, supportive leadership, and opportunities for personal growth significantly influence engagement. The tie between engagement and well-being underscores the benefits of fostering a positive workplace culture (Bakker, Demerouti, 2008).

Furthermore, job satisfaction is equally critical, as it represents an individual's emotional response to their job and its various aspects, including tasks, colleagues, and organizational policies. Higher job satisfaction is associated with increased OCB, greater organizational commitment, and reduced turnover (Judge et al., 2001). In opposition, job dissatisfaction can lead to negative outcomes, such as lower productivity and higher employee turnover rates. Addressing factors that enhance satisfaction, such as fair compensation and meaningful work tasks, is essential for maintaining organizational performance.

Moreover, workplace productivity is a central indicator of organizational success, determined by the efficiency and effectiveness of employees' goal attainment (Campbell, 1990). OCB significantly enhances productivity by fostering cooperation and minimizing workplace conflicts (Podsakoff et al., 2009). Additionally, cultivating a culture of recognition and support can motivate employees to exceed expectations and achieve higher performance levels. Key to fostering such culture is organizational commitment, which reflects an employee's psychological attachment to their organization and their willingness to contribute to its success. Commitment is a strong predictor of OCB, as dedicated employees are more inclined to engage in behaviors that support organizational goals (Mathieu, Zajac, 1990). Leadership style, workplace culture, and HRM practices are critical in strengthening this sense of commitment and reducing turnover rates.

However, it is important to highlight that occupational stress poses a significant challenge to employee well-being and organizational success which will be a part discussed in this research paper. High stress levels can diminish PWB and reduce employees' capacity to engage in positive workplace behaviors (Sonnentag, Frese, 2003). Stress management interventions, such as mindfulness programs and flexible work arrangements, can mitigate these effects and promote well-being (Quick et al., 1997) and as can be seen across multiple organizations is

incorporated into day to day work activities. Many organizations employ trainers, psychologists or masseurs to enhance the well-being of their employees.

However, external counselling and motivators are not the sole drivers of OCB; leadership plays a transformative role by shaping workplace culture and motivating employees (Bass, 1990). There are many kinds of leadership that the managers, supervisors and other kinds of leaders can choose from. They vary from one personal style to another but transformational leadership has proven to be one of the most motivating leadership styles to exist. Transformational leadership, which inspires and empowers employees, is particularly effective in promoting discretionary behaviors (Podsakoff et al., 1996). Ethical leadership practices further enhance organizational commitment and reduce conflicts, creating an environment conducive to employee success. A positive workplace culture, which is defined by shared values, norms, and practices, is very important for employees' well-being and OCB (Schein, 2010). Inclusive and respectful cultures nurture a sense of belonging and motivation of such employees, at the same time it is enhancing performance and reducing turnover (Cameron, Quinn, 2011). On the contrary, toxic cultures can have detrimental effects, leading to disengagement and turnover. HRM practices are also important in nurturing OCB by shaping employees' experiences of support from the given organization (Delery, Doty, 1996). Initiatives such as training, performance reviews, appraisals and recognition programs highlight the value of discretionary behavior and enhance overall satisfaction and performance. Thus, organizational performance is linked to employee behavior, with positive actions driving efficiency and innovation (Katz, Kahn, 1978). Investing in supportive work environment and recognition of employee contributions is key to having a sustainable success (Fondas, Denison 1991) As there is a variety of contributors to OCB in an organization, motivation - both intrinsic and extrinsic motivation - plays a crucial role in OCB. Intrinsic motivation, fueled by longing for personal growth and meaningful work, is particularly effective in fostering such behaviors. Understanding the relationship between motivation and workplace behavior is essential for designing strategies to enhance engagement and organizational outcomes (Gagné, Deci, 2005).

The relationship between OCB and employee PWB, work engagement and occupational stress can be understood as dynamic and conditional. When OCB is driven by intrinsic motivation and supported by recognition and managerial support, it is more likely to enhance work engagement and reinforce psychological well-being. In such contexts, discretionary behaviors are experienced as meaningful and self-endorsed, strengthening employees' sense of purpose and positive affect. Conversely, when OCB is implicitly expected, insufficiently recognized or combined with high workload demands, it may contribute to role overload and increased occupational stress, undermining psychological well-being. The same behaviors that foster engagement under supportive conditions may become sources of strain when perceived as obligatory rather than voluntary. This highlights the central role of motivation, stress, and engagement as key mechanisms shaping whether OCB functions as a resource or a risk for employee well-being.

Research on OCB and well-being utilizes different methodologies, including cross-sectional and longitudinal studies, to explore these dynamics over time (Podsakoff et al., 2009). Insights from management research further highlight the importance of leadership in creating supportive environments (Kelloway et al., 2012). The dimensions of OCB, such as altruism and courtesy, remain pivotal to the understanding of its impact on organizational success (Farh, Podsakoff, Organ, 1990).

Given the literature review, the identified research gaps and author's personal interest in the subject, the following **research questions** were stated:

1. What is the relationship between Organizational Citizenship Behavior (OCB) and employee psychological well-being (PWB) in modern workplaces?
2. Are there business risks associated with promoting excessive OCB, such as employee burnout or reduced job satisfaction, and how can these risks be mitigated?
3. What are the implications of OCB for employee well-being in organizations with varying levels of managerial support and recognition systems?

Overall, prior research underscores the complex nature of the relationship between OCB and employee's PWB. By addressing the identified research gap this study aims to contribute to the literature by deepening understanding of the mechanisms and contextual factors shaping this relationship. Accordingly, the research questions are designed to extend existing theoretical perspectives and empirical insights.

3. Research methodology

The study employed a qualitative, multi-source research design, integrating semi-structured interviews with document analysis of annual reports and an in-depth literature review. This approach was chosen to enable data triangulation by combining employee narratives, organizational self-reporting, and theoretical frameworks, thereby providing a broader understanding of the relationship between Organizational Citizenship Behavior and Psychological Well-Being in modern organizations.

The literature review, discussed in the previous section, was followed by a documentation analysis focusing on large organizations that are either of Polish origin or have an international background but conduct part of their business operations in Poland. To further refine the selection criteria only organizations listed in the Najlepsi Pracodawcy 2024 (Best Employers 2024) ranking published by the Polish edition of Forbes magazine were included. Forbes and the analytics and research company Statista have published the ranking of Poland's Best Employers 2024. This list features 300 companies operating in Poland whose achievements in the field of human resources have earned them the title of best employer. The evaluation was based on anonymous surveys completed by employees. A representative group of 20,000

people employed in large companies was invited to participate, providing data for the analysis. This direct input from employees ensured the independence of the results. In 2024, the assessment covered approximately 2000 organizations that employ at least 250 people in Poland and operate in one or more of the 25 sectors included in the ranking. Two main evaluation criteria were applied:

- Direct recommendation – the willingness to recommend one’s own employer, measured by asking employees to rate, on a scale from 0 (least likely) to 10 (most likely), how likely they would be to recommend their employer to a friend or family member. Direct recommendation carried the greatest weight in the overall score.
- Indirect recommendation – the willingness to recommend other employers in the same sector, assessed on a scale from “definitely yes” to “definitely no”, with the option of “no answer”.

Both recommendations were complemented by an evaluation of employers across more than 40 individual aspects grouped into seven areas: company image and economic growth, relationships between employees and management, development and career prospects, workload, sustainability, pay, and working conditions including equipment. The results of Poland's Best Employers 2023 were also taken into account as an additional factor reflecting stable reputation, although they carried less weight than the current recommendations. The maximum possible score in the assessment was 100 points. The survey was conducted between October 20 and November 30, 2023, and participants were invited to take part via online panels (www.forbes.pl, 2024).

To further enrich the study and enable an in-depth exploration of organizational practices, the author contacted employees from companies listed in the Best Employers 2024 ranking that are also based in Warsaw, Poland, and are listed on the Polish stock exchange. From the companies contacted, one organization agreed to participate (Table 2), providing 10 respondents representing different hierarchical levels in the organization (Table 3). This diversity of perspectives was considered vital for capturing a comprehensive view of employees’ perceptions.

Table 2.

Company profile from which employees have taken part in the study

Field	Details
Industry	Fast-moving consumer goods; health-oriented foods and beverages sold globally
Business segments	Dairy & Plant-Based; Waters; Specialized Nutrition (infant & medical)
Company form	Public company listed in the EU; global operations
Global workforce	89,528 employees (as of 2024)
Geographic footprint	Mainly Europe, North America, China/ North Asia/ Oceania, Latin America, and rest of the world in smaller volumes
Polish entity	circa 3200 employees; 7 manufacturing plants; competence centers serving 16 countries
Polish locations	Multi-site presence across the country (8+ locations incl. Warsaw, Opole and Katowice)
ESG/ certifications	B Corp coverage over most of global sales (92.8% of 2024 sales)

Source: own elaboration.

Table 3.*Interviewed participants profiles*

Interviewee code	Gender F – female, M – male	Experience at the company [years]	Position [level of hierarchy]
A	F	5	Middle level specialist
B	F	2	Manager
C	F	2	Senior level specialist
D	F	1,5	Junior level specialist
E	M	1	Intern
F	M	2	Middle level specialist
G	M	1,5	Senior level specialist
H	M	4	Manager
I	F	2	Senior level specialist
J	F	1	Middle level specialist

Source: own elaboration.

In summary, the applied research methodology was designed to ensure rigor and coherence in addressing the formulated research questions. The combination of systematic literature review, document analysis and qualitative interviews enabled a comprehensive exploration of the relationship between OCB and employee's PWB. This methodological approach provides a robust foundation for the analysis and interpretation of the study's findings presented in the following section.

4. Data Collection and Ethics of the study

The semi-structured interviews were conducted between April 2025 and July 2025. Each interview lasted for approximately 60 minutes and took place online via Microsoft Teams platform, with the participants' consent for recording and possibility to remain anonymous which each participant took advantage of.

The interview focused on key themes relevant to the study, including organizational culture, examples of OCB, perceptions of managerial support and recognition, and the perceived impact of such behaviors on individual well-being. The interview questions were asked in the same order to each participant with the questions placed in appendix number 1.

The document analysis covered annual reports and public disclosures from 74 companies featured in the Best Employers 2024 ranking that were chosen accordingly with the previously stated criteria. These documents were examined for references to well-being initiatives, OCB-related practices, and employee support programs. The analysis combined keyword searches with a review of the broader context in which relevant terms appeared, ensuring that findings were grounded in the companies' narratives rather than isolated statements.

The study followed ethical guidelines for qualitative research. (Mirza, H., Mirza, C., Bellalem, 2023) Informed consent was obtained from all interview participants, and their anonymity and confidentiality were maintained throughout the process.

All company data used in the document analysis came from publicly available sources, ensuring compliance with intellectual property and privacy regulations.

5. Results

The findings presented in this section are based on two main sources of empirical data:

1. Analysis of annual reports and public disclosures from 74 companies featured in the Best Employers 2024 ranking.
2. Semi-structured interviews with ten employees from a single company, meeting the selection criteria.

These empirical insights are interpreted considering the theoretical frameworks discussed earlier in literature review, particularly the dimensions of Organizational Citizenship Behavior (Podsakoff et al., 2000) and Psychological Well-Being (Ryff, 1989). The discussion of the findings is rooted in the research questions that were stated.

Relationship between Organizational Citizenship Behavior (OCB) and employee psychological well-being (PWB) in modern workplaces

The relationship between Organizational Citizenship Behavior and psychological well-being in modern workplaces appears as conditional rather than uniformly positive or negative, which can be seen in respondent's answers during the interviews. On one hand, when OCB is voluntary, employees often report it as energizing and meaningful. As employee A explained, "these activities recharge me more than they drain me... it was intense, but it was worth it" highlighting the benefits of contribution. Similarly, employee H described feelings of "self-satisfaction" and the opportunity to "learn something I can use in future" underlining how OCB can enhance competences and career growth. However, when OCB is imposed from levels higher than the employee's or remains unrecognized, it undermines the well-being, for example employee C noted that "things 'from above' stressed me out more... when I initiate something myself, I feel more in control and less stressed", while employee F admitted that "if I do something extra and no one notices then that's demotivating". Moreover, excessive OCB in the context of limited time resources generates pressure, as employee M acknowledged: "now... more stress would come from the OCB ones, because... I currently don't have much time". These accounts align with organizational reporting practices as companies like UPS emphasize structured recognition systems through initiatives such as "People Led" focusing on employee experience and culture, being focused on strong partnership and corporate culture. "People Led" program is strongly based on the probability of a referral of the workplace to a friend or family member of the employee's (UPS Annual Report, 2024). While Manpower explicitly links well-being to awareness of mental health and diversity at the workplace. Active engagement of

employees is also measured through cyclical surveys so called “pulse surveys” (Manpower Annual Report, 2024) and Orange incorporates psychological safety into its health and safety metrics (Orange Consolidated Annual Report, 2024). Similarly, ERBUD’s measures to track overtime and provide social dialogue mechanisms reflect the importance of protecting time slack, a condition repeatedly underscored in employee testimonies. Interestingly ERBUD’s Operations Report also highlights work-life balance, diversity and training and skills and development (Erbud Capital Group 2024 Operations Report, 2024).

Taken together, the evidence shows that OCB enhances PWB when it is chosen, visible, and adequately resourced, but can diminish well-being when it is imposed, invisible, or layered onto already overloaded roles. The decisive factors are managerial recognition, workload protection, and support structures that allow discretionary effort to be experienced as fulfilling rather than draining. From the reports provided by the companies it can be seen that the problems are being accounted for and there are structures that are suppose to be a safe net in terms of OCB and PWB; on the other hand it must be highlighted that the company’s micro environment and culture is a decisive factor that influences how employees perceive the situation they are in.

Business risks associated with promoting excessive OCB, such as employee burnout or reduced job satisfaction, and mitigation of such risks

The interviews show that while OCB can be meaningful, promoting it excessively creates real-life business risks related to stress, burnout, and decline in motivation. Several respondents in the interview pointed to the problem of the time scarcity, with employee M admitting that “constant lack of time... now more stress would come from the OCB ones [behaviors], because I currently don’t have much time”, while employee L described being “regularly stressed from just how many things are going on”, indicating that additional extra-role behaviors can aggravate workload strain. This often is translated into unpaid overtime, as employee J noted, “with OCB I think I would take some overtime on my own”, suggesting hidden labour costs for both individuals and organizations. The lack of recognition further compounds these risks, with employee C adding, “I did a lot and no one noticed - that’s demotivating”, illustrating how invisible contributions deplete morale of the staff. Moreover, some respondents described difficulty in setting boundaries, such as employee G who confessed, “I just can’t say no”, which led to frustration and overload.

These findings resonate with organizational reports that emphasize the need for protective mechanisms, for example, ERBUD outlines practices around leave and overtime monitoring (Erbud Capital Group 2024 Operations Report, 2024), and Orange tracks both physical and mental health indicators (Orange Consolidated Annual Report, 2024), both of which mitigate the risk of OCB-driven fatigue. At the same time, firms such as Manpower highlight programs to raise awareness of mental well-being (Manpower Annual Report, 2024), showing recognition of the potential for stress spillover. Collectively, the gathered data suggests that the risks of

OCB are not fundamental but arise when they are introduced as compulsory, unrecognized, and unsupported. They can be mitigated through formal recognition systems, workload management practices, and explicit protection of voluntariness, which ensure that OCB contributes to organizational goals without sacrificing employee well-being, which corresponds with theory of PWB and OCB.

Implications of OCB for employee well-being in organizations with varying levels of managerial support and recognition systems

The way OCB influences employee well-being depends largely on how much support and recognition people receive from their managers, making it a case that benefits from further discussion.

When employees feel supported and their efforts are noticed, OCB often brings positive emotions. For example, employee A said, “these activities recharge me more than they drain me... it was intense, but it was worth it,” showing that extra tasks can give energy when they are voluntary and valued. Employee H also mentioned “self-satisfaction” and the chance to “learn something I can use in future,” which suggests that OCB can build confidence and personal and career growth. However, when support and recognition are missing, OCB becomes tiring and discouraging. Employee C explained, “If I do something extra and no one notices - that’s demotivating”, and also admitted that “things ‘from above’ stressed me out more... when I initiate something myself, I feel more in control and less stressed”. This shows that imposed OCB without support is more stressful. Time pressure makes the problem worse, as employee M noted: “now... more stress would come from the OCB ones, because... I currently don’t have much time”.

The company reports back the notion up as UPS describes its “People Led” program to monitor employee experience (UPS Annual Report, 2024), Manpower promotes awareness of mental health (Manpower Annual Report, 2024), and Orange measures both physical and mental health outcomes (Orange Consolidated Annual Report, 2024), all examples of recognition systems that help employees cope with extra effort. Overall, OCB can improve well-being in supportive environments, but without recognition and managerial backing, it risks leaving employees overworked and demotivated.

6. Discussion

The findings of this study demonstrate that Organizational Citizenship Behavior has a complex influence on employee psychological well-being. Drawing on both interview data and organizational reports, the results indicate that OCB can generate either positive or negative outcomes, depending on the degree of managerial support, recognition systems and

voluntariness. This outcome is consistent with earlier available research in the field which has shown that discretionary behaviors are essential for collaboration, trust and innovation (Podsakoff et al., 2009), yet they may impose hidden costs on employees when performed excessively or under external pressure which was discussed by scholars, for example by Bolino and Turnley in 2003 as well as was visible in the research conducted in this study. On the positive side, employees reported that OCB gave them energy and meaning when it was voluntary and appreciated. These reports suggest that discretionary efforts associated with OCB may function as psychological resources when they are perceived as personally meaningful and development oriented. Rather than being experienced as draining, such behaviors can enhance employees' sense of self-efficacy and future-oriented competences, thus reinforcing PWB. Further through this process OCB may enhance work engagement which functions as a key psychological mechanism linking discretionary effort with improved PWB under supportive conditions. This aligns with the view that intrinsically motivated OCB may contribute to well-being by fostering learning, self-satisfaction, and personal growth, particularly in supportive organizational contexts. These findings support the idea that OCB can foster well-being that is linked to growth and purpose (Ryff, Keyes, 1995) and are consistent with earlier studies showing that OCB improves teamwork and satisfaction (Podsakoff et al., 2009; Robertson, Cooper, 2010). However, the interviews also showed risks when OCB is imposed, unrecognized or added to existing heavy workloads. In such contexts, discretionary behaviors tend to lose their voluntary character and are more likely to be experienced as externally driven obligations. This shift reduces employees' perceived sense of control and increases role overload, intensifying occupational stress and diminishing psychological well-being. Moreover, the absence of recognition weakens motivational resources, while time pressure constrains employees' capacity to sustain discretionary efforts without unfavorable well-being consequences. These examples align with the concepts of citizenship pressure and citizenship fatigue (Bolino et al., 2010), and also with Conservation of Resources theory, which argues that stress grows when personal resources such as time and energy are drained (Hobfoll, 1989). The analysis of company reports support these findings. Organizations that emphasize recognition and well-being, such as UPS, Manpower and Orange, provide conditions where OCB can strengthen well-being. In contrast there were companies which did not mention employee recognition in their reports, illustrating the potential risk of OCB becoming invisible and draining.

By conceptualizing stress and work engagement as central mechanisms through which voluntariness, recognition, and managerial support shape the outcomes of Organizational Citizenship Behavior, this study extends existing OCB research beyond descriptive accounts. Specifically, it demonstrates how discretionary behaviors enhance psychological well-being by fostering engagement and personal growth under supportive conditions, while generating strain and diminished well-being when such behaviors are perceived as obligatory, insufficiently recognized, or combined with excessive workload. In doing so, the study offers a coherent

explanation for why similar forms of OCB produce divergent psychological well-being outcomes across organizational contexts. These findings build on OCB by Organ (1988) and Podsakoff et al. (2009) and highlight the importance of managerial support, which acts as a bridging condition that decides whether OCB is a source of motivation or stress. However, while Podsakoff et al. (2009) focused mainly on outcomes of OCB at the unit level, this study highlights its conditional impact on individual well-being depending on recognition and support systems. In contrast to Bolino and Turnley (2003), who described the general risk of hidden costs linked to OCB, this study provides empirical evidence from interviews that lack of recognition and excessive workload directly translate into stress and demotivation of the employees which was seen in their subjective responses.

7. Summary

This study demonstrates that the relationship between Organizational Citizenship Behavior (OCB) and Psychological Well-Being (PWB) in modern workplaces is complex and conditional. Concluding on interviews and document analysis, the findings indicate that OCB enhances well-being when it is voluntary, recognized, and supported by adequate resources, while excessive or imposed OCB generates stress, fatigue, and demotivation. It is important to mention that managerial support and recognition systems are key moderators of the relationship, as employees stated that acknowledgement and fair workload management transformed OCB into a positive, energizing experience. The analysis of annual reports strengthened these insights by highlighting organizational practices such as employee experience surveys, well-being programs, and overtime monitoring that create conditions for OCB to thrive without harm to well-being.

This article contributes to the growing literature on OCB and employee well-being by offering a multi-source perspective that connects employee narratives with organizational disclosures. For practitioners, the findings underscore the need to cultivate recognition-rich environments and protect voluntariness to ensure that OCB strengthens both individual well-being and organizational performance.

8. Limitations and acknowledgment

Despite its contributions, this study has several limitations that should be acknowledged. First, the qualitative research design relied on a relatively small sample of ten interviews within a single company, which limits the ability of generalization of the findings. While this approach

allowed for in-depth exploration of employee experiences, it does not capture the diversity of organizational contexts. Secondly, the document analysis was restricted to companies listed in the Forbes Best Employers 2024 ranking, which may not represent organizations with weaker reputations or different industries. Third, the findings are subject to interpretation bias, particularly in coding and linking interview data with company reports. Finally, the cross-sectional design prevents conclusions about causality; it is not possible to determine whether OCB directly improves well-being or whether employees with higher well-being are more eager to engage in OCB.

Full interview transcripts are available from the author upon request.

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Appendix

Interview questions

1. How would you describe the organizational culture in your company?
2. Can you recall any examples where you got involved in things beyond your formal responsibilities?
3. How did you feel emotionally and mentally after doing those extra activities-what were your feelings and emotions?
4. What motivates you to help your coworkers or to go beyond your formal responsibilities?
5. Did you feel that all those extra activities you did, the help you offered to others-were they acknowledged or appreciated by the people you report to?
6. And how do you try to balance your core responsibilities with additional activities?
7. Have you ever felt stressed or overwhelmed taking on extra activities? And here, could you distinguish between those assigned by your manager and the ones you came up with yourself?
8. Does your organization support employees who go beyond their formal duties?
9. How would you describe or evaluate your overall well-being at work?
10. In your opinion, does engagement in organizational citizenship behaviors (OCB) affect your personal well-being positively or negatively?

TAKING CARE OF EMPLOYEES' WELL-BEING AS A DIMENSION OF SOCIALLY-RESPONSIBLE HUMAN RESOURCE DEVELOPMENT. THE CONTEXT OF ORGANIZATIONAL SUSTAINABLE PERFORMANCE

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Purpose: This study aims to examine the relationship between well-being oriented human resource development (WB-HRD) and organizational sustainable performance.

Design/methodology/approach: This study uses data conducted among 400 mid-sized and large companies in Poland. The author used R programming (version 4.2.2) (R Core Team, 2021) to count the descriptive statistics, conduct confirmatory factor analysis and verify the linear regression model.

Findings: Statistical analyses revealed that WB-HRD is positively related to SP.

Research limitations/implications: This study has issue with generalization of empirical findings because of data collection from only companies located in Poland with the focus on mid-sized and large enterprises. Future research is needed to collect data from SMEs and in other countries. Second, many relationships between dependent and independent variables are mediated and moderated by additional factors. The introduction of potential mediators/moderators such as, e.g., sustainable leadership could result in bringing valuable results.

Practical implications: This study also demonstrates areas which must be improved in practice to make HRD more well-being oriented. The surveyed companies should intense HR training which increases employees' awareness and skills related to mental and physical health as well as combine HRD with economic well-being. This will help in achieving a higher level of WB-HRD and – in result – a higher level of SP.

Social implications: Companies that prioritize WB-HRD contribute to broader societal benefits by promoting health and well-being beyond the workplace. Healthier employees are more likely to engage in their communities, support social initiatives, and maintain a better quality of life.

Originality/value: Although extant literature shows the linkage between employees' well-being and organizational sustainable performance (SP) as well as between socially-oriented HRM practices and this performance, none of previous studies examined the relationship between well-being oriented human resource development (WB-HRD) and SP.

Keywords: corporate social responsibility, sustainable development, sustainability, socially-responsible HRM, socially-responsible HRD.

Category of the paper: Research paper.

1. Introduction

Recently many changes have occurred in different areas of the social-economic life. The transformation of manufacturing era into knowledge-based economy forced changes in the way people see the world. Traditional manufacturing factors (inputs) such as land, labor and capital are not the only determinants of companies' growth. One of the symptoms of the new economy is the increase of the role of human resources in companies. The so-called third wave by Toffler symbolizes a vast importance of knowledge and information assets. Companies need employees who are, i.a., courageous and entrepreneurial. During this third wave people are needed who are able to accomplish more tasks and quickly adapt to changing requirements (Beyer, 2012). Acquiring competencies needed by the employees now and in the future takes place in HR development processes.

Sims (2006) relates HR development to notions such as learning, efficiency and changes. The literature dedicated to human resource management presents different methods (ways, tools) of HR development. However, as Armstrong (2006) emphasized, HR development is mainly based on allowing employees to learn, planning and organizing training courses, and assessing the effectiveness of these processes. Therefore, it has been assumed that HRD takes place mainly in HR training processes.

As Penc (2007) rightly observed, HR training is not the aim itself but the mean to the implementation of changes in companies and the achievement of organizational goals. Essential changes related to the implementation of the idea of corporate social responsibility (CSR) are visible in modern companies. Bowen defined CSR as "the obligations of businessmen to pursue those policies, to make those decisions, or to follow those lines of action which are desirable in terms of the objectives and values of our society" (Bowen, 1953, p. 6). CSR may be implemented towards different groups of company stakeholders, including external and internal ones. Companies are required not only to concentrate on the profit and expense spreadsheet (requirements of owners and shareholders), but also measure their impact on the natural environment and the extent they are socially-responsible. Among the external company stakeholders the natural environment is placed (Haigh, Griffiths, 2009; Li et al., 2022), which causes that both concepts of CSR and sustainable development aim to fulfill the same goals (i.e., economic, environmental and social) (Aslaksen et al., 2021). However, many studies argue that employees are the most important company's stakeholders (de Bussy, Suprawan, 2012). Therefore, the concept of socially-responsible HRM and – consequently – socially-responsible HRD emerged.

Socially-responsible HRM is one of the sustainability-oriented HRM concepts¹. It focuses on employees' needs and organizational efforts to encourage employees to implement CSR policies through the application of HRM policies (Zhao et al., 2021). Similarly, Bierema and D'Abundo (2004) defined socially-responsible HRD as serving an educative and supportive role to help organizations use their resources to benefit their stakeholders. Socially-responsible HR training has been defined as building employee competencies based on CSR principles such as transparency, objectivity and nondiscriminatory activities (Diaz-Carrion et al., 2019). Many authors emphasized that socially-responsible employer cares for their employees' well-being (Abdelmotaleb, Saha, 2020; El Akremi et al., 2018; Omid, Dal Zotto, 2022; Zhang et al., 2022) which refers to pleasure idea at work, work meaning, valuation, etc. (Amrani et al., 2020) as well as the combination of feeling good and functioning well (Ruggeri et al., 2020). Therefore, the care for well-being have been listed among dimensions of socially-responsible (and broader: sustainable) HRM/HRD (Piwowar-Sulej, 2021).

The aim of this study is to determine if the care for well-being reflected in HRD processes contribute to organizational sustainable performance (SP). This performance is treated as results of implementation of sustainability-oriented activities, a company's actual and observable output (measured against its intended outputs) (Sapta et al., 2021). Pranugrahaning et al. (2021) listed the set of SP indicators used by companies (e.g., company turnover – for economic performance, water consumption – for environmental performance, and contributions to society – for social performance).

2. The characteristics of well-being oriented HRD

The employers' care for employees' well-being means, i.a., psychological and physical recuperation (Ehnert, 2009). However, well-being covers also job security and individual employability. Job security is defined as an employee's subjective perception of having stable employment (Burchell, 2014). Employability is the ability to independently explore the labor market in order to use and develop one's potential through having employment (Hillage, Pollard, 1998). It is worth at this point mentioning that employers – within the sustainable HRM concept – are not obligated to secure employees with life-long employment, but to develop employees' employability treated as the ability to fulfill the employment expectations now and in the future (De Prins et al., 2014).

¹ The remaining sustainability-oriented concepts are green HRM, sustainable/triple bottom line HRM, and common good HRM. Sustainable HRM combines socially-responsible HRM with green HRM. The three concepts address sustainable development social and environmental challenges as less important than the firm's personal-good (financial results), whereas common good HRM emphasizes aligning HR practices with the broader societal interest, aiming to create value mainly for the community and society at large (Austen, Piwowar-Sulej, 2025).

Thanks to HR training employees may obtain various technical and interpersonal skills which will allow them to maintain the current employment or find a new job. HR training increases the sense of job security and employees' retention (Beynon et al., 2015; Kashyap, Rangnekar, 2014; Khan, 2018) defined as staying in an organization for the maximum amount of time or as long as the dispatched tasks require (Singh, Dixit, 2011).

During HR training employees may also learn how to care for themselves, fight with stress, deal with uncertainty and change (Mohan, Gomathi, 2015), manage a healthy diet and physical exercise, to recuperate after work. It is worth highlighting that physical activity may have a positive impact on cognitive ability (Hertzog et al., 2008). The latter is utmost important in the face of a need to adapt to continuous changes and incorporation of information coming from many sources (e.g., emails, tweets, videoconferences).

Beyond the above-characterized psychological and physical aspects of well-being, there are also social and economic dimensions. Social well-being is associated with a subjective assessment of experiences related to being a member of a society of employees, whereas economic well-being is connected with the level of earnings (Rath et al., 2014).

HR training may contribute to a friendly atmosphere at work, through promoting value of cooperation, as well as increase the material status of employees. A competent and healthy employee becomes for their employer a key employee and have a chance for long-time employment as well as an increase of their salary. Highly-developed competencies gain meaning in times of changes, including economic crises. Even if an employee is made redundant, they easily find a new job because of their up-graded skills. HRD – as emphasized numerous – is strictly related to the increase of employability (Blanco, 2014).

It is important to emphasize that the level of well-being experienced in the workplace will be reflected in the level of the overall life well-being. The professional life is one of the arenas of our existence and – simultaneously – one which we spend much time in (Piwowar-Sulej, 2018).

3. Hypothesis and research methodology

Extant literature shows that employees' well-being contributes to company's performance (Kundi et al., 2021), including sustainable performance (Amrani et al., 2020; Jackson Preston, 2022). Furthermore, research shows that socially-responsible HRM practices lead to higher financial and non-financial firm performance (Barrena-Martínez et al., 2017; Tongo, 2015). Therefore it is expected that promotion of well-being within HRD processes will also contribute to organizational sustainable performance. This has been reflected in the following hypothesis: H: Well-being oriented HRD positively contributes to organizational sustainable performance.

The above characteristics of well-being oriented HRD (abbreviated as WB-HRD) have been reflected in a measurement scale designed by Piwowar-Sulej and validated in the book titled “Sustainable human resource development through training” (Piwowar-Sulej, 2022). This scale has been used in this paper. In turn, organizational sustainable performance (SP) was measured with the use of the 15-item scale adopted from (Yong et al., 2020). SP consists of three components such as environmental performance (ENP), economic performance (ECP) and social performance (SCP). In both above-presented measurement scales the five-point Likert scale ranging from 1 – fully disagree to 5 – fully agree was used.

The method used was CATI (computer-assisted telephone interviewing). The author employed a research agency to collect data among mid-sized and large companies – with one respondent from each company. The author focused on larger companies because they have more developed HRM practices than smaller ones. They employ larger HR teams and have larger budgets to invest in modern HRM tools. Their executives are also often more aware of the valuable role HRM plays in building and maintaining positive corporate culture (Singh, 2022). According to the results obtained with the use of a sample size calculator (Naukowiec.org, 2022), the minimum required sample size was 380. The agency contacted in total 424 respondents, of which 400 delivered valid questionnaires.

Diversity among the sample group in terms of the businesses and location was achieved, which is a necessary condition that ensures the validity of the research (Kirchherr, Charles, 2018). The most represented were large manufacturing enterprises ($n = 32$) and mid-sized service companies ($n = 32$). All voivodeships were represented in this study. Out of 400 respondents, 182 people worked on managerial positions, and the rest ($n = 218$) – on non-managerial ones. They worked mainly in administrative departments. 202 respondents were female, whereas 198 – male. As many as 154 respondents had more than 10 years of job tenure, 104 – more than 5 years but less than 10 years, 111 – more than 1 year but less than 5 years and only 31 – less than 1 year. The latter is important, taking into account that the longer people work in a given company, the more they become familiar with the company's developmental policies and practices.

The author used R programming (version 4.2.2) (R Core Team, 2021) to count the descriptive statistics, conduct confirmatory factor analysis and verify the linear regression model.

4. Results

A general overview of the data is provided below. Descriptive statistics for all measured constructs, including central tendency and dispersion indicators, are presented in Table 1.

Table 1.
Descriptive statistics

Construct	N	Mean	SD	Median	Min	Max	Q1	Q3
WB	400	3.17	0.64	3.21	0.92	4.58	2.75	3.58
SP	400	2.76	0.6	2.83	0.83	4.17	2.44	3.17
ECP	400	2.98	0.65	3	0.83	4.17	2.62	3.33
ENP	400	2.65	0.73	2.67	0.83	4.17	2.17	3.17
SCP	400	2.66	0.68	2.67	0.83	4.17	2.33	3.17

SD – standard deviation, Q1 – lower quadrant, Q3 - upper quadrant.

Source: own work.

As above-explained, the WB-HRD scale was positively validated by Piwowar-Sulej (2022). In turn, for the purpose of this paper the author validated the SP scale. For 3-factor structure of SP the author obtained a satisfactory fit indices: RMSEA, CFI, TLI and SRMR (Table 2). As Hu and Bentler (1999) stated, a model is fit when $RMSEA < 0,06$, CFI and TLI $> 0,95$ and $SRMR < 0,08$. However, they indicated that the fulfilment of all four requirements is often too restrictive. So, they proposed a two-index strategy which argues that a model is fit when $SRMR < 0,09$ and additionally when one of the following requirements is met: CFI $> 0,96$, TLI $> 0,96$ or $RMSEA < 0,06$.

Table 2.
Fit indices for SP

Model	Chi-square test			RMSEA	CFI	TLI	SRMR
	χ^2	df	p				
I	88.371	87	0.439	0.006	>0,999	>0.999	0.051

Source: own work.

In the current study, the loadings of subsequent items are in the range of 0,546 and 0,913 and are statistically significant ($p < 0,05$) (Table 3). Loadings associated with CFA-implied item-total correlations should be interpreted as correlations of items with a subscale to which they belong to. Their significance means that all items significantly correlate with the value of their subscale.

Table 3.
The loadings of items

Construct	Item	Loading	p
ECP	ECP1	0.641	$p < 0.001$
	ECP2	0.604	$p < 0.001$
	ECP3	0.619	$p < 0.001$
	ECP4	0.725	$p < 0.001$
	ECP5	0.721	$p < 0.001$
ENP	ENP1	0.655	$p < 0.001$
	ENP2	0.730	$p < 0.001$
	ENP3	0.751	$p < 0.001$
	ENP4	0.711	$p < 0.001$
	ENP5	0.718	$p < 0.001$

Cont. table 3.

SCP	SCP1	0.587	$p < 0.001$
	SCP2	0.546	$p < 0.001$
	SCP3	0.668	$p < 0.001$
	SCP4	0.793	$p < 0.001$
	SCP5	0.709	$p < 0.001$
SP	ECP	0.913	$p < 0.001$
	ENP	0.845	$p < 0.001$
	SCP	0.858	$p < 0.001$

Source: own work.

Alpha Cronbach value for SP is 0,908. So, this scale is reliable. In other words, the results of using this scale are repetitive and not influenced by coincidence. It is assumed that Alpha above 0.7 is an indicator of a reliable scale (Nunnally, Bernstein, 1994). Moreover, all the items have positive discriminant indicates which means that they positively correlate with other items included in a scale. The latter is a very desired effect. Finally, after excluding any item, the Alpha Cronbach value did not increase. Therefore, it can be ascertained that both scales are appropriately designed and do not demand an improvement.

WB-HRD correlates significantly ($p < 0,05$) and positively ($r > 0$) with SP as well as with each of SP's subdimensions (Table 4). Moreover, WB-HRD significantly positively impacts SP and each of its subdimension in the form of ECP, ENP and SCP, which allows for the confirmation of hypothesis H.

Table 4.

Values for Spearman's Rank correlation between WB-HRD and SP (including its subconstructs)

Construct	WB-HRD
	Spearman's Rank correlation coefficient
SP	$r = 0.734, p < 0.001 *$
ECP	$r = 0.686, p < 0.001 *$
ENP	$r = 0.588, p < 0.001 *$
SCP	$r = 0.631, p < 0.001 *$

* statistically significant relationship ($p < 0,05$).

Source: own work.

Table 5.

Results of the verification of the one factor linear regression model

Dependent variable	Independent variable	Parameter **	95% CI		p
SP	WB	0.72	0.659	0.782	$< 0.001 *$
ECP	WB	0.726	0.655	0.797	$< 0.001 *$
ENP	WB	0.735	0.647	0.822	$< 0.001 *$
SCP	WB	0.701	0.621	0.78	$< 0.001 *$

* statistically significant relationship ($p < 0,05$).

** univariate linear regression.

Source: own work.

Since WB-HRD significantly influences SP, it is worth highlighting the areas of WB-HRD which should be improved. Figure 1 presents medians for all items included in the WB-HRD scale. Out of 11 items most obtained a median value of 4. One item, however, has a median

value of only 2.5 (WB-HRD2 – employer offers training on how to maintain good physical health). In turn, responses to questions WB-HRD1, WB-HRD3, WB-HRD4 and WB-HRD9 confirmed that employers rarely offer training which promotes psychological health. Moreover, the organized training does not have a clearly positive impact on the employees' psychological, physical and economic well-being.

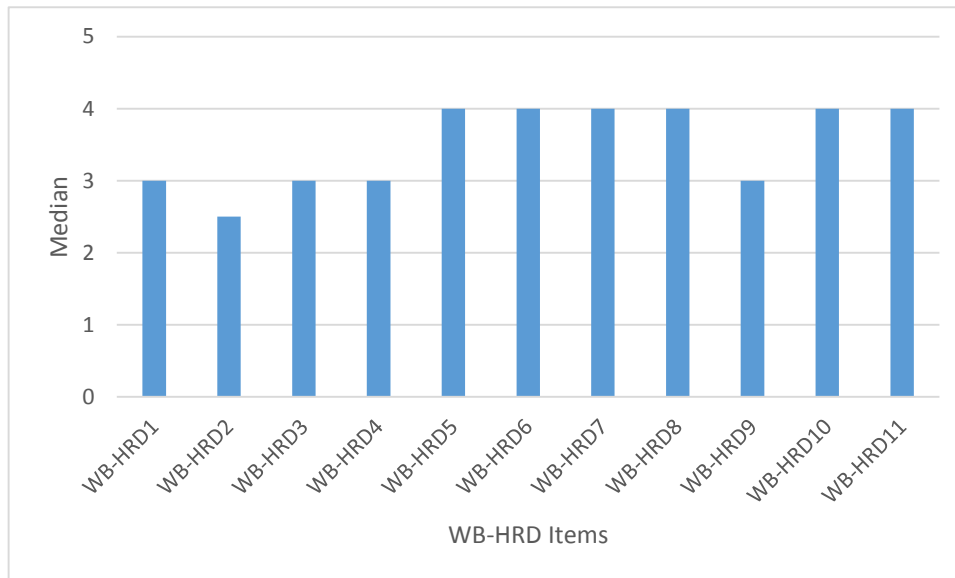


Figure 1. Medians calculated for items assigned to WB-HRD.

5. Discussion

This study confirmed a hypothesis that well-being oriented HRD contributes to organizational sustainable performance. In this way it extended studies which focused on the link between employees' well-being and firm performance (e.g., (Amrani et al., 2020)) as well as socially-responsible HRM practices and firm performance (e.g., (Tongo, 2015)).

Furthermore, this study identified areas that need improvement to achieve higher levels of WB-HRD in the surveyed companies, such as the infrequent organization of training focused on both employees' psychological and physical health. This finding is in line with the data of The Main Polish Statistical Office (GUS, 2017), according to which companies care mainly for the development of employees' technical skills, as well as results of research conducted in Poland twice (in 2015 and 2017), presented by Puchalski and Korzeniowska (2016, 2019). The cited research covered 1000 companies hiring more than 50 employees and focused on not mandatory employers' activities in the area of promoting health. In 2015 only 3.7% of surveyed companies organized training on how to cope with stress. The education in occupational health and safety (OHS) issue which goes beyond the legal requirements took place in 1.3% of companies (Puchalski, Korzeniowska, 2016). In turn, in 2017 stress-related training was

organized in 2.8% of surveyed companies while the not mandatory OHS education was implemented in 2.3% of companies (Puchalski, Korzeniowska, 2019).

This study also showed that despite the provision of HR training, its impact on employees' psychological, physical, and economic well-being appears limited. This may be due to several factors. First, the training content may not fully align with employees' actual needs or daily work demands, reducing its practical relevance. Second, low engagement or poorly structured delivery can hinder learning and application. Third, training alone cannot address broader organizational conditions such as workload, culture, or resource constraints, which are crucial for transferring skills into meaningful well-being improvements. Finally, economic benefits from training, such as promotions or pay increases, may be indirect or delayed, limiting immediate effects on employees' financial well-being. Together, these factors suggest that while training is valuable, it must be complemented by supportive organizational practices to produce a clearly positive impact on overall employee well-being.

It is important to note that the study was conducted during the COVID-19 pandemic, which may have influenced the observed results. During this period, many organizations shifted to remote work, reduced in-person interactions, and faced financial and operational constraints. As a result, employers may have been less able or less motivated to organize training programs, particularly those aimed at promoting psychological and physical health. Additionally, employees' well-being may have been affected by pandemic-related stress, uncertainty, and work-life balance challenges (Hamouche, 2020), potentially limiting the perceived effectiveness of any training offered.

6. Conclusions

The aim of this study was to examine the link between well-being oriented HRD processes (as a symptom of socially-responsible HRD) and organizational sustainable performance. This relationship has been confirmed based on the research conducted in 2020 in Poland among 400 mid-sized and large companies.

This study contributes to the better understanding of the role of HRD processes in companies sustainable performance and enriches previous studies which focused on the relationships between socially-responsible HRM and firm performance as well as workplace well-being and firm performance. It also brings numerous implications for the surveyed companies. At this point it is worth emphasizing that Bombiak and Marciniuk-Kluska (2019) argued that socially-responsible HRM practices provide a path for the sustainable development of organizations, which finally result in increasing societal well-being. This emphasizes that though well-being oriented HRD processes companies may develop general – in life – well-being of their employees.

Based on the findings of this study, public institutions and industry regulators can play a crucial role in promoting well-being oriented HRD processes. They could provide incentives, such as recognition programs, to encourage organizations to implement structured employee well-being initiatives. Developing and disseminating guidelines or best practices for effective HRD programs, alongside offering training and certification for HR professionals, would support capacity building. Additionally, requiring transparent reporting on WB-HRD and establishing awards or certifications for organizations demonstrating excellence in this area could enhance adoption and visibility. Finally, funding longitudinal research on the impact of these practices would provide evidence-based insights, helping to align organizational HRD efforts with sustainable performance and societal well-being.

This study possesses some limitations which may work as future research avenues. First, this study has issue with generalization of empirical findings because of data collection from only companies located in Poland with the focus on mid-sized and large enterprises. Future research is needed to collect data from SMEs and in other countries. Second, many relationships between dependent and independent variables are mediated and moderated by additional factors. The introduction of potential mediators/moderators such as, e.g., sustainable leadership could result in bringing valuable results. Comparative studies using pandemic and post-pandemic data could also help isolate the impact of COVID-19 on the study results.

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Appendix

Table A1.
Measurement scale for WB-HRD

WB-HRD1	The employer organizes training on mental health (e.g., stress management, burnout prevention, work-life balance).
WB-HRD2	The employer organizes training on physical health (e.g., principles of healthy eating, spine care).
WB-HRD3	The training provided positively impacts employees' mental well-being (by increasing competencies in this area).
WB-HRD4	The training provided positively impacts employees' physical well-being (by increasing competencies in this area).
WB-HRD5	The training sessions have a pleasant atmosphere.
WB-HRD6	The training has a positive effect on the work environment.
WB-HRD7	The intensity of the training does not cause physical overload.
WB-HRD8	The intensity of training on various topics does not cause mental overload.
WB-HRD9	The training provided positively impacts employees' economic well-being (by linking salary increases with skill development).
WB-HRD10	I believe that the training offered by my employer enhances my chances of long-term employment at my current workplace.
WB-HRD11	I believe that the training offered by my employer enhances my chances of finding employment in another organization.

Source: own work.

THE GREENWASHING STRATEGY IN FINANCIAL SERVICES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Purpose: The rapid growth of sustainable finance, crucial for achieving SDGs, has led to a significant intensification of greenwashing—the deliberate misrepresentation of sustainability efforts. This study addresses a research gap by identifying and analyzing specific greenwashing strategies in the financial sector (including insurance products) and assessing their systemic impact on the achievement of SDGs and critical consumer/investor trust.

Methodology: The research methodology combines a systematic literature review and an in-depth analysis of key EU legal acts (SFDR, EU Taxonomy, CSRD, and Green Claims Directive) to establish a theoretical framework. This is supported by an empirical component involving the content analysis of non-financial reports and the results of investor surveys.

Findings: The study concludes that the scale of greenwashing necessitates its classification as a real systemic risk, rather than merely a reputational issue, due to its potential for misallocating capital. Effective countermeasures require the synergistic application of strict regulatory frameworks, robust internal sector control, and continuous empirical monitoring. Rebuilding trust in the sustainable transition hinges on the complete standardization, auditability, and transparency of all ESG data.

Regulatory context: The EU regulatory system is focused on enforcing consistency between marketing claims and actual ESG policy. We recommend systemic implementation of the Green Claims Directive (GCD) and the introduction of a uniform European labeling system ("EU Green Label") for financial products based on objective criteria. Furthermore, clear guidelines on the presentation of ESG data in promotional materials and mandatory publication of the methodology used for investment sustainability assessment are essential for cross-border comparability and market credibility.

Social implications: The financial services sector plays a crucial role as a capital allocator, channeling funds to projects that support sustainable development goals, such as renewable energy sources or the improvement of energy efficiency.

Practical implications: The systemic level (regulatory and supervisory) should focus on limiting the scope for greenwashing and increasing transparency in environmental communication through the implementation and enforcement of the Green Claims Directive (GCD). Detailed guidelines are necessary regarding the presentation of ESG data in promotional materials and financial reports (analogous to SFDR requirements), as well as the introduction of a uniform European labeling system for financial products (e.g., „EU Green

Label”) based on objective environmental criteria. Harmonization of the classification of non-financial data (EU Taxonomy, CSRD) is essential for cross-border comparability. With a view to the transparency of ESG data and methodologies, financial institutions should publish the methodology used to assess the sustainability of investments and products (e.g., scoring models, data sources, exclusion criteria).

Originality: This paper fills a gap by providing a detailed analysis of strategies like *greenlighting* and *greenhushing* and evaluating the effectiveness of the current EU regulatory response, offering specific, actionable recommendations to safeguard the sustainable finance market's integrity and ensure its effectiveness in driving real environmental change.

Keywords: sustainable development, financial services, greenwashing, ESG, consumer trust.

Category of the paper: Research paper.

1. Introduction

The contemporary economy is increasingly aligning with the paradigm of sustainable development, which assumes the harmonious combination of economic growth with social well-being and environmental protection (Witek, 2014; Cato, 2022). This is a broad concept whose goal is to meet the needs of current generations without compromising the development possibilities of future generations.

In this context, the financial services sector plays an important role as a capital allocator, directing funds to projects supporting sustainable development goals, such as renewable energy sources or the improvement of energy efficiency. Financial institutions including banks, investment funds, and insurance companies are increasingly presenting themselves as „green” or „socially responsible” entities, offering products defined as sustainable, such as green bonds, ESG funds (Schramade, 2016), or loans that consider environmental, social, and governance factors.

Sustainable finance, as a concept, integrates these factors into investment and risk decision-making processes (Cato, 2022). Nevertheless, the growing importance of this trend has led to an increasing number of greenwashing cases being observed i.e., the deliberate misleading of clients and stakeholders regarding the pro-ecological nature of financial institutions' activities or the products they offer (Grant, 2007; Polonsky, 2010). An example might be promoting a fund as "green", even though its portfolio includes shares in fossil fuel companies.

Greenwashing in the financial sector poses a serious risk to the effectiveness of the transformation towards a sustainable economy; it can lead to a loss of investor and consumer trust, as well as inefficient capital allocation. Despite the growing number of scientific publications, there is still a lack of comprehensive studies that combine a theoretical approach with empirical analysis, focusing on specific greenwashing strategies in financial services and assessing their effects in light of existing regulations, such as the SFDR Regulation. According to what we were able to find, there is a lack of comprehensive studies referring and reporting

on the specific greenwashing strategies in the financial sector and empirically verifying their impact on trust and the effectiveness of EU regulations such as the SFDR.

By addressing this gap, this study analyzes greenwashing strategies in the financial sector with particular emphasis on insurance products and evaluates their impact on market participants' trust and the effectiveness of achieving sustainable development goals. Particular attention is also paid to assessing the effectiveness of the existing regulatory frameworks in mitigating this phenomenon. In connection with the adopted objective, the following research hypotheses were established: H1: The scale of greenwashing in the financial sector is significant enough to constitute a real systemic risk, negatively affecting capital allocation and investor trust. H2: Current EU regulatory frameworks (including SFDR and Taxonomy) are insufficient to fully mitigate the phenomenon of greenwashing without the implementation of additional mechanisms for transparency and auditability. The methodology adopted is mixed (theoretical-empirical), based on a systematic literature review and analysis of EU legal frameworks, supplemented by the content analysis of non-financial reports and the results of investor surveys. In connection with the adopted objective, the structure of the paper includes: systematization of concepts related to greenwashing in the context of finance, analysis of the regulatory framework considering current EU regulations, an empirical part based on the analysis of non-financial reports and the results of survey research, conclusions and recommendations for counteracting greenwashing in the financial sector.

2. Literature review

Although the phenomenon of greenwashing initially referred mainly to the marketing communication of industrial companies, in recent years it has also gained significance in the context of the financial sector. In the face of growing interest in sustainable development, financial and insurance institutions are increasingly promoting their products as „green” or „socially responsible”, which is not always reflected in the actual composition of investment portfolios or operational activities. This chapter reviews the definitions, strategies, and consequences of greenwashing, with particular emphasis on its occurrence in financial and insurance services, and also assesses the current state of research on the effectiveness of regulatory frameworks in counteracting this phenomenon.

2.1. The concept of Greenwashing – definitions and typologies

The phenomenon of greenwashing, also referred to as „eco-sham” or „greenwashing”, is increasingly becoming a subject of interest for researchers, market practitioners, and regulators. Initially, it mainly referred to the marketing practices of industrial companies

that promoted themselves as environmentally friendly without supporting evidence. Currently, this term is also applied in the context of the financial sector, including insurance, where greenwashing takes on more complex and harder-to-detect forms. One of the most frequently cited definitions of greenwashing was proposed by Delmas and Burbano (2011), who describe this phenomenon as „the discrepancy between declared and actual environmental performance of a firm”. The authors indicate that greenwashing occurs when a company presents itself as ecological without undertaking real actions in this regard. Lyon and Montgomery (2015) broaden this definition, stating that greenwashing is deliberate communication activities aimed at creating a false or exaggerated image of an organization as sustainable or environmentally responsible, when these activities are not supported by actual operational or investment policy.

In the context of financial services, greenwashing can manifest, for example, through the offering of so-called „green” investment funds which, despite declarations, still contain a significant share of instruments related to the fossil fuel, aviation, or high-emission industries, or through insurance contracts where, for instance, technical engineering insurance policies still contain clauses linked to high emissions.

2.2. Typologies and strategies of greenwashing

The relevant literature provides several typologies that help in understanding the mechanisms and scope of greenwashing. One of the more comprehensive classifications is proposed by Walker and Wan (2012), who distinguish three levels of greenwashing:

1. Product-level – concerns specific products or services that are presented as environmentally friendly without sufficient justification (e.g., an „ESG” fund that does not apply actual ESG criteria).
2. Organizational-level – involves creating the image of the entire organization as „green”, even though environmental activities are limited, marginal, or superficial.
3. Communication-level – related to marketing communication and reporting, for example, highlighting insignificant ecological actions while simultaneously concealing harmful practices of the core business.

In turn, Lyon and Montgomery (2015) classify greenwashing based on intentionality and effectiveness:

- 1) Symbolic – purely image-building activities, without real changes (e.g., changing the logo to green, without changing the business model).
- 2) Strategic – deliberate actions aimed at gaining a competitive advantage through „eco-labeling”.
- 3) Defensive – aimed at minimizing criticism or responsibility for the environmental consequences of activities.

Greenwashing in the financial sector, including insurance, can take various forms, often classified as the „seven sins of greenwashing” (Grant, 2007; Griesse, Werner, Hogg, 2017). This phenomenon is based on a strategy of deliberate deception, manifesting as:

1. Hidden trade-off – focusing on one ecological aspect of a product while ignoring other, potentially negative ones (e.g., a loan for an electric car whose production is highly energy-intensive).
2. Lack of proof – claims about the pro-environmental nature of a fund, without the possibility of data verification (Lyon, Maxwell, 2011).
3. Vagueness – using generalized, unverifiable terms, such as „ethical fund” or "green" (Chen, Chang, 2013).
4. False labels – creating proprietary, non-certified ecological markings.
5. Irrelevance – promoting actions that are legally mandatory as exceptional achievements.
6. Lesser of two evils – promoting a product as "green" within an industry that is inherently harmful to the environment (e.g., „green” bonds issued by a fossil fuel company).
7. Fibbing – openly stating false information.

Considering the complexity of financial and insurance products, the low level of awareness among retail investors and insurance policyholders means the risk of misinformation in this sector is particularly high. In practice, this means that many entities can use green narratives without incurring the real costs of changing their business model.

In this context, the following greenwashing strategies can be distinguished (Torelli, Balluchi, Furlotti, 2023):

1. Greenlighting – this involves highlighting one, often marginal, pro-ecological action to divert attention from other, more environmentally harmful aspects of the business. An example is a bank that boasts about financing wind farms while continuing to grant large loans for fossil fuel projects.
2. Greencrowding – this is a practice of joining large, industry-wide initiatives that set general and non-binding goals (e.g., „climate neutrality by 2050”) without taking specific, measurable actions at the company level. As a result, the company appears active and engaged, while its contribution to the actual transformation is minimal.
3. Greenhushing – this involves deliberately concealing data and progress in sustainable development to avoid criticism from investors and regulators. The company does not boast about its „green” achievements because it knows they are insufficient or that its overall operations are inconsistent with ESG goals.
4. Greenbleaching – this strategy relies on the general, unfounded use of terms such as „ecological”, „sustainable”, or „environmentally friendly” in the names of financial products or marketing campaigns, without specific data confirming these claims. An example might be an investment fund promoted as „green” whose portfolio is not transparent and whose investments are not verified in terms of their environmental impact.
5. Hidden trade-offs – this type of greenwashing involves promoting one positive attribute of an insurance product while simultaneously concealing negative characteristics.

These strategies often overlap and are used to manipulate the perception of investors and insurance policyholders, undermining trust in the entire sustainable finance sector.

The phenomenon of greenwashing covers a wide range of practices, from vague labeling to deliberately misleading customers and investors. In the financial sector, it takes forms that are difficult to identify unequivocally, especially under conditions of undefined classification and reporting standards. A clear definition and typology of these practices constitute an essential foundation for further analysis of the effectiveness of regulations and the assessment of greenwashing's impact on investment decisions and the achievement of sustainable development goals.

2.3. Green marketing versus greenwashing

Greenwashing has a destructive impact on the achievement of sustainable development goals. By misleading stakeholders, it directs capital to the wrong places. Instead of financing genuinely sustainable projects, funds may flow to entities that only pretend to be pro-ecological. This state of affairs slows down the economic transformation and reduces the effectiveness of actions taken by other, truly responsible entities.

Impact on consumer trust

Trust is the foundation of the financial sector. Greenwashing, by concealing the truth and misleading, undermines this trust (Chen, Chang, 2013; Laufer, 2003). When consumers and investors discover that a company's declarations are false, they lose faith not only in that particular institution but also in the entire sustainable finance market. Such a loss of credibility can lead to a decrease in demand for „green” financial products, even authentic ones, which constitutes a serious barrier to the development of this sector (Witek, 2014; Polonsky, 2010).

In the subject literature, the necessity of distinguishing greenwashing from green marketing is emphasized, even though both phenomena operate with similar language and communication tools. Green marketing is an honest and fact-based form of promotion, in which economic entities communicate genuine pro-ecological activities, confirmed by measurable results or certificates (Peattie, Crane, 2005). Meanwhile, greenwashing involves the conscious misleading of recipients creating an illusion of environmental commitment without actual support in the company's strategy or operational activities (Delmas, Burbano, 2011). The key difference between these phenomena is therefore transparency, intentionality, and the consistency of communication with facts. Table 1 illustrates the fundamental differences between these concepts.

Table 1.*Comparison of green marketing and greenwashing*

Criterion	Green Marketing	Greenwashing
Purpose	Informing about genuine pro-ecological activities	Building a false ecological image
Correspondence with Reality	High, supported by evidence, certificates	Low or none, lack of transparency
Intentionality	Communication based on company values	Image manipulation to achieve benefits
Operational activities	Implementing real changes (e.g., emission reduction, managing carbon footprint)	Superficial actions, no impact on the business model
Social perception	Builds trust and reputation	Leads to loss of credibility and trust
Example	A company with certified ecological products and ESG reporting	A „green” fund that invests in fossil fuel companies

Source: Own elaboration based on Peattie, Crane (2005), Delmas, Burbano (2011).

Digital media, and especially social media, have created a new space for greenwashing activities. Companies use platforms such as Instagram, LinkedIn, Facebook, and X (formerly Twitter) to create ecological narratives, often without accountability for their verification (Table 2).

Typical practices of digital greenwashing include:

- emotional storytelling about the „company's green mission” without hard data,
- publishing image-based photos of nature, trees, and photovoltaic farms,
- using hashtags like greenfinance, sustainability without specifics,
- promoting one-off „green actions” while lacking strategic changes.

Table 2.*Examples of greenwashing on social media (financial and insurance industry)*

Detail	Case Description	Context
DWS (Deutsche Bank)	Accused of inflating the ESG level in investment products – intensive promotion on LinkedIn	SEC and BaFin proceedings (2022)
HSBC	Promoted green bonds while simultaneously financing coal projects; campaign on Twitter and YouTube	Advertisements blocked by the UK regulator (ASA)
BlackRock	Public declarations about responsible investing, while lacking industry exclusions in ESG funds	Media and NGO criticism
Shell	#MaketheFuture campaign – promoting ecological innovations, alongside expanding oil extraction	Example of „organizational greenwashing”

Source: Own elaboration based on media data and regulator reports (2022-2024).

Greenwashing in the age of digital media has become more subtle, narrative-driven, and harder to identify. In contrast to honest green marketing, it relies on a superficial aesthetic of sustainability, rather than on real operational changes. Its popularity stems from its low cost and high short-term effectiveness. At the same time, it poses a threat to the credibility of the entire financial and insurance sector, and consequently, to the effective achievement of sustainable development goals.

The preceding systematic review has established a robust theoretical framework, detailing the definitions, complex typologies, and severe consequences of greenwashing across various sectors, with a clear focus on financial services. While the literature extensively defines the

phenomenon (Grant, 2007; Delmas, Burbano, 2011) and provides classifications of deceptive strategies (Walker, Wan, 2012; Torelli et al., 2023), a critical gap remains in the comprehensive empirical assessment of these strategies within the highly regulated EU financial sector, specifically concerning their measured impact on consumer trust and the effectiveness of key regulatory tools such as SFDR and the EU Taxonomy. Existing studies often focus on general marketing or isolated cases. This structured review therefore confirms the lack of studies that integrate a wide spectrum of greenwashing strategies with an empirical analysis of non-financial reporting practices and investor perception, which this study aims to address.

3. Methods

The study combines theoretical analysis, analysis of normative documents, and synthesis of secondary research. This is essential due to the interdisciplinary nature of greenwashing (linking law, finance, and communication).

3.1. Justification of the Research Methodology

The research employs a mixed-method approach integrating theoretical analysis with empirical synthesis. This approach was selected specifically to address the complexity of greenwashing, which requires both an understanding of legal frameworks and an assessment of its real-world market impact.

The theoretical component (literature review and normative analysis) is necessary to formally evaluate hypothesis H2 (regulatory insufficiency). Simultaneously, the empirical component (synthesis of secondary data) is crucial for substantiating the scale of the phenomenon and its link to trust erosion, thereby validating hypothesis H1 (greenwashing as a systemic risk). This integrated methodology ensures the findings are grounded in both legal reality and observed market practices.

3.2. Methods Applied in the study

The adopted research methodology, characterized by a mixed-method approach, was implemented through four sequential and distinct stages. This structure was essential to systematically address the complex, interdisciplinary nature of financial greenwashing and to ensure that the findings are robustly grounded in both theoretical frameworks and empirical evidence.

Stage I: The initial stage focused on establishing a solid theoretical and conceptual base for the study:

- 1) Methodology – this stage employed a systematic literature review combined with content analysis. This approach allowed for the comprehensive mapping of the research landscape.
- 2) Purpose – the primary objective was to systematize the existing typologies and strategies of greenwashing (detailed in Chapter 2) and, critically, to identify specific research gaps concerning the financial services sector.
- 3) Criteria for source selection - the analysis was limited to academic publications (peer-reviewed articles and monographs) published within the key period of 2007 to 2024, which captures the emergence and intensification of the greenwashing concept. Sources focused specifically on ESG, sustainable finance, financial misconduct, and consumer trust, retrieved predominantly from authoritative academic databases, namely Web of Science and Scopus.

Stage II: The second stage transitioned the focus to the legal and policy environment, which is crucial for addressing the study's second hypothesis (H2):

- 1) Methodology – the core method was the analysis of normative documents.
- 2) Purpose – the aim was to evaluate the coherence and effectiveness of key European Union legal frameworks specifically the Sustainable Finance Disclosure Regulation (SFDR), the EU Taxonomy Regulation, the Corporate Sustainability Reporting Directive (CSRD), and the forthcoming Green Claims Directive (GCD)—in limiting the potential scope for greenwashing practices. This analysis directly supported the verification of Hypothesis H2.
- 3) Criteria for source selection – source material was restricted to official texts of European Union Regulations and Directives (as published in the Official Journal of the European Union), supplemented by related implementation guidelines issued by key European Supervisory Authorities (ESMA, EBA, EIOPA) to ensure an up-to-date and authoritative understanding of the regulatory environment.

Stage III: The third stage incorporated the empirical dimension, designed to validate the hypothesis concerning the systemic risk of greenwashing (H1):

- 1) Methodology – this stage utilized the synthesis of secondary empirical data in conjunction with content analysis of institutional reports.
- 2) Purpose – the primary goal was to substantiate the scale and empirical magnitude of the greenwashing problem, thereby validating Hypothesis H1 (greenwashing as a systemic risk), and assessing its discernible impact on public trust.
- 3) Criteria for source selection – data sources included findings from national and European market reports, surveys, and market studies conducted by recognized authoritative bodies, such as the European Commission, the European Securities and Markets Authority (ESMA), national regulators (e.g., UOKiK, BaFin), and prominent financial

market auditors (e.g., PwC, Deloitte). The analysis primarily concentrated on data covering the period 2021–2024, reflecting the post-SFDR regulatory landscape. Crucially, this included the content analysis of non-financial reports from major EU financial institutions related to their ESG product offerings and mandated disclosures.

Stage IV: The final stage served to integrate the preceding findings and translate them into actionable conclusions:

- 1) Methodology – the stage involved deductive and inductive analysis.
- 2) Purpose – the overarching objective was to synthesize the integrated findings from the theoretical (Stage I), normative (Stage II), and empirical (Stage III) stages to formulate robust, specific practical and regulatory recommendations aimed at mitigating greenwashing and restoring market credibility.

4. Legal regulations and the phenomenon of greenwashing in the context of finance, insurance, and sustainable development

As the concept of sustainable development becomes increasingly integrated with economic policy, energy transition, and capital allocation, the financial sector, including insurance, gains a crucial role as an intermediary in channeling funds toward investments and products with a positive environmental and social impact. Concurrently, however, the dynamic growth of the so-called „green market” reveals a serious risk of informational abuse, the most explicit form of which is greenwashing the phenomenon of misleading stakeholders through false or exaggerated claims about an organization's alleged commitment to sustainable activities.

The scale of this phenomenon is confirmed by analyses from the European Commission (2020/2023), which showed that over half (53%) of the examined green claims in the EU were vague, misleading, or unfounded, and 40% lacked any supporting evidence. These data constitute the main justification for tightening the EU's legal framework (European Commission (2020): <https://ec.europa.eu>: updated: 19.11.2025; European Commission (2023): <https://environment.ec.europa.eu>: update: 19.11.2025). The insurance sector faces a unique challenge, often described as „dual-level risk”, where greenwashing can occur both in asset management (investments) and in the design and marketing of insurance products. The urgency of addressing this risk is supported by direct supervisory evidence from EIOPA. For example, analyses of the European insurance market and dedicated thematic reviews conducted by EIOPA revealed that a significant percentage of insurers lack robust internal controls regarding the alignment of ESG product labels and sustainable claims with actual investment or underwriting practices. A 2024 EIOPA analysis on the implementation of the Sustainable Finance Disclosure Regulation (SFDR) highlighted that while reporting is increasing, significant inconsistencies remain in how firms classify and market products under Articles 8

and 9, particularly regarding the clear definition and measurement of "sustainable investments" and the application of Do No Significant Harm (DNSH) criteria. Furthermore, EIOPA data consistently point to a risk of mis-selling, where marketing materials use overly aspirational or ambiguous environmental terminology, making it difficult for consumers to assess genuine sustainability credentials. These supervisory findings directly underscore the need for enhanced regulatory clarity and oversight in the insurance sector, complementing the broader European Commission's legislative drive (EIOPA (2023): <https://sip.lex.pl>: update: 20.11.2025).

In the context of finance and insurance, greenwashing can take the form of:

- a) incorrect classification of funds as „sustainable”,
- b) promotion of „climate insurance” without adequate ESG risk analyses,
- c) suggesting that a given product supports the ecological transition – without evidence.

Such activities not only distort market mechanisms but also hinder the achievement of sustainable development goals (e.g., SDG 13 – Climate Action), undermining the trust of consumers, investors, and regulators.

The phenomenon of greenwashing, although previously imprecisely, regulated has been covered by increasingly stringent legal frameworks in recent years, particularly at the European Union (EU) level. These regulations aim to:

- a) ensure transparency and comparability of information regarding financial and insurance products declared as „sustainable”,
- b) enforce accountability of financial and insurance institutions for the ESG data they present,
- c) protect consumers and investors from market manipulation.

To this end, key EU legal acts relevant to the financial-insurance sector have been developed:

- 1) SFDR Regulation (2019/2088). This is the Regulation on sustainability-related disclosures in the financial services sector (SFDR), which:
 - a) imposes ESG policy disclosure obligations on financial market participants, including life insurance companies offering investment products,
 - b) introduces the categorization of financial and insurance products (Art. 6, 8, 9), allowing their classification based on the integration of ESG factors,
 - c) requires reporting on the principal adverse impacts (PAI) of investment activity.

For the insurance sector, SFDR is crucial because unit-linked or pension products are often promoted as „sustainable”, despite lacking the appropriate investment profile. In the context of the Taxonomy, this link is somewhat weaker, as insurers are often required to show what percentage of their activities or investment portfolio meets the criteria. The Taxonomy directly influences Green Claims in the products offered, especially those under Article 8 and 9 of SFDR. Furthermore, SFDR imposes a requirement for consistency between marketing and investment reality.

- 2) Taxonomy Regulation (2020/852). This Regulation introduces scientific technical criteria that allow for a clear determination of whether a given activity is „environmentally sustainable”. In practice, this means that financial and insurance institutions must demonstrate:
 - a) what percentage of their activities or investment portfolio meets the Taxonomy criteria,
 - b) whether the insurance products offered support environmental goals, e.g., by insuring investments in Renewable Energy Sources (RES) or sustainable construction.

This approach minimizes the room for greenwashing by formally indicating which activities have a real environmental impact.

- 3) CSRD Directive and ESRS standards. This expands the reporting obligations for financial institutions, including insurers not only regarding their own operations but also in relation to their investment portfolios and customer relations. Key changes include (Korca, Costa, and Bouten, 2023):
 - a) the obligation to apply the European Sustainability Reporting Standards (ESRS),
 - b) full disclosure of ESG risks, including climate, social, and corporate governance risks,
 - c) integration of the „double materiality” perspective the impact of ESG on the company, and the company's impact on the environment and society. For the financial and insurance sector, this necessitates transparent documentation of sustainable activities, which makes it harder to employ greenwashing strategies based on vague claims.

Despite ambitious assumptions, the implementation of regulations faces numerous difficulties, primarily related to the varying quality of ESG data many institutions lack systems for collecting data consistent with ESRS or Taxonomy, low ESG competence among staff in the financial-insurance sector, and a lack of sanctions in the case of „soft” greenwashing, such as marketing containing suggestive but unverifiable slogans („ecological investing”, „green portfolio”).

In the insurance sector, there is also a problem associated with the fact that many insurance products are promoted as „sustainable”, but there is a lack of real mechanisms to measure their impact on the climate, for example, through climate risk management or limiting exposure to harmful industries (e.g., fossil fuel extraction). Responding to these regulatory shortcomings, the European Commission (EC) proposed the Green Claims Directive in 2023. Its purpose is to prohibit companies from making generic, unsubstantiated marketing claims, impose an evidentiary obligation (scientific, auditable) for every pro-environmental claim, and facilitate the enforcement and sanctioning of greenwashing, particularly in the area of advertising and investment offers.

In combination with CSRD and SFDR, this directive has the potential to significantly limit the scale of the phenomenon in the future, especially in the finance and insurance sector, which is the main channel for communicating „green promises”.

5. Results

The phenomenon of greenwashing in the financial and insurance sectors is becoming a subject of increasing interest for researchers, regulators, and market participants. Along with the dynamic development of the concept of sustainable finance and the growing popularity of products labeled as „green” or „socially responsible”, significant doubts have also arisen regarding the actual impact of these instruments on the environment and society. Particularly important are concerns related to the discrepancy between marketing claims and the actual operations of financial and insurance institutions, which leads to consumer misinformation and the misallocation of capital.

The aim of this subsection is to synthetically present the most important empirical research findings concerning greenwashing in the context of finance and insurance globally and in Poland.

The focus is on both identifying the methods used to detect this phenomenon and assessing its impact on investment decisions, institutional reputation, and the effectiveness of the transition toward sustainable development. The discussed research allows for an understanding of the scale of the problem, its measurement methods, and the barriers hindering its effective mitigation. Particular attention is also paid to existing gaps in the literature that can serve as a starting point for further analysis especially in the context of the insurance sector, which has so far been analyzed to a limited extent

5.1. Studies, their scope, and methods within finance and insurance sectors

Previous empirical studies worldwide on greenwashing in the financial sector, and to a lesser extent, the insurance sector, have utilized diverse methodological approaches (Table 3). The choice of approach depended primarily on data availability, the specificity of the market under study, and the objective of the analysis i.e., whether it focused on identifying the disinformation strategies themselves or rather on assessing their economic consequences.

Table 3.*Studies, their scope, and methods within finance and insurance sectors*

Author/title	Scope (geographical/ sectoral)	Methodology	Main findings	Limitations/ gaps
Spotting portfolio greenwashing in environmental funds (springer link)	USA, environmental investment funds	Comparative analysis of ESG vs. conventional funds, analysis of fund flows (inflows), analysis of portfolio carbon emissions	Funds that declare sustainability often do not reduce their carbon emissions compared to the control group; despite this, these declarations lead to an increase in capital inflows. This is a strong signal of greenwashing	Focus on emissions; does not cover insurance specifics; potential limitations arising from the quality of emissions data
Unmasking Greenwashing in Finance: A PROMETHEE II-Based Evaluation... (MDPI)	Europe, financial institutions (banks, insurance companies, financial service providers)	Comparative assessment: ESG disclosures vs. actual environmental performance (green accounting); greenwashing risk index using a multi-criteria method (PROMETHEE II)	Significant discrepancies: many institutions have high ESG disclosure scores, but their environmental actions in practice are insufficient; insurance institutions also exhibited this problem	Data relates to a single year/ situation; green accounting requires better standardization; potential for hidden actions not reflected in the data
Public Funding, ESG Strategies, and the Risk of Greenwashing: Evidence from Greek Financial and Public Institutions (MDPI)	Greece; Financial and Public Institutions	Mixed method: Data Envelopment Analysis (DEA) for efficiency, qualitative analysis of ESG report quality, content analysis of disclosures, bibliometric	Institutions that formally declare ESG strategies are often not technically efficient; institutions that performed better had better internal governance and better reporting quality	Country-specific context (Greece) — may differ in other systems; limited number of insurance institutions analyzed separately; potential for broader international comparison
<i>How Greenwashing Affects Firm Risk: An International Perspective</i> MDPI	Greenwashing affects firm risk: an international perspective (MDPI) international (70 countries), general companies (including financial?)	Dynamic panel data analysis; measuring greenwashing and its impact on risk and financial metrics	Greenwashing was associated with certain benefits (e.g., better image) but also with an increase in risk; greenwashing firms have a lower cost of capital and higher leverage, but also greater volatility	Broad sectoral study, not all results specifically targeted the insurance sector; requires further sectoral breakdown
<i>Costs may be a blessing in disguise: Litigation risk and greenwashing</i> IDEAS/RePEc	China; listed companies	Analysis of the impact of litigation risk and D&O (Directors and Officers) insurance on greenwashing	A high level of legal risk limits greenwashing (firms are more cautious), but having D&O insurance increases the propensity for greenwashing ("liability shield") in conditions of regulatory uncertainty	Focus on China; regulatory and legal specificities may vary; does not specifically analyze insurance products from a consumer/ investor perspective

Source: developed based on (Boiral, Brotherton, Talbot. 2024; Efthalitsidou, Kanavas, Kagias, Sarianndis, 2025).

One of the most frequently used approaches is the panel data analysis of companies. This allows for the observation of changes occurring over time, for example, before and after a given institution introduces an ESG declaration which enables the assessment of the actual impact of „green” policies on the firms' operational and environmental activities. They also allow for the consideration of lagged effects and variations depending on the industry or region.

Comparative analyses using the difference-in-differences method are also highly popular, especially in the context of investment funds that declare compliance with ESG principles. In these types of studies, the behavior or performance of „green” funds is compared with a control group – traditional funds – which allows researchers to determine whether the „green” status actually translates into different investment decisions, better environmental results, or higher capital inflows.

An interesting solution, primarily used in research on the quality of ESG disclosures, involves multicriteria methods, such as PROMETHEE II. These methods allow researchers to assess the consistency between the ESG indicators declared by institutions and their real environmental effects (e.g., reduction of CO₂ emissions, impact on biodiversity). By integrating quantitative and qualitative data, they enable a more comprehensive evaluation of the alignment between reported activities and reality.

Another important method is the content analysis of non-financial reports, which is used to evaluate the quality and completeness of disclosed ESG information. Studies of this type often focus on the level of detail, consistency, and transparency of companies' sustainability communication. Based on the content of such reports, it is possible to identify potential instances of narrative greenwashing (e.g., the exaggerated promotion of pro-environmental activities without confirming their real impact).

To a lesser extent, especially in the context of the insurance sector, survey research and case studies have been used. While these methods offer valuable insights into the perspectives of consumers, managers, or regulators, they still constitute a marginal part of the academic output in this area. There is a particular lack of qualitative research concerning the motivations and mechanisms for employing greenwashing by institutions that offer insurance products labeled as „sustainable”.

5.2. Studies, their Scope, and Methods within the Financial and Insurance Sectors in Poland

In Poland, the issues of ESG and the risks associated with disinformation (greenwashing) in the financial and insurance sectors are becoming an increasing focus for academics, analysts, and regulators (Table 4). Although empirical studies strictly concerning greenwashing in financial or insurance products are still scarce, several important works already exist that provide knowledge on the state of reporting, perception, and institutional readiness to meet regulatory requirements.

For instance, an analysis conducted by M. Białek-Szkudlarek (2025) indicated differences in the scale and volume of ESG disclosures in the reports of Polish banks, using text mining techniques.

This research shows that although ESG reporting is increasingly used by insurers, the scope of disclosures and the degree of achievement of declared environmental goals are highly varied (Lament, 2023).

Works analyzing green financial instruments in the context of the risk of superficial declarations are also increasingly appearing in Polish literature. For example, D. Ślażyńska-Kluczek (2023) hypothesizes that the issuance of sustainable bonds may be used to emphasize environmental effectiveness that is not, in reality, adequate to the declarations. It should be noted that although the Polish financial market is dynamically adapting to the SFDR requirements, a significant discrepancy is observed in the analysis of sustainable financial instruments. Market data (e.g., KNF/IZFiA reports) indicate that the majority of assets classified as sustainable have Article 8 status (promoting ESG characteristics), whereas funds with an explicitly sustainable objective (Article 9) constitute only a small percentage of the market. This structure increases the risk of greenwashing by 'diluting' the most ambitious declarations (<https://www.knf.gov.pl>, 20.11.2025; <https://www.izfa.pl>, 20.11.2025).

Proposed measurable indicators:

- 1) Insurer Investment Consistency Index (IICI). The percentage share of the insurer's assets (technical provisions) invested in low-carbon initiatives (consistent with the EU Taxonomy) relative to the volume of insurance products sold that are labelled as sustainable (measured annually).
- 2) Sustainable Allocation Change Index (SACI).
 - a) the percentage increase (or decrease) in the share of Article 9 assets in Total Assets Under Management (AUM) over subsequent years (<https://rf.gov.pl/o-nas/sprawozdania>, 20.11.2025).
 - b) the Customer Service Quality Indicator (Wjok) – based on these questions, a survey of customer service quality was developed, relating to the level of customer satisfaction with the service offered (insurance coverage scope, claims settlement procedures, and the timeliness and speed of claims payment). This indicator allows for the assessment of the professionalism (preparation, expertise, knowledge, experience, communication skills, effectiveness, empathy) of the insurance company's employees and insurance intermediaries (agents and brokers) (see: Przybytniowski, 2023, pp. 86-87).
- 3) Correlation Between Outflow and Sustainability Abandonment (COSA). An examination of the correlation between the volume of redemptions from Article 9 funds and the subsequent re-classification of these funds to Article 8 (or outside SFDR).

Table 4.*Studies, their scope, and methods within the financial and insurance sectors in Poland*

Specification	What it examines/discusses	Degree of relevance to greenwashing/finance/insurance
PwC Poland: „As many as 94% of investors fear that ESG reports may contain false statements”	Survey of investor opinion regarding the credibility of ESG reports; the level of concern about potentially false or exaggerated claims	Directly concerns greenwashing in the context of ESG and finance. This study shows the perception of the market/investors
„Greening Financial Markets – Selected Legal and Financial Instruments from the Perspective of the Greenwashing Phenomenon”	Conceptual/review article — discusses legal and financial instruments, treasury bonds, and financial institutions from the perspective of green instruments and regulatory problems, including greenwashing	More theoretical/review-based than empirical; fewer numerical data points, few insurance products discussed
EY Institutional Investor Survey — „Does ESG affect investment decisions”?	Survey of institutional investors in Poland; indicates a discrepancy between ESG declarations and the actual consideration of ESG factors in investment decisions	Very close to greenwashing – declarations vs. actions. Concerns finance, but not necessarily insurance products
„Greenwashing – The President of UOKiK Goes on the Offensive” (PwC Poland)	Description of the regulator's actions (UOKiK), charges against enterprises in Poland for marketing communication that may constitute greenwashing, including the use of „green” slogans unsupported by evidence	Practical example of „marketing” greenwashing; more focused on the general services/trade sector than on finance/insurance

Source: prepared based on (Ślażyńska-Kluczek, 2023; Białek-Szkudlarek, 2025; Lament, 2023; <https://www.pwc.pl>, 18.10.2025; <https://www.ey.com/pl>, 10.10.2025; Lelek, 2024).

Despite these advancements, significant gaps can still be observed in Polish research. It is particularly important to empirically examine the concept of „dual-level risk,” in the insurance sector. European supervisory authorities (e.g., EIOPA) have repeatedly signaled the problem of the difficulty in verifying the consistency of ESG declarations with insurers' actual investment policy, which is crucial for trust (<https://www.knf.gov.pl>, 20.11.2025; <https://www.izfa.pl>, 20.11.2025). The processes of verifying environmental claims within the insurance sector are relatively poorly documented empirically, as is the impact of regulations and supervisory actions on mitigating greenwashing. Polish studies often focus on the analysis of disclosures or perception, and less on comparing declarations with real operational effects.

The introduction of the cited indicators allows for a transition from a general research recommendation to a concrete empirical project. Studies based on these parameters will provide measurable evidence regarding the effectiveness of regulations, the actual scale of greenwashing, and the impact of supervisory actions on the behavior of entities in the Polish financial market. Longitudinal research is indispensable for quantifying the influence of regulatory and supervisory interventions (EIOPA/KNF) on the congruence between insurers' ESG declarations and their tangible operational and investment practices; this analysis will be presented in the subsequent scholarly contribution.

Previous empirical research indicates that greenwashing in the financial and insurance sectors is a common, diverse, and difficult-to-detect phenomenon using standard reporting tools. Analyses show that ESG declarations often do not translate into actual environmental

impact, and the effectiveness of regulatory actions in eliminating this problem is limited. In this context, it seems particularly important to continue research on consumer perception, transparency of market communication, and the development of tools enabling a reliable assessment of the alignment between institutional actions and their „green” claims. Filling these gaps, especially in the insurance area, constitutes an important direction for further academic research and for creating effective policies to counteract disinformation in the financial sector.

5.3. Identification of research gaps and limitations

Despite the growing interest in ESG and greenwashing in Polish academic research and industry reports, significant limitations are still visible regarding the scope, methodology, and depth of the analyses conducted in this area. The vast majority of available studies focus on the declarative aspect the formal analysis of ESG report content, the examination of readiness to report according to new standards (e.g., CSRD, SFDR), or the diagnosis of institutions' general awareness of sustainable development. However, there is a lack of in-depth analyses that confront these declarations with the institutions' actual environmental and financial activities.

In particular, there is a noticeable shortage of empirical comparative studies that would juxtapose the content of ESG declarations with real operational indicators (e.g., the structure of investment portfolios, emission levels, underwriting policies). This type of research is crucial for identifying greenwashing because it allows verification of whether a company's „green image” is reflected in its actual business practice. Concurrently, little attention has been paid in the literature to analyzing the impact of seemingly pro-environmental actions on investor or consumer decisions, which limits the ability to assess the consequences of greenwashing for market functioning.

Additionally, the insurance sector remains marginally represented in Polish research. While banking institutions and investment funds are relatively more often subjected to ESG analysis, insurance companies rarely become the subject of in-depth analysis in the context of sustainable finance. Meanwhile, the products they offer, such as „green” motor, health, or property insurance, are increasingly used in marketing campaigns whose credibility is not always easy to assess.

Another barrier to research development is the short-term nature of available data and the lack of a longitudinal approach. Most studies rely on a one-time analysis of reports from a single financial year, which makes it difficult to track trends over time and assess the durability of adopted ESG strategies. There is also a lack of comprehensive research based on panel data or dynamic models for assessing changes in the environmental practices of institutions.

Finally, the area of qualitative research remains underdeveloped in Poland, such as case studies, expert interviews, or analyses of customer perception. Although institutional investor perception is partially captured in surveys by consulting firms (e.g., EY, PwC), there is a lack of grounded knowledge on how consumers and insurance clients interpret ESG communications, what expectations they have for „green products”, and how they recognize (or fail to recognize) greenwashing. This is a significant gap, particularly in the context of building trust and loyalty among clients in the sustainable finance market.

5.4. Suggestions for future research avenues in the financial and insurance sectors

In response to the identified gaps and limitations in Polish research concerning greenwashing in the financial and insurance sectors, there are several directions that could significantly enrich academic knowledge and contribute to the development of market practice and regulation.

Firstly, empirical comparative studies are needed that will confront the declared ESG activities of financial and insurance institutions with their actual environmental results. Such analyses should be based on comparing the content of non-financial reports with hard operational data (e.g., investment portfolio structure, greenhouse gas emissions, exposure to coal sectors, or approach to ESG risk). It is also worthwhile to introduce a systematic assessment of the consistency between ESG marketing and actual business policy, which will allow for the identification of cases of narrative and structural greenwashing.

This perspective is particularly important in the context of increasingly demanding European regulations and stakeholder expectations regarding a credible transformation of financial institutions.

It is also worth considering the expansion of qualitative research, specifically through conducting in-depth interviews with representatives of financial institutions, regulators, auditors, and individual clients. This type of approach can reveal not only the motivations and barriers associated with ESG implementation but also indicate the practical mechanisms by which greenwashing occurs – whether it is intentional or results from unawareness or lack of knowledge.

A significant deficiency in the existing literature is also the lack of research on the perception of consumers and insurance clients. It is therefore worthwhile to conduct survey or experimental studies that will help assess the extent to which clients are able to recognize greenwashing, how they perceive products labeled as „green”, and how ESG information influences their purchasing and investment decisions. This can provide valuable insight into the effectiveness (or ineffectiveness) of current forms of communication and identify the risks associated with a loss of market trust.

Sectoral studies focused on less explored areas, such as insurance, are also of particular importance. Analysis of insurance products offered as sustainable (e.g., green comprehensive motor insurance, pro-environmental property policies) should cover both their construction and their promotion methods and consistency with real ESG criteria. This will allow for a better assessment of whether the insurance sector genuinely contributes to economic transformation or merely uses the pro-environmental trend as a branding tool.

Recommendations regarding ESG audits should be specified and linked to applicable assurance standards. In the context of requirements stemming from the CSRD Directive, which mandates limited or reasonable assurance for the verification of sustainability reporting, referencing international frameworks is crucial. It is suggested that future recommendations be anchored in the ISAE 3000 (Revised) standard or, in the context of verifying historical data, in newer, specific standards (e.g., the draft ISSA 5000) designed to ensure a uniform methodology for the verification of non-financial information. Such a linkage will enhance regulatory coherence and the practical applicability of the proposed actions, ensuring that audit processes meet the highest requirements of professional integrity (<https://www.iaasb.org>, 20.11.2025).

Finally, in the age of digitalization, it is worth considering research into greenwashing in the digital space, including social media and online communication channels. Analysis of ESG rhetoric in internet communication can help identify new, often harder-to-detect forms of disinformation that are not recorded in official reports but have a real impact on consumer decisions (Table 5).

Table 5.

A conceptual framework for greenwashing in the financial and insurance industries

Area	Greenwashing mechanism	Description	Example (real/hypothetical)
Investment products	ESG-wrapping	An investment product declared as „green” despite low ESG compliance	An ESG fund investing in oil companies
Green bonds/loans	Unverified financing of „green” projects	Issuing bonds as „green” but without independent certification	A green bond issued by a firm with high CO ₂ emissions and no reduction commitments
Insurance	Insuring high-carbon risks under the guise of „transitionary”	An insurer claims to support transformation but continues to underwrite open-pit mines	A reinsurer financing coal assets
„Net Zero” declarations	Declarations without a strategy or interim targets	An institution declares a Net Zero goal without a concrete implementation plan	A bank announces a Net Zero goal by 2050 but increases loans to heavy industry in 2025
Mismatched disclosure vs. performance	Discrepancy between communication and operational data	Public reports do not reflect actual operations	A bank declares 40% of its portfolio is „green” but actual operational data shows 12%
„Social washing”	Using CSR elements to cover up environmental impact	Emphasizing gender equality and diversity instead of real environmental ESG actions	A fund advertises a female-led board but invests in the coal industry

Cont. table 5.

Portfolio composition	Selective presentation of „green” assets	Emphasizing green projects while hiding large investments in high-emission assets	A fund promotes its involvement in renewable energy sources but does not disclose investments in cement plants.
Simplified ESG metrics	Using ESG rankings without understanding methodology	Focusing on „ratings” without in-depth data analysis.	An institution boasts a high ESG score that excludes CO ₂ emissions
Low sanctions and oversight	Exploiting the lack of control and audit	Lack of mandatory ESG audit allows for declarative statements without risk	Lack of external verification of green products by an insurance institution
Reputational „smokescreen”	„Eco” branding and advertising without real action	Marketing campaign without coverage in policy change	Commercial spots promoting a „green bank” that finances shale gas

Source: prepared based on (Sklavos, Zournatzidou, Ragazou and Sariannidis, 2025, Dempere, Alamash and Mattos, 2024; Bosone, Cerchiello, Kostiuk, 2025; Costanza, B., Cerchiello, P., Kostiuk, Y. 2025).

6. Discussion

The phenomenon of greenwashing, defined as the deliberate misleading of stakeholders regarding the genuine pro-environmental nature of activities or products, constitutes a globally recognized challenge, the scale and consequences of which directly impact the credibility of the sustainable transition in financial services. Statistical data and international reports provide a solid empirical basis, confirming both the prevalence of the problem and its negative impact on consumer trust, which is key to achieving the goals of the present study.

Research conducted by supranational institutions reveals an alarming level of unreliability in ecological declarations, providing the backdrop for the analysis of greenwashing strategies in finance. A comprehensive analysis conducted by the European Commission (2020/2023) is a key reference point here: in 2020, it demonstrated that over half (53%) of the examined „green” marketing claims were vague, misleading, or unfounded, and 40% lacked any supporting evidence. Newer findings from 2023 confirm that over half of the declarations regarding the environmental impact of products are incomplete, misleading, or outright false. Similar conclusions emerge from analyses by the International Consumer Protection and Enforcement Network (ICPEN) and other EU reports, which estimate that although 80% of advertisements and websites contain information concerning the environmental impact of products, over half of these declarations are unreliable. This data provides the empirical foundation for the research hypothesis posed in the abstract, indicating that greenwashing has a wide reach and the potential to undermine the effectiveness of the sustainable transition (Lyon, Maxwell, 2011).

6.1. The erosion of consumer and investor confidence

The scale of greenwashing is leading to increasing skepticism and an erosion of trust among both consumers and investors, which is critical for the financial sector offering sustainable products (ESG). National studies perfectly illustrate this process:

1. The „EKObaremtr Index” Report (NowyMarketing, 2024) indicates that nearly 7 out of 10 Poles (68%) support the thesis that ecological slogans are used primarily for promotional purposes, and 58% complain about the excessive use of ecology in marketing campaigns.
2. Research by SW Research and ESG Impact Network confirms that one in three Poles is aware of the phenomenon of greenwashing, and over 60% believe that companies abuse ecological slogans.

This high level of incredulity poses a direct threat to the credibility of ESG funds, green bonds, and other sustainable products offered by financial institutions, weakening their ability to raise capital and thereby undermining trust in the sector. This is empirical confirmation of the validity of the second part of the adopted research hypothesis.

6.2. Characteristics of greenwashing in the financial and insurance sectors

The financial and insurance sectors are particularly fertile ground for greenwashing strategies, especially in the face of increasing regulatory (e.g., SFDR) and investor pressure regarding ESG factors. Disinformation practices in this sector take specific forms:

- 1) Rebranding and superficial „Greenness” – greenwashing in finance often involves offering „green policies” or „sustainable products” whose actual contribution to sustainable development is minimal. This can be reduced to rebranding existing products or using very general clauses, without significant changes to the scope, price, or processes related to underwriting.
- 2) Two-tiered risk – as warned by EIOPA (European Insurance and Occupational Pensions Authority), greenwashing in insurance can occur at every stage of the policy lifecycle. Moreover, an insurer may be guilty of greenwashing in its own corporate reports while simultaneously insuring companies with questionable environmental reputations without appropriate ESG risk differentiation, which generates a dual reputational and regulatory risk.
- 3) ESG risk modeling challenges – greenwashing can also manifest in exaggerating the accuracy and sophistication of models used to assess ESG risk in the underwriting process, when in reality, many of them still rely on incomplete or unstructured data, leading to incorrect risk pricing and underestimation of exposure to climate risks.

These specific forms of deception confirm the necessity of a detailed analysis of greenwashing strategies in the financial sector and an empirical assessment of whether the existing regulatory frameworks are effective in limiting their negative impact, forming the core research problem of this article.

The high scale of greenwashing entails growing legal and regulatory risk, which further justifies the need for research in this area:

- 1) Tightening EU regulations – the European Commission's work on new legislation, such as the Green Claims Directive, is a direct response to the prevalence of the problem and an effort to increase transparency.
- 2) Supervisory activity – in Poland, the Office of Competition and Consumer Protection (UOKiK) actively monitors and imposes penalties (up to 10% of annual turnover) for violations related to greenwashing, based on regulations concerning unfair competition and consumer protection.

The growing number of penalties and regulations attests to the critical weight of the phenomenon, confirming that greenwashing is a significant risk factor for the financial sector, which necessitates an in-depth assessment of its strategies and the actual effectiveness of existing control mechanisms.

1) Scale of the problem:

- a) European Commission Study (2020/2023) – one of the most cited studies, conducted by the European Commission in 2020, analyzed „green” claims on the websites of companies across various sectors (including fashion, cosmetics, food). The results were alarming: 53% of the examined claims were vague, misleading, or unfounded, and 40% lacked any supporting evidence. Newer data from 2023 indicates that over half of the declarations regarding the environmental impact of products are incomplete, misleading, or outright false,
- b) International Consumer Protection and Enforcement Network (ICPEN, 2021) – Reviewed 500 websites of major brands. Many contained problematic environmental claims.
- c) EU Reports – as many as 80% of online stores, websites, and advertisements contain information concerning the environmental impact of products, but over half of these declarations are incomplete, misleading, or outright false. Research shows that 56% of EU consumers have already encountered greenwashing practices.

2) Consumer perception (including in Poland):

- a) „EKObareometr Index” Report (NowyMarketing, 2024) – indicates that nearly 7 out of 10 Poles (68%) support the thesis that ecological slogans are used solely for promotional purposes. Almost 6 out of 10 (58%) complain that companies exaggerate the use of ecology in their marketing campaigns. As many as 57% fear that even well-known environmental activists use ecology for self-promotion. This clearly demonstrates the high level of skepticism and awareness of greenwashing among Polish consumers.

- b) SW Research and ESG Impact Network Studies – indicate that one in three Poles knows what greenwashing is, and over 60% believe that companies abuse ecological slogans.

Conclusions and recommendations

The empirical evidence synthesized within this study confirms that greenwashing in the financial and insurance sectors is not merely an isolated ethical lapse but a structural market failure. This analysis definitively validates both research hypotheses (Table 6):

1. H1 (systemic risk) – the magnitude of unsubstantiated and misleading claims (exceeding 50% in the EU market) fundamentally undermines the integrity of capital allocation, distorting investor signals, and causing a profound loss of confidence. This warrants the reclassification of greenwashing from a reputational issue to a critical systemic risk for the sustainable transition (SDG 13).
2. H2 (regulatory insufficiency) – the current regulatory response (SFDR/Taxonomy) is necessary but demonstrably insufficient to ensure the necessary market transparency. Evasion strategies, such as *Greenhushing* and the exploitation of methodological ambiguities, confirm that compliance is decoupled from genuine environmental impact. Comprehensive mitigation requires additional mechanisms for stringent auditability and standardized disclosure methodologies.

This research advances academic knowledge and policy development through specific, actionable contributions, addressing the identified gaps in the literature (i.e., the lack of empirical comparison of claims vs. operational data in the insurance sector).

Table 6.

Scientific contribution and research Innovation in the context of financial greenwashing

Contribution type	Key finding / new knowledge introduced	Impact on the field
Theoretical & conceptual	refined typology of evasion: formalized the analysis of advanced strategies (<i>greenlighting</i> , <i>greencrowding</i> , <i>greenhushing</i>) as intentional mechanisms for regulatory arbitrage, moving beyond simple marketing misstatements	Provides a more robust framework for risk modeling and regulatory anticipation
Methodological	sector-specific metrics: introduced the insurer investment consistency index (iici) and the correlation between outflow and sustainability abandonment (cosa)	Offers standardized, quantitative tools for supervisors (EIOPA, national regulators) to measure the dual-level risk in the insurance sector
Policy & practical	urgency of standardization: demonstrated that restoring market trust hinges on mandating the full transparency and external auditability of ESG scoring methodologies and data sources	directly informs the necessity for the stringent enforcement of the Green Claims Directive (GCD) as the crucial enforcement pillar

Source: own elaboration based on theoretical and empirical studies.

Recommendations:

Based on the validated systemic risks and regulatory gaps, the following recommendations are proposed, designed to move the market from declarative compliance to verified, auditable sustainability.

The regulatory framework must shift its focus from mere disclosure to enforcement and standardization.

- 1) Mandatory European labeling standard – the EU must immediately implement a uniform, verifiable European labeling system („EU Green Label”) for financial products. This label must be based exclusively on objective, auditable criteria derived from the EU Taxonomy, not on firm-specific scoring models.
- 2) Stringent GCD enforcement – national supervisory bodies (UOKiK, KNF) must establish joint, robust control and sanction procedures explicitly targeting misleading environmental claims in the financial sector's promotional materials, utilizing the full penalty potential (up to 10% of annual turnover).
- 3) Audit and data harmonization – given the mandate of the CSRD, it is critical to mandate external assurance (limited or reasonable) for all material ESG disclosures, anchoring verification procedures in international standards such as ISAE 3000 (Revised) or the forthcoming ISSA 5000, thereby ensuring cross-border comparability.
- 4) Methodology disclosure mandate – financial institutions must be legally required to publicly disclose the full methodology used to assess the sustainability of products (including scoring models, data sources, and exclusion criteria), enabling investors and regulators to independently verify their claims.

Institutions must embed greenwashing risk into their core governance and operational control mechanisms.

- 1) Integrated ERM Framework – greenwashing risk must be formally integrated into the Enterprise Risk Management (ERM) framework, treating it as a financial, legal, and operational risk, not solely a reputational one.
- 2) Internal due diligence and audits – insurers and asset managers must implement independent, periodic internal ESG audits that directly verify the consistency between marketing communication and actual investment/underwriting portfolios, explicitly using metrics like the IICI to detect discrepancies.
- 3) Ethical and competence upgrade – mandatory, continuous training must be implemented for all staff, particularly those in sales, marketing, and portfolio management, to build ESG competence and establish a clear internal code of conduct with sanctions for deliberate disinformation.

Future research must focus on quantitative, technology-driven methods to enhance detection capabilities.

- 1) Advanced detection tools – further development and deployment of artificial intelligence (AI) and text mining algorithms are recommended for the automatic, large-scale detection of manipulative narrative greenwashing in unofficial sources (social media, corporate blogs) that evade traditional reporting controls.
- 2) Longitudinal monitoring – future academic studies must prioritize longitudinal panel data analysis, utilizing the IICI and COSA indicators to quantify the long-term effectiveness of regulatory interventions (SFDR, GCD) on actual changes in institutional behavior.
- 3) Perception and behavior – dedicated qualitative and experimental research is essential to fully understand how retail consumers and insurance clients interpret the growing volume of ESG information and how their ability (or inability) to detect greenwashing influences their purchasing decisions.

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STRUCTURE OF SUSTAINABLE BOND ISSUANCES IN THE VISEGRAD GROUP COUNTRIES IN YEARS 2020-2024

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Purpose: The aim of the study is to assess the degree of concentration in the ESG bond market issued in the Visegrád Group (V4) countries in the years 2020-2024, based on the number and value of bond issuances, the type of bonds, and the type of issuer.

Design/methodology/approach: The study employed both qualitative and quantitative methods. Initially, a critical analysis of national and international literature on the subject was conducted. Subsequently, in order to assess the degree of market concentration, the Herfindahl-Hirschman Index (HHI) was utilized, calculated based on data obtained from the EFD database.

Findings: The analysis of the value of ESG bond issuances in the Visegrád Group countries in the years 2020-2024 indicates a persistent and very high geographic concentration of the market. In each of the years analyzed, the vast majority of issuance value was generated by two or three countries, which is confirmed by the Herfindahl-Hirschman Index (HHI) values ranging from 0,342 to 0,395. According to the adopted interpretative scale, these values are characteristic of an oligopolistic market structure.

Research limitations/implications: The short temporal horizon of the analysis, resulting from the gradual development of the ESG debt instruments market in the analyzed countries.

Practical implications: The study conducted holds practical value for both market regulators and financial market participants. The research findings can serve as a basis for further analyses concerning the development of the ESG debt securities market.

Originality/value: To date, no studies have been conducted to assess the level of concentration in the ESG debt instruments market in the Visegrád Group countries. Therefore, the study should be regarded as innovative.

Keywords: green debt securities, sustainable bonds, market concentration.

Category of the paper: Research paper.

1. Introduction

The intensive development of the sustainable financial instruments market is one of the most significant manifestations of the evolution of international financial markets. Alongside the growing importance of environmental, social, and governance (ESG) objectives, there has been not only an intensification of issuances of specialized debt instruments but also a deepening institutionalization of the principles governing their functioning. Standards such as those developed by the International Capital Market Association (ICMA) (e.g., Green Bond Principles, Social Bond Principles), the Climate Bonds Initiative (CBI) (e.g., Climate Bonds Standard), and the European Green Bond Standard (EUGBS) are creating an increasingly complex regulatory architecture aimed at enhancing market transparency, reducing information asymmetry, and minimizing the risk of greenwashing. At the same time, the latest data indicate that this market is becoming increasingly diverse in terms of issuer structure, financing objectives, and the geographic conditions of capital supply.

Despite the growing interest in the sustainable instruments market, in-depth analyses of the ESG bond market structure and its implications for allocative efficiency, cost of capital, and investment risk profile are still lacking. Previous studies have primarily focused on the integration of environmental, social, and governance objectives (Vulturius et al., 2022), differences between types of instruments (Taghizadeh-Hesary et al., 2021), or the analysis of allocation directions of funds from sustainable bonds (Mishra et al., 2023). Meanwhile, the degree of concentration in the sustainable instruments market is a critical parameter for its assessment, which has so far been insufficiently explored and constitutes a significant research gap.

The aim of this article is to assess the degree of concentration in the ESG bond market issued in the Visegrád Group (V4) countries in the years 2020-2024, across four dimensions: 1) value dimension (the value of ESG bond issuances), 2) quantitative dimension (the number of ESG bond issuances), 3) type dimension (types of green bonds), and 4) sectoral dimension (according to the type of ESG bond issuer). The analysis period covers full calendar years from the moment ESG bond issuances became widespread in the V4 countries. The Herfindahl-Hirschman Index (HHI) was used as a measure of market structure.

The study tests the following hypotheses:

- **H1:** In the years 2020-2024, ESG bond issuances in the V4 countries were characterized by a high level of concentration, both in terms of the nominal value of issuances and the number of issuances carried out.
- **H2:** In the years 2020-2024, the green bond segment had the highest share within the ESG bond sector, indicating that it constitutes the dominant category among all instruments financing sustainable development.

- **H3:** In the years 2020-2024, concentration of ESG bond issuers occurred primarily in the financial sector, and this sector served as the leading issuer in the ESG bond market.
- **H4:** In the years 2020-2024, among the V4 countries, Poland played a leading role in the number of issuances compared to other countries in the region.

The results of the ESG bond market concentration analysis are primarily useful for regulators and supervisory institutions, as they support the design of policies that foster the development of sustainable financing and mitigate systemic risk. At the same time, they serve as a source of knowledge for issuers considering entry into the ESG market. From the perspective of institutional investors, the study's findings provide information on the degree of concentration, which may affect risk assessment, pricing efficiency, and portfolio diversification opportunities. Moreover, this analysis responds to the growing demand within the academic community for in-depth research on the structure of the sustainable instruments market.

The further structure of this article is as follows: the second section presents a review of the existing literature. The third section outlines the research methodology employed. The fourth section discusses the results of the empirical analysis, while the fifth section contains the discussion and concluding remarks.

2. Bonds as instruments for financing sustainable development – literature review

The achievement of sustainable development goals (UN Agenda 2030, 2016) requires the mobilization of appropriate resources to implement sustainable investments. One solution increasingly employed in this area is bonds, whose significance has been steadily growing. Their emergence responded both to the demand from enterprises and organizations for environmentally oriented forms of capital raising and to investors seeking to consciously allocate their capital to projects with ESG relevance. Bonds financing sustainable development can be classified according to various criteria, including the type of issuer, maturity period, interest rate structure, or form of collateral. According to the World Bank, bonds issued for the purpose of financing sustainable investments are debt securities distinguished from other bonds by the objective of issuance (The World Bank, 2015). By definition, the only factor that differentiates ESG bonds from traditional bonds is the issuance purpose, i.e., the scope of use of funds raised from the bond issuance for implementing sustainable investments. According to the European Parliament, environmentally sustainable bonds are among the main instruments for financing investments related to environmentally sustainable technologies, energy efficiency, and resource efficiency, as well as environmentally sustainable transport infrastructure and research infrastructure. Such bonds may be issued by financial and non-

financial enterprises, as well as non-enterprise entities, such as sovereign debt issuers. Sustainable development-linked bonds are exclusively those whose financial or structural characteristics depend on whether the issuer achieves predetermined environmental sustainability targets (European Parliament Regulation, 2023).

In the international financial market, in order for bonds to be recognized as financing sustainable development, they must undergo a certification process overseen by the International Capital Market Association (ICMA), a globally recognized institution issuing widely accepted guidelines in this area. Considering the purpose of issuance, the following types of so-called ESG bonds can be distinguished (Kiertowicz et al., 2025; ICMA, 2025):

- green bonds, the proceeds of which are used to fully or partially finance or refinance new or existing environmentally beneficial projects,
- social bonds, the proceeds of which are used to finance social projects,
- sustainability bonds, the proceeds of which are used to finance both environmental and social projects,
- Sustainability-Linked Bonds (SLB), the proceeds of which serve to finance and support enterprises contributing to sustainable development (from the perspective of environmental, social, or governance objectives),
- Climate Transition Bonds (CTB), the proceeds of which are allocated to support the (re)financing of key projects aimed at achieving the goals of the Paris Agreement, especially in high-emission sectors and/or activities (“high-emission issuers”).

For the purposes of this article, the classification of ESG bonds proposed by ICMA will be applied.

Some authors propose a further subdivision of ESG bonds, distinguishing, among others, blue bonds, forest bonds, and stable bonds. Blue bonds are debt instruments issued by governments, development banks, or other entities to raise capital from environmentally conscious investors for financing marine and ocean projects that generate positive environmental, economic, and climate benefits. Their purpose is to secure funding for projects related to ocean and inland water protection, as well as the development of the so-called blue economy, which includes sustainable fisheries, water waste management, and biodiversity conservation (Bosman, de Mariz, 2023). Forest bonds, in turn, are issued to raise capital for sustainable forest management, environmental protection, and forestry-related projects. They respond to the growing investment needs in the forestry sector, particularly in the context of combating deforestation and the degradation of forest ecosystems (Laskowska, 2020). Stable bonds are a type of ESG bond issued to finance projects that ensure the achievement of environmental and social objectives (Levytska et al., 2024).

Proceeds from ESG bond issuances should be allocated to projects that contribute to the achievement of social, governance, and environmental objectives. The environmental objective relates to climate change, as well as the reduction of energy consumption, pollutant emissions, and waste management. Social aspects include respect for human rights and the promotion of

diversity and equality, regardless of gender or background. The governance criterion primarily concerns issues related to the protection of shareholder rights. The categories used to qualify projects financed through ESG bonds include, among others, the following areas: renewable energy; energy efficiency; pollution prevention; clean transportation (e.g., electric transport and reduction of harmful emissions); eco-efficient products, technologies, and production processes; and green buildings meeting applicable standards and certification requirements (Frydrych, 2023).

One of the criteria for classifying ESG bonds, according to which certified and non-certified bonds can be distinguished, is compliance with certain standards (so-called certification) (Weber et al., 2016, p. 388). The absence of internationally recognized standards in the issuance of green bonds may reduce their credibility among potential investors. Consequently, many issuers choose to utilize certifications developed by reputable and specialized institutions in this field.

Among the most widely used ESG bond standards, whose proceeds are allocated to sustainable investment projects, are those developed by ICMA. These principles are applied by the market and constitute voluntary procedural guidelines that recommend transparency and full disclosure, while promoting integrity in the development of the green bond market by clarifying all details of the issuance process. They provide issuers with guidance on launching bond issuances to finance ESG projects and, by promoting accessibility, accuracy, and integrity of information, help investors assess the environmental impact of their investments. The recommendations contained in these principles particularly pertain to four aspects presented in Table 1.

Table 1.

Criteria included in the Principles for green, social, and climate transition bonds

Aspect			
Use of Proceeds	Process for Project Evaluation and Selection	Management of Proceeds	Reporting
Green Bond Principles			
The use of proceeds from green bonds to finance projects that are appropriately described in the documentation and qualify as “green,” providing clear and indisputable environmental benefits. Bond issuance should contribute to the achievement of environmental objectives such as climate change mitigation, climate change adaptation, protection of natural	The issuer should disclose to investors: the environmental sustainability objectives of the eligible Green Projects; the process by which the projects are aligned with the eligible project categories; and additional information on the processes through which the issuer identifies and manages perceived social and environmental risks associated with the given project(s).	The funds raised should be recorded in a separate sub-account to ensure that they are used exclusively to finance green projects. The issuer should inform investors about the planned types of investment of any unallocated net proceeds. The proceeds from the issuance may be managed on an individual basis (bond-by-bond approach) or collectively in the case	The issuer should make available and regularly update reports on the level of utilization of the funds raised, while indicating the projects that have been or are being financed with the proceeds. Information should be provided either in general terms or in aggregated form (e.g., expressed as percentages allocated to specific project categories). The issuer should apply qualitative performance indicators

resources, conservation of biodiversity, and pollution prevention and control.		of multiple green bonds (portfolio approach).	and, where possible, quantitative performance measures, and disclose the key methodology and/or assumptions used in the quantitative assessment of impact.
Social Bond Principles			
The use of bond proceeds for social projects that should deliver clear social benefits. These projects include assets, investments, and activities, as well as other related and supporting expenditures, such as research and development, which may fall into more than one category. Such categories include, among others: water and sanitation infrastructure; access to essential healthcare and educational services; access to housing; job creation; ensuring food security; and socio-economic advancement and empowerment.	The issuer should present to investors: the social objectives; the process used by the issuer to classify projects as social in accordance with the categories listed above; the eligibility criteria and, where possible, any criteria for the potential exclusion of projects; as well as the process for identifying potential risks related to the implementation of social and environmental projects.	Proceeds from the issuance, or an equivalent amount, should be deposited into a sub-account, transferred to a separate portfolio, or otherwise appropriately monitored by the issuer, and reflected in the issuer's formal internal procedures related to its credit and investment policy concerning social projects.	Issuers should collect and disclose information regarding the use of proceeds from the issuance. This information should be updated annually until the proceeds are fully allocated and promptly in the event of material changes. The annual report should include a list of projects to which social bond proceeds have been allocated, along with a brief description of the projects and their expected impact, as well as the amounts allocated.
Climate Transition Bond Guidelines			
The basis is the use of proceeds from bonds for eligible Climate Transition (CT) projects, which should be appropriately described in the legal documentation. CT projects are defined as encompassing assets, investments, and activities, early retirement and decommissioning, as well as other expenditures, such as research and development related to high-emission activities, which lead to a significant and measurable avoidance, reduction, or removal of greenhouse gas emissions. CT projects	Issuers should provide information regarding eligibility criteria, safeguards, classification, and, where applicable, exclusions for CT projects. This should include any links or alignment with official sectoral and market taxonomies, decarbonization pathways and plans, and/or other international and national decarbonization policy frameworks. Issuers should clearly communicate to investors the processes for mitigating significant negative social or environmental impacts. This should cover how "just transition," climate change adaptation, and the protection of nature and biodiversity are taken into account.	Net proceeds from CTBs, or an amount equivalent to such net proceeds, should be recorded in a sub-account, transferred to a sub-portfolio, or otherwise appropriately monitored by the issuer, and also verified by the issuer through a formal internal process related to the issuer's lending and investment activities concerning eligible CT projects and any other eligible projects.	Issuers should provide and maintain easily accessible, up-to-date information on the use of proceeds—annually until full allocation and promptly in the event of material occurrences. The annual report should include a list of projects to which CTB proceeds have been allocated, along with a brief description of the projects, the amounts allocated, and their expected impact.

complement and go beyond the scope of Green Projects under the GBP, aiming to achieve the objectives of the Paris Agreement.			

Source: ICMA, 2025b; ICMA, 2025c; ICMA 2025d.

In the case of Sustainability Bonds, the guidelines indicate that these bonds meet the four fundamental criteria of the Principles (Table 1) for green and social bonds, with the former being particularly relevant for eligible green projects and the latter for eligible social projects (ICMA, 2021). The Principles for sustainability-linked bonds are process guidelines that present best practices for financial instruments to incorporate ESG performance forecasts and promote integrity in the development of the market for these bonds by specifying the approach to issuance. The Principles consist of five key elements: the selection of Key Performance Indicators (KPIs); the calibration of sustainability performance targets; bond characteristics; reporting; and verification (ICMA, 2024).

In 2010, the Climate Bonds Initiative (CBI) was established, an international organization working to mobilize global capital and climate action. CBI developed and introduced its system of standards and certification for climate bonds, defining them with reference to green bonds. The system was launched in 2012 to strengthen confidence in the credibility of green bonds and other debt instruments addressing climate change, as well as to facilitate investment decision-making (CBI, 2024, p. 2). The Climate Bond Standard specifies the requirements that issuers must meet to obtain a green certification for a bond, loan, or other debt instrument. The requirements are divided into those to be fulfilled before the issuance of financial instruments and those to be met after issuance. The CBI standards and certification system includes:

- Climate Bond Standard, serving as the overarching system (currently Version 4.2, effective from June 2024).
- Climate Bonds Taxonomy, for the purposes of climate bonds.
- Sector Eligibility Criteria.
- Certification guidelines and documentation (Lipowicz, 2023).

Regardless of international ESG bond initiatives and standards, the European Union has introduced legal regulations in this area. As of 21 December 2024, European Parliament Regulation 2023/2061 came into effect, establishing the European Green Bond Standard (EUGBS). The regulation sets out a detailed set of requirements for bonds issued by financial and non-financial enterprises, as well as sovereign debt issuers, who wish to use the label “European Green Bond” or “EuGB” in relation to such bonds. Issuers are required to link proceeds to investments aligned with the EU Sustainable Finance Taxonomy and to comply with strict reporting and external verification requirements. The objective is to increase transparency and prevent greenwashing. The regulation establishes a voluntary standard, but its adoption is intended to encourage the issuance of high-quality, credible bonds.

EuGBs must be assessed by external verifiers, for whom a registration and supervision system has been established. Issuers are required to complete information templates prior to issuance and to publish allocation reports every 12 months (European Parliament Regulation, 2023). The most significant difference between the EU Green Bond Standard (EUGBS) and other standards is the alignment of the former with European legal regulations, including the so-called Taxonomy, i.e., the regulation defining the framework for sustainable investments.

According to the CBI report, the global sustainable bond market reached a record level of USD 6.5 trillion by the end of the third quarter of 2025, measured according to the adopted methodology, and also demonstrated a strong presence in Europe, providing a significant stimulus to local markets. Various segments of the sustainable bond market are developing at different rates, as indicated by their share of issuance value: green bonds accounted for 61%, social bonds for 19%, sustainability bonds for 19%, and sustainability-linked bonds for 1%. ESG bond issuers are primarily large corporations (27%), financial institutions (26%), development banks (22%), and governments and municipalities (16%). The main currencies of issuance are EUR and USD (CBI, 2025).

According to Lindner and Chung (2023), ESG bonds provide issuers with the opportunity to achieve environmental, social, and governance objectives at lower financing costs while simultaneously diversifying the investor base. Financing environmental and social goals through ESG bonds helps demonstrate the issuer's commitment to these objectives and strengthens ESG-focused expenditures. In emerging markets, both domestic and international ESG bonds have contributed to investor base diversification, although issuing ESG bonds in a small or underdeveloped local bond market in the local currency may lead to market fragmentation and conflict with the objectives of low-cost financing and market development. Lindner and Chung identify the main drivers of ESG bond issuance as follows: emphasizing commitment to environmental and social objectives, the Paris Agreement, and the UN Sustainable Development Goals, while increasing the issuer's international visibility; strengthening ESG capital markets and building a green yield curve; accessing cost-effective financing, particularly for ESG-related projects; and expanding and diversifying the investor base. They note that most ESG bond issuances by developing countries have occurred on international bond markets, due to strong investor demand for ESG bonds. This market is primarily concentrated on USD and EUR denominated issuances, issued under New York or UK law, and serviced by a group of intermediaries - banks, advisors, law firms, and SPO (Second Party Opinion) providers - which have introduced a high degree of standardization to the global ESG bond market, facilitating access for both investors and issuers. However, with regard to domestic ESG bond issuance, countries must balance the opportunities offered by local issuance with the risk of fragmenting the domestic bond market. The authors highlight that many ESG bond issuances are syndicated, with one of the key factors behind this preference being issuers' desire to secure a significant share of ESG-focused investors in their investor base. Syndicate members can engage with ESG investors, helping the

issuer achieve two objectives: diversifying the investor base and promoting its environmental credentials. Syndicated issuances also allow the issuer to direct allocations to specific investors, typically giving priority to ESG-focused investors. Syndicated issuances, supported by a sustainable structuring advisor, help build credible issuance frameworks, select projects, and streamline inter-agency coordination within the issuer's government.

The dynamic development of the ESG bond market in Europe demonstrates the important role regional markets can play in promoting sustainable development. According to a report prepared by the Jagiellonian Institute and the Polish Wind Energy Association, in Poland between 2025 and 2040, as part of sustainable development investments, funds are primarily expected to be allocated to financing the transition to more sustainable energy sources, modernizing transport infrastructure, and adapting buildings and agriculture, with sustainable bonds serving as a key financing instrument (Olszewska, 2024). Research conducted by Frydrych (2023) for the global market on the objectives of ESG bond issuance indicates that the issuance of ESG debt instruments for a selected objective is related to the number of issuances for other objectives. In the period analyzed (2012–2021), 40.11% of bonds were issued by the financial sector (banks and other financial entities), while non-financial entities also had a significant share in ESG bond issuance. Considering ESG bond issuances, the “Clean Transport” objective accounted for 20.65% of all instruments issued. It was also shown that there is a relationship between sectors and ESG bond issuance objectives, although the strength of this relationship is weak. Moreover, a strong positive correlation was observed between ESG bond issuance objectives such as clean transport, energy efficiency, eligible Green Projects, green buildings, and alternative energy. Conversely, a weak inverse correlation was observed between objectives such as climate change adaptation and renewable energy projects, as well as climate change adaptation and alternative energy. De Mariz (2022) notes that the issuance of the four types of bonds classified according to ICMA reached a record level globally in 2021. Sustainability bond issuance now represents nearly 10% of total bonds issued by the public sector and is expected to grow. More than 60% of asset inflows go to asset managers based in the European Union (EU), and the issuances were aligned with ESG principles. Although Europe constitutes the largest market for these bonds within global sustainability bond issuance, other regional markets are catching up. Emerging markets (EM) accounted for 21% of total bond issuance in 2021, and while there remain some barriers to sustainable financing in emerging markets, lessons learned from the development of other markets, particularly Brazil, can be useful for policymakers in developing countries.

Climate and sustainability-linked bonds can provide financing to African governments and corporations for projects that help mitigate climate change, combat biodiversity loss, and support sustainable development. However, less than 0.3% of the global ESG bond issuance volume is allocated to projects in Africa. The African Development Bank, several private banks, and a few publicly listed companies operating in the renewable energy sector issue ESG bonds. In most cases, foreign asset managers are involved, and ESG bonds are often denominated in

foreign currencies to attract international investors. Additionally, a number of sovereign ESG bonds have been issued in Africa, with Egypt and Nigeria showing the highest activity. Certification of ESG bonds, as opposed to self-labeled bonds, is particularly important, as non-certified ESG bonds do not offer similar benefits. Obtaining certification reduces information asymmetry and signals higher bond quality, making certification advantageous for both issuers and investors. This indicates that green macroeconomic policies and financial regulations that reduce information asymmetry should positively impact the development of the African ESG bond market. The study confirms the view that the potential for ESG bond issuance in Africa is enormous and largely untapped (Mutarindwa et al., 2024).

The need for sustainable infrastructure development in India has prompted the search for innovative financing mechanisms, with ESG bonds emerging as a key solution. The potential of ESG bonds to mobilize financial resources for environmentally sustainable projects is evident in several key sectors, including renewable energy, transport, and waste management. Sustainability bonds have a dual impact, generating both environmental and economic benefits. They help reduce carbon dioxide emissions by enabling investments in renewable technologies and efficient infrastructure. Furthermore, these bonds positively influence economic growth by stimulating innovation and creating jobs in green technology sectors (Singh, 2025).

Analysis of the green bond market in Europe indicates that European issuers are dominated by green instruments denominated in EUR, with fixed coupons and maturities of 3-6 years. ESG bonds are most commonly found in sectors where the natural environment is financially significant for business operations, including utilities, real estate, industrials, basic materials, energy, and technology, supporting this hypothesis. The issuance objectives of these bonds by European issuers align with the Climate Bond Standard and the Green Bond Principles. Proceeds from green bond issuances are allocated to objectives such as Eligible Green Projects, Clean Transport, Green/Certified Buildings, Renewable Energy Projects, and Alternative Energy (Frydrych, 2021).

Considering the Visegrad Group (V4) countries, the main issuers of green bonds are the public sector (Poland 66% of total issuance, Hungary 86%) and state-controlled enterprises (Poland – the largest bank and the largest oil company). In the Czech Republic and Slovakia, issuers are primarily private enterprises. The involvement of the public sector is essential for the development of the green bond market, as governments, and particularly the companies dependent on them, should pursue sustainable development and invest in this area. While this is a necessary condition, it is not sufficient. Greater attention should be given to private enterprises (both financial and non-financial institutions) that invest in sustainable development and should be interested in raising capital through green bond issuance (Hadaś-Dyduch et al., 2022).

3. Research methodology

To achieve the research objective adopted in this study, the Herfindahl–Hirschman Index (HHI) was applied. This index is one of the most commonly used measures of market concentration in economics and finance. It serves to assess the extent to which a given market, sector, or economic aggregate (e.g., bond issuances, bank assets, or a country's share in the green bond market) is dominated by a limited number of entities. In empirical research, the HHI is widely used in analyses of sectoral, banking, and regional concentration, as well as in studies of financial markets, including the bond market and ESG instruments.

The HHI was independently proposed by Herfindahl in his 1950 doctoral dissertation and by Hirschman, who popularized the index in an article published in the *American Economic Review* (Herfindahl, 1950; Hirschman, 1964). The HHI is defined as the sum of the squares of the market shares of individual entities:

$$HHI = \sum_{i=1}^N s_i^2,$$

where:

s_i – denotes the market share of the i -th entity,

N – number of entities.

The index values range from 0 to 1 (or alternatively from 0 to 10 000 depending on the scale used). It should be emphasized that the original authors of the index did not propose formal interpretative thresholds. The HHI was initially intended as a comparative tool, used to analyze relative differences in market concentration and its changes over time. One of the first systematic attempts to interpret HHI values was presented by Rhoades (1993), who indicated that values below 0,10 are characteristic of fragmented markets, while an increase in the HHI signals a shift toward oligopolistic market structures.

The most widely used and commonly applied interpretative thresholds were later introduced in competition policy guidelines by the U.S. Department of Justice and the Federal Trade Commission (DOJ/FTC, 2010; 2023). According to this approach, markets with an HHI value below 0,15 are considered low-concentration, those in the range of 0,15-0,25 are considered moderately concentrated, and values above 0,25 indicate high concentration. OECD documents on market concentration and competition policy use the HHI as a standard measure of concentration, referring to similar interpretative ranges applied in regulatory practice (OECD, 2018).

At the same time, academic literature indicates that for markets with elevated concentration, further differentiation of HHI levels is necessary. Scherer and Ross (1990) and Rhoades (1993) emphasize that values exceeding 0,30 are characteristic of oligopolistic structures, while further increases in HHI indicate an increasingly strong dominance of one or several entities. Research in the banking sector additionally suggests that HHI values above

0,40-0,50 can be interpreted as very high concentration, approaching a quasi-monopoly (Bikker, Haaf, 2002).

In the literature, there is no single, universal interpretative scale for the Herfindahl-Hirschman Index. However, specific HHI thresholds are widely applied in industrial economics research, competition policy, and sectoral analyses (Rhoades, 1993; Scherer, Ross, 1990; Bikker, Haaf, 2002; OECD, 2018; DOJ/FTC, 2010; 2023). In this study, a synthetic interpretative scale integrating these approaches was adopted, tailored to the specifics of the ESG bond market in the V4 countries. The adopted scale is intended for organizational purposes and empirical interpretation, rather than for normative market classification. The principles for interpreting HHI values are presented in Table 2.

Table 2.
Interpretation of HHI values

HHI	Interpretation
$0.00 \leq \text{HHI} < 0.10$	low concentration (fragmented market)
$0.10 \leq \text{HHI} < 0.20$	moderate concentration
$0.20 \leq \text{HHI} < 0.30$	high concentration
$0.30 \leq \text{HHI} < 0.40$	very high concentration (oligopoly)
$0.40 \leq \text{HHI} < 0.60$	extremely high concentration
$\text{HHI} \geq 0.60$	quasi-monopoly / monopoly

Source: own elaboration based on Rhoades (1993), DOJ/FTC (2010, 2023), Scherer, Ross (1990), Bikker, Haaf (2002).

In this study, the research period covers the years 2020-2024. This is due to the fact that the ESG-related bond market in the Visegrad Group countries only began to develop from 2020 onwards. It should be noted, however, that individual issuances occurred earlier. The first took place in Poland in 2016, consisting of a green bond worth USD 791.86 million, issued by the Republic of Poland. In 2017, no issuances were recorded among the V4 countries. Another single issuance occurred in 2018, again in Poland, amounting to USD 1,234 million, also issued by the Republic of Poland. In 2019, the ESG bond market saw a revival, with four issuances, all green bonds in Poland totaling USD 2,405.63 million, issued by the Republic of Poland. The breakthrough year was 2020, when, in addition to Poland, Hungary also joined the group of issuers. In Slovakia, the first issuance occurred only in 2021.

In this article, the concentration of ESG bond issuances in the V4 countries will be analyzed across the following dimensions: total issuance value, type of bond, and type of issuer. The data used in the study were sourced from the Environmental Finance Data database (efdata.org).

4. Research results

4.1 Analysis of concentration in the value of ESG-related bond issuances in the V4 countries in 2020-2024

The analysis of the value of ESG-related bond issuances in the Visegrad Group countries over the period 2020-2024 indicates a persistent and very high level of geographical concentration of the market. In each of the analyzed years, the vast majority of issuance value was generated by two or three countries, which is confirmed by the values of the Herfindahl-Hirschman Index (HHI), ranging from 0.342-0.395. According to the adopted interpretative scale, these values are characteristic of an oligopolistic market structure.

At the same time, attention should be paid to the distribution of the number of issuances across individual years. Hungary was the leader in terms of the number of bonds issued in the period 2020-2024; however, this did not always translate into the highest issuance value within the V4 group. As shown by the data presented in Tables 3-6, in 2021, 2023, and 2024 Hungary accounted for the largest number of issuances, while the Czech Republic was the leader in terms of issuance value. This points to significant differences between issuance intensity and the financial scale of individual bond issuances.

Table 3.

Number and value of ESG-related bond issuances in the V4 countries in 2020 (USD million)

Country	Number of issuances	Value	Share (%)
Czechia	2	1234.38	29.02%
Hungary	6	2237.83	52.61%
Poland	3	781.31	18.37%
Slovakia	0	0.00	0.00%
Total	11	4253.52	100%

Source: own calculation based on efdata.org

The ESG bond market in 2020 (Table 3) in the V4 countries was dominated by Hungary, which carried out six issuances and accounted for more than half of the total issuance value (52.61%). A significant role was also played by the Czech Republic (29.02%), while Poland's share was relatively small (18.37%). Slovakia did not record any issuances. Such a structure, in which two countries generate more than 80% of the total issuance value, is reflected in the Herfindahl-Hirschman Index (HHI) value of 0.395, which, according to the adopted interpretation scale, indicates a very high level of market concentration with a clear dominance of Hungary.

Table 4.*Number and value of ESG-related bond issuances in the V4 countries in 2021 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	6	3554.76	49.05%
Hungary	20	1620.36	22.36%
Poland	4	1554.49	21.45%
Slovakia	3	518.20	7.15%
Total	33	7247.80	100%

Source: own calculation based on efdata.org

In 2021 (Table 4), a more balanced market structure was observed compared to 2020. The Czech Republic remained the largest issuer in terms of value (49.05%); however, the activity of Hungary (22.36%) and Poland (21.45%) was comparable. Slovakia issued ESG bonds for the first time, reaching a 7.15% share of the total issuance value in the V4 countries. The diversification of issuance values among the four countries resulted in a decline in the HHI to 0.342, the lowest level in the entire analyzed period. Despite this a temporary decrease in concentration, according to the adopted interpretation scale, the market in 2021 was still characterized by very high concentration, typical of an oligopolistic structure, although with lower intensity than in the previous year.

Table 5.*Number and value of ESG-related bond issuances in the V4 countries in 2022 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	3	1943.30	25.93%
Hungary	38	4103.84	54.77%
Poland	2	584.79	7.80%
Slovakia	6	861.07	11.49%
Total	49	7493.00	100%

Source: own calculation based on efdata.org

The following year, i.e. 2022 (Table 5), was characterized by a return to a pronounced asymmetry in the distribution of ESG bond issuance values in the V4 countries. Hungary, with 38 issues, accounted for more than half of the total issuance value (54.77%), the Czech Republic for 25.93%, while Poland and Slovakia recorded relatively small shares (7.80% and 11.49%, respectively). The market structure once again assumed an oligopolistic form with a clear leader, which was reflected in an increase in the HHI to 0.387. According to the adopted interpretation scale, this indicates a very high level of concentration, higher than in 2021.

Table 6.*Number and value of ESG-related bond issuances in the V4 countries in 2023 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	2	4425.50	39.36%
Hungary	15	3691.93	32.84%
Poland	9	2676.68	23.81%
Slovakia	2	448.98	3.99%
Total	28	11 243.08	100%

Source: own calculation based on efdata.org

The proportions of issuance values among the three V4 countries became slightly more balanced in 2023 (Table 6). The Czech Republic accounted for 39.36% of the ESG-related bond market value, Hungary for 32.84%, and Poland for 23.81%. Slovakia was the only V4 country to lag clearly behind the others in terms of issuance value, accounting for a share of 3.99%. The market was therefore mainly shaped by the three largest economies of the region, and the level of concentration declined compared to 2022, although according to the adopted interpretation scale it remained very high ($HHI = 0.376$). At the same time, this was the second most balanced year in the analysed period, after 2021.

Table 7.

Number and value of ESG-related bond issuances in the V4 countries in 2024 (USD million)

Country	Number of issuances	Value	Share (%)
Czechia	10	4425.50	39.40%
Hungary	14	3691.93	32.80%
Poland	11	2676.68	23.80%
Slovakia	5	448.98	4.00%
Total	40	11 243.08	100%

Source: own calculation based on efdata.org

In 2024 (Table 7), the structure of ESG-related bond issuance values was almost identical to that observed in 2023. The Czech Republic, Hungary, and Poland jointly accounted for 96% of the total issuance value, while Slovakia's share amounted to 4%. The HHI value of 0.321 indicates that the market maintained a very high level of concentration, characteristic of an oligopolistic structure, with a stable distribution of shares among the three main issuers.

In summary, the concentration of ESG-related bond issuance values in the V4 countries in the period 2020-2024 remained persistently very high, as all HHI values fell within the range of 0.30-0.40. Hungary and the Czech Republic played a key role, alternately dominating in individual years. Poland gradually increased its importance, reaching a stable share of approximately 24% from 2021 onwards, whereas Slovakia remained a marginal issuer throughout the entire analysed period.

4.2 Analysis of concentration in the value of ESG-related bond issuances by type of instrument in the V4 countries in 2020-2024

The analysis of the structure of ESG-related bond issuance in the V4 countries by instrument type (Tables 8-12) shows that the period 2020-2024 was characterized by very high concentration, particularly in the green bonds category, with a relatively small share of sustainability-linked bonds. In most years, the market for a given bond category was dominated by a single country, which is directly reflected in the very high values of the Herfindahl-Hirschman Index.

Table 8.

Value of ESG-related bond issuances by instrument type in the V4 countries in 2020 (USD million)

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1234.38	0.00	0.00	0.00
Hungary	2237.83	0.00	0.00	0.00
Poland	255.37	0.00	525.95	0.00
Slovakia	0.00	0.00	0.00	0.00
Total	3727.58	0.00	525.95	0.00

Source: own calculation based on efdata.org

In 2020 (Table 8), issuances concerned almost exclusively green bonds, and the market was largely divided between two countries: Hungary and the Czech Republic. Poland issued only small amounts of green bonds and SLBs, while Slovakia did not record any issuances. The HHI value of 0.783 indicates an extremely high concentration, typical of a situation in which 1-2 countries account for nearly the entire issuance value. The analysis shows that these countries are the Czech Republic and Hungary, both issuing only green bonds.

Table 9.

Value of ESG-related bond issuances by instrument type in the V4 countries in 2021 (USD million)

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	3554.76	0.00	0.00	0.00
Hungary	1620.36	0.00	0.00	0.00
Poland	1298.83	0.00	255.66	0.00
Slovakia	518.20	0.00	0.00	0.00
Total	6992.14	0.00	255.66	0.00

Source: own calculation based on efdata.org

The ESG bond market in the V4 countries in 2021 (Table 9) was characterized by an extremely high concentration (HHI = 0.932), indicating that issuances were practically dominated by a single type of instrument. The vast majority consisted of green bonds, with a total value of USD 6992.14 million, which was more than 27 times higher than the value of the second instrument present, sustainability-linked bonds (USD 255.66 million). The issuance structure shows that the Czech Republic accounted for half of the entire green bond market in the region, while Hungary and Poland had significant but noticeably smaller shares, and Slovakia played a marginal role. SLBs appeared exclusively in Poland and had a marginal significance compared to the dominance of green bonds. It should also be noted that there were no issuances in the sustainability bond or social bond categories.

Table 10.

Value of ESG-related bond issuances by instrument type in the V4 countries in 2022 (USD million)

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1280.47	0.00	662.83	0.00
Hungary	4103.84	0.00	0.00	0.00
Poland	584.79	0.00	0.00	0.00
Slovakia	861.07	0.00	0.00	0.00
Total	6830.17	0.00	662.83	0.00

Source: own calculation based on efdata.org

The structure of ESG-related bond issuances in the V4 countries in 2022 (Table 10) exhibited a quasi-monopolistic pattern ($HHI = 0.839$), although the level of concentration was slightly lower than in 2021. This indicates that the market remained highly unbalanced and largely dependent on a single dominant segment, namely green bonds, as well as on the activity of selected countries. Hungary was by far the largest issuer of green bonds (4103.84 million USD), accounting for over 60% of the total value of green bond issuances in the region. The Czech Republic held the second position and was the only country issuing sustainability-linked bonds, which only slightly increased the diversity of instruments. Poland and Slovakia held a relatively small share of the market, while no issuances of sustainability bonds or social bonds were recorded.

Table 11.

Value of ESG-related bond issuances by instrument type in the V4 countries in 2023 (USD million)

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1085.66	0.00	0.00	0.00
Hungary	1172.35	0.00	0.00	0.00
Poland	1539.31	430.64	808.37	801.90
Slovakia	637.89	0.00	0.00	0.00
Total	4435.21	430.643	808.37	801.90

Source: own calculation based on efdata.org

In 2023 (Table 11), a significant change occurred in the structure of ESG-related bond issuances in the V4 countries. Poland was the only country issuing all four types of instruments (green bonds, sustainability bonds, sustainability-linked bonds, and social bonds), whereas the Czech Republic, Hungary, and Slovakia issued exclusively green bonds. The increased diversity of instrument types and greater engagement of Poland contributed to a reduction in market concentration. However, the HHI value of 0.489 indicates that the market still exhibited extremely high concentration, although it was noticeably lower than in 2020-2022. Therefore, 2023 can be interpreted as the reduction in concentration levels in the ESG market in the region, both in terms of product variety and geographic distribution, while the market structure remained strongly oligopolistic.

Table 12.

Value of ESG-related bond issuances by instrument type in the V4 countries in 2024 (USD million)

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	2286.13	543.48	1595.89	0.00
Hungary	3191.93	500.00	0.00	0.00
Poland	2676.68	0.00	0.00	0.00
Slovakia	448.98	0.00	0.00	0.00
Total	8603.71	1043.48	1595.89	0.00

Source: own calculation based on efdata.org

The following year (Table 12) saw a renewed increase in market concentration by bond type. The HHI value of 0.614 indicates a quasi-monopolistic structure, though less pronounced than in 2020–2022. The Czech Republic, Hungary, and Poland dominated the green bonds segment. The Czech Republic was the only country issuing sustainability-linked bonds, while both the Czech Republic and Hungary issued sustainability bonds. No social bond issuances were recorded in 2024.

In summary, concentration by bond type was higher than the concentration of the overall value of ESG bond issuances in the V4 countries. In 2020–2022, the market exhibited a quasi-monopolistic structure, with HHI values exceeding 0.78 and reaching up to 0.93. The year 2023 brought a noticeable temporary decrease in concentration, primarily due to Poland's activity across all instrument types. In 2024, concentration increased again; however, the market remained more diversified than in 2020–2022. The limited presence of sustainability bonds and the absence of social bonds further reinforced concentration in green bonds and sustainability-linked bonds.

4.3 Analysis of concentration in the value of ESG-related bond issuances by type of issuer in the V4 countries in 2020–2024

Analysis of the structure of ESG bond issuance by issuer type (agency, corporate, financial institutions, municipal, sovereign, supranational) indicates that in 2020–2024 this market in the V4 countries was characterized by very high, and periodically even extremely high, concentration, dominated by single issuer segments in particular years. The Herfindahl-Hirschman Index (HHI) value throughout the analyzed period ranged from 0.341 to 0.501, clearly confirming a persistently concentrated, oligopolistic market structure, with episodes of extremely high concentration.

Table 13.*Value of ESG bond issuances by issuer type in the V4 countries in 2020 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	1234.38	0.00	0.00	0.00	0.00
Hungary	0.00	217.94	0.00	0.00	2019.89	0.00
Poland	0.00	781.31	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	2233.63	0.00	0.00	2019.89	0.00

Source: own calculation based on efdata.org

In 2020 (Table 13), the ESG bond issuance market in the V4 countries included only two types of issuers: corporate (52.5% share) and sovereign (47.5% share). Such a strong dominance of these two categories resulted in an HHI value of 0.501, which, according to the adopted interpretative scale, indicates an extremely high level of concentration. The market was, in practice, divided between the corporate segment (Czech Republic, Poland, and Hungary) and sovereign issuances (exclusively Hungary). The absence of activity from financial institutions, municipalities, and supranational issuers further reinforced market concentration.

Table 14.*Value of ESG bond issuances by issuer type in the V4 countries in 2021 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	2961.20	593.56	0.00	0.00	0.00
Hungary	0.00	609.99	399.61	0.00	610.76	0.00
Poland	0.00	963.84	590.65	0.00	0.00	0.00
Slovakia	0.00	0.00	518.20	0.00	0.00	0.00
Total	0.00	4535.03	2102.02	0.00	610.76	0.00

Source: own calculation based on efdata.org

In 2021 (Table 14), the market became more diversified due to numerous issuances by financial institutions (2102.02 mln USD) from, among others, the Czech Republic, Poland, and Slovakia. Nevertheless, the corporate segment remained dominant (4535.03 mln USD), and sovereign issuances were limited to a single country (Hungary). This resulted in a decrease in concentration to $HHI = 0.483$, which still indicates an extremely high level of concentration. The entry of financial institutions mitigated the dominance of the corporate segment but did not fundamentally alter the asymmetric distribution of bond values by issuer type.

Table 15.*Value of ESG bond issuances by issuer type in the V4 countries in 2022 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	1943.30	0.00	0.00	0.00	0.00
Hungary	0.00	592.81	613.50	0.00	2897.54	0.00
Poland	0.00	57.10	527.69	0.00	0.00	0.00
Slovakia	0.00	0.00	861.07	0.00	0.00	0.00
Total	0.00	2593.21	2002.26	0.00	2897.54	0.00

Source: own calculation based on efdata.org

The greatest diversification of issuer types during the analyzed period was observed in 2022 (Table 15). The three active issuer segments (corporate, financial institutions, and sovereign) had relatively similar shares, which led to a partial balancing of the market structure. The HHI value fell to 0.341, the lowest in the years 2020-2024, yet it still indicates a very high level of concentration, typical of an oligopolistic structure, though noticeably lower than in the other years analyzed. Therefore, 2022 can be interpreted as a period of relatively greatest diversification of the ESG market in the V4 countries in terms of issuer type, while maintaining a high concentration.

Table 16.

Value of ESG bond issuances by issuer type in the V4 countries in 2023 (USD million)

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	0.00	1085.66	0.00	0.00	0.00
Hungary	0.00	750.00	210.80	0.00	211.56	0.00
Poland	0.00	1797.15	1783.07	0.00	0.00	0.00
Slovakia	0.00	0.00	637.89	0.00	0.00	0.00
Total	0.00	2547.15	3717.42	0.00	211.56	0.00

Source: own calculation based on efdata.org

In 2023 (Table 16), the ESG bond market in the V4 countries was characterized by an extremely high concentration (HHI = 0.485), indicating a clear dominance of selected issuer types, although to a lesser extent than in 2020-2022. Data presented in Table 14 show that issuance activity was concentrated in two categories: financial institutions (3717.42 mln USD) and corporate (2547.15 mln USD), which together determined the market structure. Other issuer types were of marginal or zero significance; only sovereign (211.56 mln USD) appeared to a limited extent and exclusively in Hungary. It is worth noting that Poland was the largest issuer in the region, particularly in the corporate (1797.15 mln USD) and financial institutions (1783.07 mln USD) segments. The Czech Republic and Slovakia focused solely on financial institution issuances (1085.66 mln USD and 637.89 mln USD, respectively), whereas Hungary exhibited a relatively more diversified issuer structure, covering corporate, financial institutions, and sovereign segments.

Table 17.

Value of ESG bond issuances by issuer type in the V4 countries in 2024 (USD million)

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	3882.02	543.48	0.00	0.00	0.00
Hungary	0.00	609.38	1129.14	0.00	1922.46	0.00
Poland	0.00	731.86	1944.81	0.00	0.00	0.00
Slovakia	0.00	32.80	416.18	0.00	0.00	0.00
Total	0.00	5256.07	4033.61	0.00	1922.46	0.00

Source: own calculation based on efdata.org

The values presented in Table 17 indicate that in 2024 the market was again dominated by three main issuer segments, with corporate and financial institutions being the most significant. The HHI index decreased to 0.379 indicating a very high level of concentration, characteristic of an oligopolistic market structure. At the same time, the decline in HHI compared to 2023 demonstrates an improvement in the diversification of issuer types.

In summary, the analysis of concentration by issuer type shows that during 2020-2024, the ESG bond market in the V4 countries remained persistently highly concentrated, with periods of extremely high concentration. All HHI values exceeded 0.34, and in three years they were above 0.48. In 2020-2021, the market was dominated by corporate and sovereign issuances. The year 2022 was characterized by relatively the most balanced market structure in terms of issuer types, as the total values of corporate, financial institutions, and sovereign issuances were similar. In 2023, financial institutions played the dominant role, whereas in 2024 the market was primarily shaped by two issuer segments: corporate and financial institutions.

5. Conclusions and Discussion

The results of the present study align with research in the field of sustainable finance and demonstrate that the concentration of ESG bond issuances in the Visegrád Group (V4) countries, considering total issuance value, bond type, and issuer, is heterogeneous.

The application of the Herfindahl-Hirschman Index (HHI) showed that during 2020-2024 there was a persistently very high concentration of both the value and the number of ESG bond issuances in the V4 countries. Considering the value of ESG bond issuances, the market is dominated by the Czech Republic and Hungary. On the other hand, the number of ESG bond issuances in the V4 countries has been increasing, but the market remains fragmented and primarily dominated by Hungary. Consequently, the proposed hypothesis H1, stating that during 2020-2024 ESG bond issuances in the V4 countries were characterized by a high level of concentration both in terms of nominal issuance value and the number of issuances, was not fully confirmed, as the Czech Republic played the key role in 2021, 2023, and 2024, whereas Hungary was dominant in 2020 and 2022. In terms of the number of bonds issued, Hungary dominated throughout all analyzed years. These findings are inconsistent with the observations of Sobik (2023), who indicates that Poland is the regional leader in the development of the green bond market, although the V4's share in the European market remains small compared to Western Europe. Similar conclusions were drawn by Dmuchowski et al. (2023), who argues that Poland remains the leader in the V4 region in terms of both the value and number of green bond issuances. In the other V4 countries, the market develops more slowly, with major barriers including high transaction costs, lack of standardization, and a limited number of ESG-eligible projects. Therefore, hypothesis H4, which posited that during 2020-2024 Poland played

a leading role in the number of issuances compared to other countries in the region, was not confirmed. Hungary was the leading country in terms of issuances count.

The results of the analysis using the Herfindahl-Hirschman Index (HHI) confirm that, during 2020-2024, the structure of ESG bond issuances in the V4 countries by instrument type was characterized by a very high level of concentration. This concentration was primarily due to the dominance of green bonds, with a relatively small share of sustainability-linked bonds. This is due to beneficial impact of green bonds on the issuer's cost of capital structure. Muhammad et al. (2025) indicates that issuing green bonds results in a reduction in the total cost of capital of companies, including the cost of debt and tax-adjusted WACC, and also reduces interest costs, improving the company's tax efficiency (Muhammad et al., 2025). Zhou & Kythreotis (2024) emphasizes that issuers of pure green bonds typically achieve a lower cost of financing compared to issuers of conventional or mixed bonds (Zhou, Kythreotis, 2024). Our results indicated that in the period 2020-2022, this market exhibited a quasi-monopolistic structure. In 2023, concentration was lower compared to adjacent years, as Poland issued all types of bonds, i.e., green bonds, social bonds, sustainability bonds, and sustainability-linked bonds. The conducted research confirms hypothesis H2, according to which, during 2020-2024, the green bond segment had the highest share within the ESG bond sector, indicating that it constitutes the dominant category among all instruments financing sustainable development. These results are consistent with data provided by CBI (2025), where green bonds account for over 60%, and Frydrych (2021), who also highlights the dominance of green bond issuances in Europe. The results of this study, indicating limited market diversification across countries and instrument types, with a clear dominance of green bonds and a marginal significance of other forms of ESG financing, confirm that the concentration around green bonds may limit market access for entities without clearly defined environmental projects (Vulturius et al., 2022; Mishra et al., 2023). Appropriate regulatory guidelines, harmonization and standardization of issuance frameworks, and simplification of reporting requirements and guarantee programs can limit the concentration resulting from the dominance of a single instrument type (Mutarindwa et al., 2024; Vulturius et al., 2022; Mishra et al., 2023).

Considering the structure of ESG bond issuances by type of issuer, it can be observed that the V4 market was characterized by very high (and in some periods, extremely high) concentration, dominated by selected issuer segments in specific years. The main issuers in 2020-2021 were corporate and sovereign entities; in 2022, financial institutions joined them, and in 2024, financial institutions began to play a dominant role. Based on this, hypothesis H3, which assumed that during 2020-2024 the concentration of ESG bond issuers occurred mainly in the financial sector, and that this sector served as the leading issuer in the ESG bond market, was partially confirmed. The dominant role of financial institutions in sustainable bond issuances is also highlighted by Frydrych (2023). Sobik (2023) notes that among all issuers in 2014-2020, the largest number were non-financial corporations, financial institutions,

and public sector entities. This indicates a high utilization of green bonds by the private sector, as well as the popularity of this financial instrument among financial institutions and public sector entities.

The empirical results indicate that the development of the ESG bond market in the V4 countries remains largely dependent on the activity of a limited number of dominant entities. The literature emphasizes that in such conditions, public policy instruments aimed at reducing issuance costs and market entry risks play a significant role in expanding the issuer base (Lindner, Chung, 2023; Hadaś-Dyduch et al., 2022; Azhgaliyeva, Kapsalyamova, 2023). Empirical evidence from studies covering 56 economies between 2010 and 2020 indicates that fiscal policy instruments, such as tax incentives and emission subsidies, significantly increase the likelihood of companies issuing green bonds (Azhgaliyeva, Kapsalyamova, 2023). The experience of individual countries confirms the effectiveness of such solutions. The United States offers tax-preferred green bonds, such as Qualified Energy Conservation Bonds and Clean Renewable Energy Bonds. Chile has introduced tax exemptions for foreign investors purchasing green bonds, while Brazil has introduced income tax-exempt bonds financing wind farm projects (Azhgaliyeva, Kapsalyamova, 2023). These examples demonstrate that selectively designed tax preferences can effectively stimulate both the supply and demand for green debt instruments. Tax breaks and subsidies, income tax deductions, or partial compensation for coupon payments for green bond issuers strengthen the coherence between climate policy goals, financial regulations, and capital market development, fostering increased ESG bond issuance and diversifying the issuer base (Borodin, 2023; Shalini Aggarwal et al., 2025). Therefore, implementing solutions that encourage new issuers seems justified, especially in countries with relatively low issuance activity, such as Slovakia.

The conducted research indicates that during 2020-2024, the ESG bond market in the V4 countries exhibited high concentration, measured by the HHI, both in terms of value and number of issuances, with clear dominance of selected countries. Hungary was the largest issuer in terms of number of issuances, while Slovakia was the weakest. Sectorally, the results confirmed that concentration of ESG bond issuers was highest in the financial and corporate sectors.

These findings make a significant contribution to the literature on sustainable finance and the sustainable bond market, confirming the growing importance of this market segment. ESG bond issuances are increasing dynamically worldwide and in the V4 countries, yet their concentration depends on multiple factors, such as region, issuer type, information quality, and the regulatory environment. In recent years, both the volume of issuances and the emergence of new types of ESG bonds have been observed, although the market remains characterized by considerable geographic and sectoral concentration. From a policy implications perspective, the results indicate that without targeted regulatory, institutional, and tax interventions, ESG bond markets in the Visegrad Group countries may remain highly concentrated. These findings are consistent with observations in the existing literature and

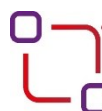
indicate that support for new issuers, diversification of ESG instruments, and further standardization of the regulatory framework could play a key role in building a more resilient and inclusive sustainable finance ecosystem in the region. Future research should therefore consider ESG objectives when analyzing issuances. The ESG bond market in the V4 countries represents an important channel for financing sustainable development, the effectiveness of which depends largely on the type of issuer and the quality of the macroeconomic environment. These results provide a basis for further research on the factors shaping issuers' decisions regarding the issuance of sustainable debt instruments.

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PREVENTIVE-RELATIONAL AND TASK-REACTIVE METHODS OF PERSONNEL RISK MANAGEMENT: GENDER-DIFFERENTIATED PATTERNS OF SUSTAINABLE HRM PRACTICES

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Purpose: The aim of this article is to present differences in approaches to managing personnel risk revealed in a qualitative study of sustainable human resource management practices in the Polish organisational context. The analysis focuses on identifying patterns of managerial actions that differentiate approaches to anticipating, responding to, and learning in the face of human resource-related risks, with particular attention to the gender aspect.

Methodology/Research Approach: The study was based on individual in-depth interviews (IDI) conducted using a questionnaire with open-ended questions. The collected data were subjected to thematic analysis in accordance with a documented research procedure. The study was exploratory in nature. The identified patterns are treated descriptively, as hypotheses for further quantitative verification. The empirical section is complemented by a synthetic meta-analysis of the literature, organising existing findings on the differentiation of leadership tools between women and men and their links to sustainable HRM practices and personnel risk profiles. Psychological safety and the psychological contract are used in the discussion as interpretive lenses and plausible mechanisms; they are not directly measured in the present qualitative study.

Findings: Two distinct patterns of working with personnel risk emerged from the participants' narratives. The first, preventive-relational, more often characteristic of women managers, involves early detection of soft signals through constant voice channels and individual conversations, systematic "closing" of expectations and cooperation rules, a mediatory approach to disputes, and knowledge consolidation after events. This style emphasises predictability and procedural fairness. The second, task-reactive, more frequently present in men managers' narratives, focuses on monitoring hard indicators and operational thresholds, rapid response under time pressure and uncertainty, cascading goals, and consistent enforcement of standards, with an emphasis on execution discipline and readiness to reconfigure tasks. The observed differences manifest throughout the entire risk management cycle: from identification and prioritisation, through response, to organisational learning and communication. Interpretation of the results takes into account contextual factors such as HR process maturity and the specifics of organisational tasks.

Originality/Value: The article contributes to the literature on sustainable HRM by highlighting links between gendered leadership patterns and approaches to managing personnel risk—an area still insufficiently explored in HRM research. It combines the perspective of risk management with the logic of sustainable organisational development, showing how different orientations (relational and task-focused) can influence organisational resilience and adaptive capacity. The article concludes with proposed research questions that serve as a starting point for further quantitative studies on the identified patterns.

Keywords: Sustainable Human Resource Management (SHRM), personnel risk, human resource management practices, managerial awareness, employee engagement, professional development, gender-differentiation.

Category of the paper: Research paper.

1. Introduction

Sustainable human resource management (SHRM) is an approach that integrates the economic goals of an organisation with concern for employee well-being and social and environmental responsibility (Ehnert, 2009; Armstrong, Taylor, 2016). Unlike traditional HRM, which focuses mainly on short-term operational efficiency, sustainable HRM takes a long-term perspective and emphasises employee health, development and engagement as key factors in organisational stability (Guest, 2017; Bombiak, 2019). In this approach, personnel risk management, understood as a set of risks related to the loss of key employees, turnover, burnout, absenteeism or a decline in motivation and productivity, takes on particular importance (Lipka, 2002; Bombiak, 2018). The implementation of a sustainable HRM strategy can reduce these risks by shaping relationships based on trust and strengthening the durability of the psychological contract (Rousseau, 2004; Rogozińska-Pawelczyk, 2024), which contributes to increased loyalty and reduces the likelihood of undesirable personnel phenomena (Rousseau, 2011; Johns, 2018). These relationships are discussed in the literature primarily as associations rather than as simple causal effects.

Contemporary organisations operate under technological, social and demographic pressure, which leads to an intensification of personnel risks (Castells, 2010; Nawaz, Durst, Hariharasudan, 2020). In highly dynamic sectors such as IT, a key challenge is to retain employees in the face of rapid changes in competencies (Widodo, 2023), while in high-pressure industries such as the financial sector, the risk of burnout and turnover is increasing. Sustainable HRM responds to these challenges through practices that support development, well-being, work-life balance and flexibility, which can reduce the likelihood of personnel risks materialising (Aust et al., 2020; Cox, Griffiths, 2005). The literature also points to the important role of leadership style in determining how personnel risks are identified and mitigated (Avery, Bergsteiner, 2011; Bombiak, 2019). Managers can act proactively, building relationships and early warning mechanisms, or rely on reactive measures, taken only after a problem has arisen.

At the same time, previous research suggests that gender may differentiate preferred leadership styles, as women are more likely to be relationship- and participation-oriented, while men are more likely to use a task- and directive-oriented approach (Eagly, Johnson, 1990; Eagly, Carli, 2003). These tendencies reflect average patterns identified at the group level and should not be interpreted as deterministic rules applying to individual managers. Despite numerous analyses of gender differences in leadership, there is still a gap in the literature linking these differences to the perception of personal risk in the sustainable HRM paradigm. In particular, there is a lack of qualitative research that would reveal the microfoundations of these mechanisms, explaining how gender and leadership style jointly shape prevention, response and organisational learning practices.

The aim of this article is to examine how the gender of a manager differentiates personal risk management styles in the context of sustainable HRM and what significance these styles have for prevention, response and organisational learning. The analysis is based on the results of a qualitative study conducted in Poland, which identified two dominant styles of human resource risk management: a preventive-relational style, more often declared by women, and a task-reactive style, more often declared by men. Given the exploratory nature of the research, instead of classic hypotheses, research questions were formulated, focusing on: (1) how a manager's gender may co-occur with their preferred style of human resource risk management, and (2) what implications for sustainable HRM are associated with adopting a relational or task-oriented approach.

The article consists of four main parts. The first part presents the theoretical framework, including the definition of personnel risk, its areas and the theoretical basis for gender differences in leadership styles, as well as a conceptual model. Next, the methodology and course of the qualitative study are presented. The next part contains the results in the form of characteristics of the two identified styles of personal risk management and their comparison. The article concludes with a discussion of the results, theoretical and practical implications, limitations, and directions for future research.

2. Literature review and research gap

This article deliberately focuses on three theoretical perspectives: personnel risk, leadership and gender differences, as these constitute the mechanism linking individual management styles with sustainable HRM practices. In terms of sustainable human resource management (SHRM), personnel risk is the likelihood of events and decisions affecting employees that may disrupt an organisation's ability to achieve its long-term goals (Ehnert, 2009; Guest, 2017). It includes, among other things, turnover and absenteeism, overload and burnout, competence shortages,

conflicts, unethical behaviour, and breaches of the psychological contract (Lipka, 2002; Bombiak, 2018; Rousseau, 2011).

From the perspective of sustainable HRM, long-term effects such as loss of human and social capital, erosion of trust, weakening of innovation, and repetition of mistakes resulting from a lack of learning are crucial (Avery, Bergsteiner, 2011; Guest, 2017). Risk analysis requires distinguishing between three complementary levels: micro (leader-employee interactions: quality of relationships, fairness, clarity of expectations), meso (HR processes: recruitment and retention, development, evaluation, workload, well-being), macro (organisational culture and climate: ethical norms, psychological safety, participation) (Lipka, 2015; Edmondson, 1999; Aust et al., 2020). At each level, there are early warning signs – e.g. a decline in participation in 1:1 conversations and initiative (micro), an accumulation of vacancies and an increase in absenteeism (meso), a deterioration in mood survey results and an increase in complaints (macro), the systematic monitoring of which is a prerequisite for prevention (Cox, Griffiths, 2005; Bombiak, 2019). Failure to take *ex ante* action increases the likelihood of *ex post* intervention (*ad hoc* replacements, disciplinary escalations), which in turn reduces the organisation's ability to learn from incidents (Argyris, Schön, 1978; Edmondson, 1999).

Leadership sets priorities in the area of HR and filters the way risk signals are interpreted. Task-reactive and directive approaches reinforce the focus on indicators and operational continuity, while preventive-relational and participatory approaches increase sensitivity to "soft" symptoms of crisis and encourage early intervention (Avery Bergsteiner, 2011; Bombiak, 2019). In practice, personnel risk is therefore managed along a prevention-reaction continuum: at one end lies proactive detection of signals, strengthening the psychological contract and well-being, and at the other end lies intervention after the problem has materialised, with an emphasis on maintaining results (Guest, 2017; Aust et al., 2020). One of the key mechanisms discussed in the literature as linking these practices with organisational learning is psychological safety, understood as the belief of team members that reporting problems and mistakes will not result in sanctions. (Edmondson, 1999; Vera, Crossan, 2004).

Meta-analytic studies indicate that gender differences in leadership are generally systematic: women are more likely to exhibit preventive-relational and participatory styles, while men are more likely to exhibit task-reactive and directive styles (Eagly, Johnson, 1990; Eagly, Carli, 2003). These discrepancies are explained, among other things, by social role theory: women are expected to exhibit supportive behaviours, while men are expected to exhibit agency and control, which translates into habitual leadership patterns (Abele, Wojciszke, 2007). At the same time, meta-analyses in economics and behavioural psychology show a higher average propensity for risk among men, although the effect depends on the context and field (Byrnes et al., 1999; Croson, Gneezy, 2009). Consequently, in the area of HR, it can be expected that female managers will more often objectify prevention (monitoring mood and workload, building feedback channels), while male managers will objectify reaction (quick procedural

decisions after a problem occurs). Both approaches can be effective in favourable conditions, but they differ in their impact on the psychological contract and learning: a preventive-relational orientation promotes trust and open reporting of errors, while a task-reactive orientation reduces response time at the expense of the depth of causal diagnosis (Rousseau, 2011; Edmondson, 1999).

The psychological contract (informal, mutual employee-organisation expectations) modulates the effects of HR practices: its fulfilment strengthens commitment and stabilises behaviour, while its violation results in a decline in trust, withdrawal and turnover, escalating personnel risk (Rousseau, 2004, 2011). Psychological safety acts as a catalyst for learning after incidents, allowing a shift from ad hoc responses to systemic changes in HR processes (Edmondson, 1999; Argyris, Schön, 1978; Vera, Crossan, 2004). In this view, leadership style is a "vehicle" for practices that either uphold the contract and create conditions for learning or undermine them. Based on the above findings, we propose a model combining the individual level (leader's gender), personal risk management style, and consequences at the level of HR processes and the organisation. The conceptual model is presented in Figure 1.

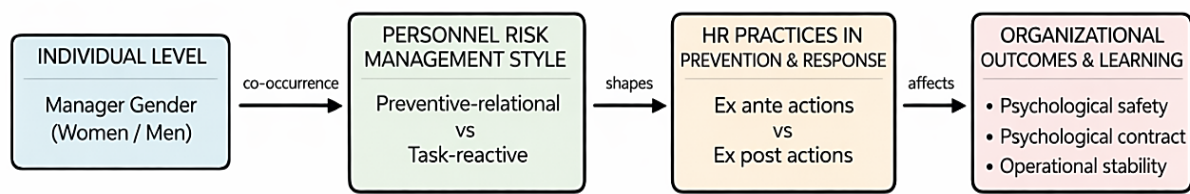


Figure 1. Conceptual model of personal risk management in HRM.

Source: Own work.

The model proposes the following sequence as a conceptual representation of relationships suggested in prior research and explored qualitatively in this study. The model assumes a directional relationship, which in the study is interpreted as co-occurrence rather than determinism. We do not test causality in the study; we describe co-occurrence. Style functions here as an intermediary mechanism that translates individual differences (averaged gender tendencies in leadership and risk preferences) into specific personal risk management practices. In turn, the psychological contract and psychological safety are mechanisms of transition between practices and organisational outcomes, determining whether incidents lead to learning and prevention of recurrence or to cyclical "firefighting" (Rousseau, 2011; Edmondson, 1999; Vera, Crossan, 2004). Finally, the strength of the links may be influenced by contextual moderators: sector, organisation size and leadership tenure (Aust et al., 2020; Bombiak, 2019). The model is instrumental in nature: it serves to interpret qualitative results and derive hypotheses for further quantitative analysis. Prior research has documented gender-differentiated leadership tendencies and has separately discussed personnel risk and sustainable HRM. However, the intersection between gendered leadership patterns and the micro-level practices through which managers identify, respond to, and learn from personnel risks within a sustainable HRM perspective remains underexplored. This study addresses this gap by

(1) identifying two qualitatively distinct styles of personnel risk management and (2) organizing their practices along the personnel risk cycle, while using the proposed conceptual model to derive propositions for further quantitative verification.

3. Methods

The study was qualitative and exploratory in nature, and its aim was to gain a deeper understanding of how managers operating in various sectors of the economy interpret and practise personal risk management. Analytic stance and interpretive lenses. The empirical claims in this paper are limited to patterns identified in managers' narratives through thematic analysis and illustrated with representative quotations. References to psychological safety and the psychological contract are introduced to interpret how the identified practices may relate to voice, trust, and learning processes in organizations. Because these constructs were not directly measured, they are treated as interpretive explanations and propositions for future quantitative testing rather than as empirically verified causal mechanisms. The project was based on an interpretative paradigm, assuming that management style, ways of responding to personnel risks and understanding of sustainable HRM are constructed through managers' daily experiences and perceptions. The choice of a qualitative research strategy was justified by the early stage of development of the issue and the need to reconstruct the patterns of action necessary for the subsequent operationalisation of the construct of personal risk management styles. It should be emphasised that the intention of the study was not to generalise the results statistically to the population of managers (which is the domain of quantitative research), but to generalise analytically (Yin, 2013). It should be noted that while the research methods employed, Individual In-Depth Interviews (IDI) and thematic analysis, are well-established globally, their application to analyze the gendered patterns of personnel risk management in the Polish institutional context represents a **novel contribution to the domestic literature**. The aim here was to relate the empirical results to the existing theory of Balanced HRM and to show how the identified mechanisms, regardless of the sample size, explain the process of increasing personnel risk. The study also served as preparation for the planned quantitative analyses, which is in line with the sequential approach of mixed methods, in which the qualitative stage serves to generate theory and verify the validity of model assumptions.

The research sample was selected deliberately, with middle and senior managers ($N = 35$) invited to participate, who held managerial positions and were responsible for decisions concerning teams, which ensured that human resource management practices in real organisational conditions could be captured. The respondents represented four sectors: IT, finance, higher education, and training and development, which allowed for a comparison of practices in different institutional contexts. The sample included 23 women and 12 men.

The diversity of organisation sizes, from micro-enterprises to medium-sized companies to large corporations, allowed for an analysis of how structural conditions influence the possibilities for implementing sustainable HR practices and personnel risk management strategies. Empirical data were collected through in-depth individual interviews (IDIs), which allowed for a free but focused exploration of the meanings and interpretations given by managers to HRM practices and risk management. The analysis was conducted in accordance with the six-step thematic analysis procedure developed by Braun and Clarke (2006).

4. Results

Analysis of the empirical material revealed clear differences in the ways of managing personnel risk, which spontaneously emerged in the managers' statements. This section reports the empirical patterns identified in the interview material; theoretical interpretation is reserved for the Discussion section. Firstly, during repeated readings of the transcripts, regularly recurring patterns were noticed in how respondents recognise warning signs, respond to problematic situations and incorporate (or ignore) elements of organisational learning in their teams. These recurring patterns became the starting point for further analysis. As the analysis deepened, it became apparent that managers differed significantly in their perception of risk signals. Some of them attached great importance to subtle signs of employee overload, low morale or withdrawal from communication. Their statements were dominated by a strong focus on relationships, attention to the team atmosphere and care to ensure that problems were identified before they escalated into incidents.

The second group of managers focused on actions taken mainly after a problem had arisen, emphasising the need to quickly restore operational efficiency and enforce procedures. In the next phase of the analysis, these qualitatively different approaches began to form two consistent patterns of behaviour, which can be described as a preventive-relational style and a task-reactive style. The analysis process identified two polar types of management styles. It should be noted that five respondents (approximately 14% of the sample) were identified as having a mixed style, combining features of both approaches in a way that prevented clear dichotomous classification. In accordance with the assumptions of the typological analysis, these cases were not included in the analysis in order to ensure the clarity of the characteristics of the identified borderline patterns. Table 1 presents a detailed distribution of these styles by gender of respondents.

Table 1.

Distribution of dominant personal risk management styles among female and male respondents (N = 35)

Style	Women (n = 23)	Men (n = 12)	Total (n = 35)
Preventive-relational	16	3	19
Task-reactive	4	7	11

Source: Own analysis based on interviews. The table only includes studies in which researchers were able to identify a dominant style. Mixed styles were omitted.

The preventive-relational style was characterised by a proactive approach to personnel risk and a strong emphasis on building interpersonal relationships. Managers exhibiting this pattern sought to prevent potential personnel problems through early identification of threats and attention to trust and good communication within the team. This style involves a proactive and relational approach to employees. Managers representing this style emphasise building positive relationships within the team, communication and employee engagement, as well as taking action to prevent potential personnel problems. This manifests itself, among other things, in the implementation of development and mentoring programmes, regular discussions with employees about their needs and satisfaction, monitoring signs of burnout or frustration, and responding quickly to the first signs of a decline in motivation. Such leaders try to prevent conflicts or resignations by building trust and providing support before minor difficulties escalate into serious problems.

The preventive-relational style is characterized by a high intensity of informal voice channels. Managers using this approach focus on the early detection of 'soft' signals, prioritizing interpersonal trust as a primary risk mitigation tool. The study noted that this style was more often declared by female managers. Respondents described their approach as "taking care of people so that they don't have to put out fires later", emphasising the importance of relationships, empathy and prevention in personnel management. This observation is consistent with earlier studies suggesting that women in managerial roles are more people- and relationship-oriented and prefer a participatory/democratic style (Eagly, Johnson, 1990; Helgesen, 1990). This translates into a tendency to notice soft signals of problems (e.g., a deterioration in team morale) earlier and to take preventive action.

The second identified style is the task-reactive style, characterised by a focus on the completion of tasks and objectives and reacting post factum to personnel incidents only when they begin to disrupt results. Managers who display this style focus primarily on measurable work results and current operational activities, treating personnel issues as secondary and dealing with them mainly when they become acute (e.g. a key employee resigns, a conflict within the team disrupts work, productivity declines). They are characterised by reactivity: instead of investing time in prevention, they "put out fires" once they have broken out. The statements of such respondents included comments such as: "as long as everything is going well, there is no need to overdo the conversations, people should do their job, and if something happens, then I intervene". This style is also associated with a more instrumental approach to

employees, with the manager focusing on assigning tasks, enforcing results and using mainly formal HR tools (procedures, periodic evaluations) instead of informal conversations about staff well-being.

In the sample studied, male managers were more likely to declare this attitude. Many of them emphasised the need to "maintain discipline" and not "spoil" employees, recognising that excessive focus on their needs can distract from business goals. Examples of statements illustrating this approach are presented in Table 2.

Table 2.

Examples of statements by managers, tailored to their management style

Personnel risk management style	Quote:
Style 1 – preventive-relational	"I always keep an eye on what's going on in the team and try to spot potential problems in advance. For me, relationships are key. When people know what's going on, (...) they feel listened to and appreciated, and are much less likely to become a problem for the organisation".
Style 1 – preventive-relational	"(...), it's mainly about catching problems with people before they escalate. When I see that someone is struggling or seems nervous, I don't wait, I sit down right away, talk to them and ask what's going on. If you have normal contact with people, a sincere relationship, you can often stop a small thing before it grows into a problem that really affects the company".
Style 1 – preventive and relational	"For me, it's crucial to be close to people. (...) When I'm with the team on a daily basis, I can immediately see when something starts to go wrong, when someone withdraws, when someone complains more often. Then I react, talk, try to get to the root of the problem. It's better to ask five times too early than once too late, when the issue has already turned into a conflict or the departure of an important person".
Style 1 – preventive-relational	"(...) the problem starts with minor frustrations that no one noticed. When people have the space to honestly say what is bothering them, we are able to address it before it turns into absenteeism, a decline in commitment or some passive blocking of change. Without such daily conversation, there can be no real risk management".
Style 1 – preventive and relational	"You can see this very clearly in production, where one frustrated operator can ruin the atmosphere for the entire shift. When I see that someone is constantly irritated, muttering under their breath, I don't sweep it under the carpet. I arrange a meeting to try to understand what is going on: is it the schedule, the conditions, or perhaps a conflict within the team? If you catch these things early on, you can steer them in the right direction instead of having to put out fires later".
Style 2 – task-oriented and reactive	"(...) I look at turnover, absenteeism, and periodic assessment results. When I see that they are starting to deviate from what we have set out, it is a signal for me to dig deeper. I prefer to have hard data rather than rely solely on impressions from conversations, because people sometimes get carried away and then when it comes down to it, it's not true".
Style 2 – task-oriented and reactive	"We have very clearly defined procedures, from recruitment, through onboarding, to termination. If someone is not delivering, we take specific steps: first a corrective conversation, then a recovery plan, and finally, if necessary, termination. It may sound harsh, but thanks to this (...) everything is organised and predictable".
Style 2 – task-oriented and reactive	"I try to look at personnel risk through the prism of results. If someone systematically fails to meet their KPIs, it means we have a potential risk. Only then do I move on to discussions: is it a question of competence, motivation, or perhaps a poor fit for the role? First, the numbers".

Source: Own work. Note that quote has been translated.

5. Discussion

In interpreting these findings, the identified management patterns are analyzed through the theoretical framework of the psychological contract and psychological safety. While these constructs were not directly measured through quantitative instruments, they serve as interpretive lenses to explain the underlying mechanisms of the identified styles. Specifically, the preventive-relational approach aligns with strengthening the durability of the psychological contract (Rogozińska-Pawełczyk, 2024; Rousseau, 2011), as it promotes an environment where employees feel safe to voice concerns, thereby stabilizing mutual expectations and reducing personnel risk. In the sample studied, there was a clear tendency for this style to be more common among women, while the task-reactive approach focused on operational discipline and procedural enforcement dominated in the narratives of men. In interpreting the findings, we distinguish between empirical evidence (themes and quotations from interviews) and theory-based contextualisation. Accordingly, any directional statements in the Discussion are presented as interpretive propositions consistent with prior literature rather than as causal effects established by measurement. Although this result corresponds with the meta-analyses of Eagly and Johnson (1990), it should be interpreted with caution. The observed convergence may result not only from gender socialisation, but also from the specific nature of the sectors in which the male respondents were overrepresented (e.g. IT, finance), which often require a more technocratic and procedural approach to risk. Gender is therefore treated here as an important, but not the only, determinant of managerial preferences. It cannot be ruled out that gender differences are secondary to task differences. At the same time, the observed differences are confirmed by research on decision-making preferences, according to which men on average show a greater propensity to take risks (Byrnes, Miller, Schafer, 1999; Croson, Gneezy, 2009). Interpretatively, this means that leaders who prefer a task-reactive style are more likely to accept a higher level of personal risk and allow for ex post reactions, while a preventive-relational style favours early diagnosis of warning signs and ex ante actions.

Both styles represent the poles of a continuum, within which many managers combine elements of both approaches. Nevertheless, their dominant configurations translate differently into practices in the areas of prevention, problem response and organisational learning. The preventative-relational style promotes the identification of early signals, such as a decline in engagement, employee withdrawal or signs of overload, and the initiation of supportive conversations and actions, as confirmed by both qualitative data and the literature on mental health at work (Aust et al., 2020; Cox, Griffiths, 2005). However, it is worth noting that this style comes at a high cost to the leader. A deep focus on relationships and constant monitoring of moods (emotional labour) can lead to emotional overload for the manager themselves, which paradoxically becomes a new area of risk within the organisation.

On the other hand, the task-reactive style, although it involves the risk of later detection of problems, has significant adaptive qualities in crisis situations. Because the interview protocol did not systematically elicit detailed crisis or urgency episodes, this “crisis adaptiveness” is presented here as theoretical contextualisation rather than as incident-level empirical evidence. The discussion of task-reactive leadership suggests it may be adaptive in crisis-like conditions due to its focus on rapid response and operational continuity. However, as the interviews did not focus on specific incident-level crisis episodes, this adaptiveness should be treated as theoretical contextualization rather than empirical evidence derived from the sample. However, its exclusive dominance – often at the expense of a deeper diagnosis of the causes – may increase the risk of recurring problems in the long term (Lipka, 2015; Kaye, Jordan-Evans, 2012). In the reaction phase, the preventive-relational style favours dialogue and mediation, while the task-reactive style favours unilateral and procedural interventions. As a result, the preventive-relational style is more conducive to organisational learning, which requires psychological safety and reflectiveness (Edmondson, 1999; Argyris, Schön, 1978; Vera, Crossan, 2004).

The results of the study make a particularly important contribution to the theory of sustainable HRM. First, they show that the effectiveness of sustainable HR practices depends on individual managerial practices and leadership style, which acts as a “vehicle” for the organisation's intentions. The preventive-relational style reinforces the implementation of long-term sustainable HRM goals, such as well-being, development and maintenance of the psychological contract (Guest, 2017; Armstrong, Taylor, 2016), while the task-reactive style may limit their implementation, especially in dynamic or pressured work environments.

Secondly, the study highlights the importance of the psychological contract as a mechanism of transition between HR practices and the level of personnel risk, integrating the literature on employee-organisation relations (Rousseau, 2004, 2011) with the perspective of sustainable HRM (Ehnert, 2009; Aust et al., 2020).

Thirdly, the results allow for a conceptual organisation of risk management styles as a bipolar continuum, which is an important starting point for further operationalisation and quantitative testing. When interpreting the results, however, it is worth considering, in addition to the aforementioned sector-specific characteristics, other contextual variables that may modulate management style regardless of gender.

Team size and scope of responsibility proved to be significant differentiating factors; managers of large structures more often described task-oriented practices, which resulted from time pressure and the need to maintain operational efficiency. It was noted that managerial seniority strengthened sensitivity to soft signals: more experienced leaders (both women and men) more often declared *ex ante* actions, which suggests a process of learning the role.

Finally, organisational culture was an important background for preferred HR practices: hierarchical, task-oriented, participatory or egalitarian, and comparative literature indicates that institutional norms can reinforce certain styles regardless of gender (Hofstede, 1980; House

et al., 2004). For example, Nordic models favour relationality and prevention, while Anglo-Saxon models more often reinforce task-orientedness and reactivity; this implies that the interpretation of gender differences must take into account the local cultural framework (Sparrow, Schuler, Jackson, 1994; Brewster, 1995).

The originality of the study lies in the fact that it combines three rarely juxtaposed perspectives: individual leadership styles, personal risk levels, and sustainable HRM assumptions. Qualitative analysis revealed not only the existence of two distinct styles, but also their different impacts on prevention, response and organisational learning, which enriches the theory of sustainable HRM with managerial microfundamentals. The study also provides new insights into how gender, not as a determinant but as one of the factors associated with leadership preferences, influences personnel risk management, while emphasising the importance of organisational and cultural context in modulating these relationships. This provides a basis for further quantitative research testing the proposed mediation model and for inter-organisational and cross-cultural comparisons. The potential adaptiveness of this style should therefore be understood as context-dependent rather than universally optimal.

The study indicates that sustainable human resource management is not a homogeneous set of practices, but a complex and diverse system of activities, the configuration of which is co-determined by leadership style and the manager's individual approach to risk. The introduction of the categories of personal risk management styles (preventive-relational and task-reactive) expands existing sustainability-oriented HRM models with a clear risk component. This allows for the conceptualisation of personal risk as a mechanism that differentiates sustainable HRM practices, which has not been present in the literature on the subject until now.

Qualitative results show that gender differences in management styles manifest themselves in different ways of working with risk. These include, among others, the way threats are identified, the approach to conflicts, the logic of decision-making, and patterns of communication and learning. This allows us to refine existing leadership theories, showing that gender differences are not merely abstract, but translate into different paths of personnel risk management.

The article proposes a new theoretical category in the field of HRM: personal risk management style, understood as an integrated set of practices including early identification of warning signs, ways of responding to emerging problems, and mechanisms for learning from events. This construct can be treated as a new theoretical variable with potential for use in future quantitative models, including as a mediator or moderator in analyses using structural equation modelling (SEM).

The results obtained indicate that the course of learning from personnel incidents differs significantly depending on the management style. This is an important theoretical implication because it shows that organisational learning is not homogeneous but is shaped by the dominant leadership style.

The article contributes theoretical value by integrating two areas that have rarely been combined before: human resource management, including sustainable HRM, and risk management. The results suggest that the way managers classify risk affects not only specific HRM processes, but also the shaping of organisational culture and the effectiveness of change management. This opens up the field for further research on the integration of personnel risk with HRM practices and broader mechanisms of organisational functioning.

The results of the study show that the effectiveness of sustainable human resource management depends to a decisive extent on the leadership style, which becomes a tool for translating strategic assumptions into everyday employee management practices.

A preventive and relationship-oriented approach, more often declared by women in the sample, promotes early disclosure of problems, maintenance of the psychological contract and building psychological security, which enables employees to signal difficulties before they escalate. This approach strengthens the long-term stability of teams, as it allows for the diagnosis of threats at the micro level and the modification of HR processes before they lead to increased turnover or absenteeism. In practice, this means that organisations should systematically invest in developing leaders' relational skills – in particular, the ability to conduct one-on-one conversations, identify subtle signs of overload and declining engagement, mediate conflicts, and use dialogue- and support-based interventions. This requires expanding development programmes to include elements of emotional intelligence, managerial coaching and a preventive approach to employee wellbeing. At the same time, organisations should equip leaders with tools to make decisions based on early risk indicators, such as short-term absence trends, signs of overload, pulse survey results, and intentional turnover rates. Collecting and analysing this data allows intuitive signal recognition to be transformed into a systematic prevention mechanism.

It is also worth formalising retrospectives after personnel incidents, treating them as part of the organisational learning cycle: analysis of the root causes of departures, conflicts or burnout should lead to the implementation of process modifications that prevent the same mistakes from recurring. Such actions enable a transition from reactive problem-solving to conscious design of a work environment in which personnel risks are continuously monitored and controlled.

Finally, the results suggest that gender diversity in management teams can be of real value to an organisation. In organisational practice, it seems reasonable to create complementary managerial dyads (or pair a leader with a strong HR Business Partner), where one person is responsible for operational stability (task-reactive style) and the other for monitoring the psychological contract (preventive-relational style). This hybridisation of styles allows the organisation to be secured in two ways: by protecting short-term results and long-term human capital. In multicultural environments, it is particularly important to develop intercultural competencies among managers, which allow them to adapt their actions to local norms regarding employee-employer relations. Only the combination of relational competencies,

analytical tools and contextual sensitivity allows the idea of sustainable HRM to be implemented in a manner consistent with the realities of the organisation.

The study has several limitations that should be taken into account when interpreting the results. First, the empirical material comes from a deliberate, qualitative sample of managers in Poland, which limits the possibility of statistically generalising the findings to other populations. Although sectoral diversity increases the transferability of the findings, the analysis reflects the specific realities of the labour market, which combines elements of the continental and post-transformation models. While remaining aware that the structure of the sample (predominantly female) may have influenced the proportions of styles, another significant limitation is the structure of the sample, which was predominantly female and had an uneven gender distribution across sectors (e.g. male dominance in technical industries). This does not allow for the complete isolation of the influence of industry culture on management style, so future research should aim to select a quota sample to verify whether women in highly task-oriented sectors (e.g. finance) adapt a masculine style or retain a relational orientation.

Secondly, the data is declarative in nature, which entails the risk of self-assessment in line with social expectations and a potential discrepancy between the declared style and the style implemented in practice. In future studies, it is recommended to verify the style through observation or HR data.

Thirdly, some cases presented a mixed profile, suggesting that the style continuum is more complex and that the boundaries between approaches need further clarification. At this stage, it would be valuable to compare managers' declarations with hard data (e.g., turnover and absenteeism rates), which would enable triangulation of sources and increase the accuracy of conclusions.

To address the qualitative limitations of this study, a concrete methodological roadmap for future research is proposed. As detailed in Table 3, the main qualitative categories are translated into candidate scale dimensions and illustrative behavioral indicators to support subsequent quantitative operationalization. This mapping serves as a starting point for item generation and psychometric validation, linking the identified styles to sustainable HRM outcomes such as turnover risk, burnout risk, and organizational learning for future empirical testing.

Table 3.

From qualitative categories to candidate scale dimensions and SHRM outcomes (proposed roadmap)

Qualitative category (from interviews)	Candidate scale dimension (for future scale)	Illustrative behavioural indicators (examples)	SHRM outcomes for future testing
Early detection of soft signals	Early warning routines	Regular scanning for early signs of overload/withdrawal; proactive check-ins before incidents	Lower turnover risk; lower burnout risk

Cont. table 3.

Constant voice channels and 1:1 conversations	Voice-channel intensity	Frequency/availability of structured and informal voice opportunities; responsiveness to voiced concerns	Higher psychological safety; higher organisational learning
“Closing” expectations and cooperation rules	Expectation alignment and procedural fairness	Explicit clarification of mutual expectations; consistent communication of rules; follow-up on agreements	Lower psychological contract breach risk; lower turnover risk
Monitoring hard indicators and thresholds	KPI thresholding and metrics-based monitoring	Use of absenteeism/turnover/ KPI deviations as primary triggers for managerial action	Faster response time; potential trade-off with burnout/contract outcomes
Consistent enforcement of standards	Procedural enforcement and corrective action	Use of corrective conversations, improvement plans, and sanctions when standards are not met	Short-term performance stability; potential long-term commitment risk
Knowledge consolidation after events	Post-incident learning routines	Conducting retrospectives; documenting lessons learned; translating incidents into process changes	Higher organisational learning; fewer repeated incidents

Source: Own work.

Future research should therefore lead to the operationalisation of the preventive-relational and task-reactive styles in the form of psychometric scales, taking into account the assessment of validity and reliability, and then to the confirmation of their factor structure and measurement invariance across genders and sectors. An essential complement to these analyses should be the adoption of a dyadic perspective (supervisor–subordinate). Confronting the leader's self-assessment with the employees' perception would allow for the verification of so-called perceptual congruence and answer the question of whether the manager's preventive intentions are actually interpreted by the team as support.

Another important area for future research is cause-and-effect analysis in longitudinal models. Only longitudinal projects will make it possible to assess whether leadership style actually shapes personnel risk indicators or whether this relationship is modified by other variables. Another valuable direction would be to verify the "hidden costs" of the preventive-relational style by examining the correlation between its use and the level of burnout among leaders themselves. Furthermore, the context of digital transformation cannot be overlooked – an important research question remains how remote and hybrid work modify the effectiveness of both styles and whether the relational approach is sustainable in a virtual environment (e-leadership). The final recommended direction is cross-cultural comparisons, which would allow us to assess which elements of the identified styles are universal and which depend on local institutional norms.

6. Summary

The article shows that personnel risk management is not just a technical procedure, but a complex social process that is strongly dependent on leadership style. It is the manager's style that filters the way threat signals are recognised, determining both the speed of response and the organisation's ability to learn from experience. The styles identified in the study: preventive-relational (more common in women's narratives) and task-reactive (dominant in men) function as two poles of a continuum, with the analysis showing that each has both adaptive qualities and significant limitations.

The preventive-relational style, by affirming the employee's subjectivity, effectively strengthens psychological security and sustains the psychological contract, which promotes proactive risk management (*ex ante*). However, this approach comes at a high cost to the leader: the need for constant emotional labour can lead to manager overload and, paradoxically, generate new risks within the organisation. On the other hand, the task-reactive style, although often criticised for its lack of empathy, plays a key role in ensuring business continuity. Its focus on procedures allows for operational stability in crisis situations and under time pressure. However, its exclusive dominance, achieved at the expense of a deeper diagnosis of the causes, increases the risk of erosion of commitment and the so-called "silent breach" of the psychological contract in the long term.

The contribution of the study is to enrich the theory of Sustainable HRM with managerial microfundamentals and to demonstrate that the full effectiveness of sustainable HRM requires the hybridisation of both approaches. The conclusions suggest that the optimal model is not to eliminate the task-reactive style, but to supplement it with relational competencies (e.g. within managerial dyads), which allows for balancing economic goals with care for human capital. The qualitative limitations of the study justify the need for further quantitative research to verify the stability of these patterns in a wider population and different organisational cultures. From a broader field perspective, the study adds managerial microfoundations to sustainable HRM by showing how personnel risk management practices can be organised into two coherent styles along the risk cycle. At the same time, the findings should be read as exploratory, given the qualitative and declarative nature of the data and the non-random sample. Practically, the proposed typology can be used as a diagnostic and developmental framework for leadership training and HR business partnering, while the operationalisation roadmap provides a concrete basis for constructing and validating measurement instruments in subsequent quantitative research. Taken together, the findings should be interpreted as analytically generalisable insights that inform theory development rather than as statistically generalisable conclusions.

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IS AI CHANGING THE UNWRITTEN RULES? THE PSYCHOLOGICAL CONTRACT IN THE ERA OF DIGITAL LEADERSHIP AND THE BIG FIVE

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Purpose: This article aims to examine the impact of artificial intelligence adoption on IT managers' perceptions of the psychological contract. Particular attention is paid to the role of digital leadership as a mediating variable and the Big Five personality traits as moderators of the strength and direction of this relationship. The study also takes into account the cultural context of Poland and Spain. The issues addressed are part of the discourse on changes in human capital management within the context of digital transformation in organisations.

Design/methodology/approach: The study used a quantitative approach based on a moderated mediation model. Data were collected using a standardised questionnaire survey of 481 IT managers from Poland (N = 231) and Spain (N = 250). The analysis was conducted using structural equation modelling (SEM), mediation (bootstrapping), moderation and intergroup comparisons (multigroup SEM).

Findings: The results confirm that AI adoption influences IT managers' perception of the psychological contract, with this relationship being significantly mediated by digital leadership. Furthermore, it was demonstrated that personality qualities, including neuroticism, extraversion, and conscientiousness, influence the intensity of this association. A comparative research demonstrated notable cultural disparities across the examined groups, highlighting a heightened significance of digital leadership in Poland and a more pronounced impact on personality qualities in Spain.

Practical implications and recommendations: The results indicate the need to adapt AI implementation strategies in IT organisations to the personality profile of managers and national characteristics. Strengthening leadership competencies in the area of technological change management may contribute to better fulfilment of the psychological contract. Practical recommendations concern the implementation of AI, the role of leaders, and the personalisation of management strategies in technology organisations.

Originality/value: The study contributes to the development of the literature on human resource management, including the theory of psychological contracts and digital leadership, by presenting an integrated empirical model that considers artificial intelligence technology, individual characteristics, and cultural context.

Keywords: artificial intelligence adoption, psychological contract, digital leadership, Big Five personality traits, IT managers, cross-cultural comparison.

Category of the paper: Research paper.

1. Introduction

The progression of digitalization presents novel issues for organizations, especially within the IT sector, regarding both the adoption of innovative technology (Benitez et al., 2022) and the reconfiguration of organizational relations (Wang, 2023). One of the key areas where the consequences of technological transformation are most evident is the psychological contract (PC), which represents the subjective perception of the organisation and its employees in relation to the giving and taking in their ongoing relationship (Rogozińska-Pawełczyk, 2016). In particular, the adoption of artificial intelligence (AI), which is increasingly present in the workplace, may alter the way employees perceive the balance of this informal exchange. Previous research suggests that adopting AI in organizations can improve work satisfaction and fulfilling of the psychological contract, as long as the technology deployment process is well handled (Wang, 2023). Research suggests that using AI impacts employee engagement and confidence in the organization (Wziątek-Staśko, 2024). Furthermore, AI can strengthen positive aspects of the psychological contract, such as a sense of agency and competency growth (Prikshtat et al., 2023). However, there have been claims of negative implications from the application of AI, such as fear of job loss, a sense of threat, a loss of control, and increasing confusion about one's professional function (Holmström, 2022).

Despite increased interest in the influence of AI on employee behavior and organizational relationships, a study of the literature finds considerable gaps in integrated models addressing the psychological repercussions of technical transition. In particular, most of the research to date has focused on the direct effects of AI implementation on variables such as job satisfaction and well-being (Jiang, Lavaysse, 2018), overlooking the psychological contract as a fundamental component of the exchange relationship between the employee and the organisation (Grassini, 2023). However, despite a leader's effectiveness and style acting as a crucial filter through which employees interpret technological changes, few studies have taken digital leadership (DL) as a mediating variable (Benitez et al., 2022; Wang, 2023; Shal et al., 2024). Similarly, the Big Five personality traits, which recent studies have shown strongly moderate employees' reactions to organisational changes and the implementation of new tools (Saef et al., 2024; Kovbasiuk et al., 2024), are rarely addressed in relation to the psychological contract and technology. The identified research gap also concerns the cross-cultural perspective. There is a lack of comparisons that take into account differences in organisational culture, leadership style and the dynamics of digital transformation between countries, even though the literature confirms the strong cultural conditioning of AI implementation processes and the shaping of organisational relationships (Budhwar et al., 2022; Prikshtat et al., 2023; Hofstede et al., 2010).

This article fills these gaps by introducing an integrated model of moderated mediation that simultaneously considers: (1) the impact of AI adoption on the psychological contract, (2) the mediating role of digital leadership, (3) the moderating influence of personality traits in the Big Five model, and (4) the cultural diversity of the effects of the studied relationships, using Poland and Spain as examples. In this way, the article contributes to the literature on human resource management in the digital environment by developing the psychological contract theory with a technological component and integrating it with the perspective of leadership and the psychology of individual differences. At the same time, the study is part of the current trend of empirical research on the social consequences of implementing artificial intelligence in knowledge work, proposing a transdisciplinary approach based on empirical comparative data.

This article aims to examine how the adoption of AI affects the perception of the psychological contract among IT managers and to investigate the role that digital leadership and personality traits, as captured in the Big Five model, play in this process. In addition, cultural differences between Poland and Spain, which may moderate the described relationships, were analysed. Based on a review of the literature, a moderated mediation model was proposed, in which digital leadership acts as a mediator and personality traits and cultural context act as moderators.

The study was conducted using structural equation modelling (SEM) on a sample of 481 IT managers from Poland and Spain. Verified measurement tools and advanced statistical techniques, such as mediation analysis (bootstrapping), moderated regression and multigroup SEM, were used to analyse the data, enabling empirical testing of the complex research model.

The article consists of five parts. Following this introduction, the second part discusses the theoretical foundations. It provides a critical review of the literature on psychological contracts, digital leadership and the Big Five personality traits in the context of AI adoption, which resulted in the development of research hypotheses. The next part presents the research methodology, including the operationalisation of variables, sample characteristics, measurement procedure, and data analysis. The fourth part presents the empirical results and their discussion in the context of previous research. The fifth part presents the conclusions, including a summary of the main research findings, a discussion of the theoretical contribution and practical implications, the study's limitations, and directions for future research on the psychological contract in the context of digital transformation.

2. Literature review and hypothesis development

2.1. Artificial intelligence adoption and the psychological contract

One of the biggest issues facing contemporary management is the implementation of artificial intelligence (AI) in the workplace, which integrates organizational, psychological, and technological elements (De Ruiter et al., 2021). The IT industry, which is a leader in applying AI-based solutions like machine learning, decision-making automation, and generative language models that redefine both operational models and interpersonal relationships, is where these changes are most noticeable (Benitez et al., 2022; Noy, Zhang, 2023). AI affects not only the structure of tasks, but also employees' sense of agency, autonomy and job security (Holmström, 2022), making it an important factor in shaping the subjective perception of organisational relationships.

In this context, the concept of a psychological contract is understood as a set of employees' subjective beliefs about mutual obligations and expectations towards the organisation (Rousseau, 1995; Morrison, Robinson, 1997). Highly complex technologies, like artificial intelligence (AI), have been shown to cause confusion, role uncertainty, and increased psychological distance, especially when implemented without sufficient support and communication (Middleton et al., 2022). On the other hand, properly implemented AI can be interpreted by employees as a sign of innovation, organisational commitment to development and care for human resources (Wang, 2023; Presbitero, Teng-Calleja, 2022). Research in IT settings has demonstrated that having access to AI-based tools, like chatbots that assist with knowledge management or decision support systems, fosters a favorable impression of the company as being modern, transparent, and supportive of development (Noy, Zhang, 2023; Grassini, 2023). In such conditions, technology becomes a psychological resource that strengthens the sense of influence, security and organisational justice, thereby building a psychological contract.

At the same time, much depends on how the technology is implemented. According to research by Holmström (2022) and De Ruiter et al. (2021), a lack of open communication, employee involvement, and inadequate consideration of their concerns may be the main causes of psychological contract violations rather than technology itself. As a decision-making technology, artificial intelligence (AI) may be seen as a threat to one's social role and professional identity, particularly if one is unaware of how it functions and how it affects daily tasks (Nadimpalli, 2017). Thus, it is the perception of technology, rather than its objective properties, that determines the impact of AI on the quality of organisational relationships (Middleton et al., 2022).

When AI is viewed as a tool that improves agency and facilitates work rather than as a form of control or a threat of replaceability, research in the IT industry demonstrates that AI can positively affect the psychological contract (Presbitero, Teng-Calleja, 2022; Wang, 2023).

Workers are less likely to report violations of the psychological contract and exhibit higher levels of organizational loyalty if they believe they have a say in how technology is implemented, receive training, and receive communication support (Budhwar et al., 2022). The empirical evidence collected thus suggests that AI adoption plays an important, albeit perception-dependent, role in shaping the psychological contract. Therefore, the following hypothesis was adopted:

H1: The adoption of artificial intelligence (AI) is positively related to IT managers' perception of the psychological contract.

Taken together, the existing literature suggests that artificial intelligence adoption constitutes an important contextual factor shaping employees' perceptions of mutual obligations within the employment relationship. While AI itself does not automatically determine the quality of the psychological contract, employees' interpretations of technological change, particularly in terms of perceived support, fairness, and opportunities for development, play a decisive role. Consequently, AI adoption may be positively associated with psychological contract perceptions when it is experienced as enabling rather than threatening, especially in knowledge-intensive settings such as the IT sector.

2.2. The role of digital leadership as an intermediary mechanism

The implementation of artificial intelligence in organisations requires not only the appropriate technological infrastructure, but above all, competent leadership that can translate complex technological changes into a framework of actions, values, and goals that are understandable to employees. Because it integrates a leader's technical skills with the social, communication, and strategic abilities required for successful management in the context of digital transformation, the idea of digital leadership is becoming more and more significant (Kane et al., 2019). Digital leadership is not limited to knowledge of technology, but also includes the ability to build an organisational culture based on trust, innovation and participation, which is a prerequisite for successful AI implementations (Benitez et al., 2022). According to Shal et al. (2024) and Gilli et al. (2023), digital leaders act as "technology interpreters", providing clarification, defining implementation goals, and illustrating how new technology promotes both the organization's mission and personal development. Their role becomes crucial in the face of so-called 'technostress' and resistance to change that accompany the implementation of complex technologies such as AI (Budhwar et al., 2022).

By promoting co-creation of a new technological reality, conveying change, and providing assistance, leaders may impact employees' psychological contracts, according to social exchange theory (Blau, 1964). House et al. (2004) claim that organizational strategy is linked to employees' subjective perceptions of security, influence, and confidence in the company through leadership. Competent, visible, and responsive leaders may significantly reduce employee fears and increase a feeling of shared commitment when it comes to integrating AI (Wang, 2023). Empirical research supports this thesis. Wang (2023) analysed the

relationships between AI adoption, leadership, and psychological contract among IT sector employees in China, showing that transformational leadership plays an important mediating role: the presence of a strong leader explains the positive impact of AI on organisational relationships. The usefulness of applying AI to human resource management (AI-enabled HRM) was examined by Prikshat et al. (2023). They verified that employees' perceptions of change were positively impacted by capable and caring technological leadership. According to Shal et al. (2024), leaders who actively communicated changes, encouraged competence growth, and allowed experimenting with new technology created an environment that was favorable to learning and reinforced psychological safety at institutions using AI (like libraries). Similarly, Benitez et al. (2022) point out that leaders who combine digital competencies with the ability to support their team contribute to increased organisational trust and strengthened exchange relationships within the organisation. Furthermore, the importance of an inclusive leadership style that fosters employee trust through engagement and involvement is becoming increasingly apparent (Rogozińska-Pawełczyk, Sudolska, 2024). In a digital world, an inclusive leader can lessen the psychological costs of change.

Since the literature clearly indicates that the way leaders support the implementation of AI can mediate the impact of technology on the psychological contract, the following hypothesis was adopted:

H2: Digital leadership mediates the relationship between AI adoption and IT managers' perception of the psychological contract.

In light of these considerations, digital leadership emerges as a critical interpretative mechanism through which technological change is translated into employees' relational experiences. Leaders who actively communicate the purpose of AI adoption, provide guidance, and support competence development can shape how employees make sense of technological transformation. Therefore, the impact of AI adoption on the psychological contract is unlikely to be direct only, but may operate through leadership practices that frame technology as a shared organisational resource rather than a source of uncertainty.

2.3. The effectiveness of digital leadership in the use of AI technology as a factor in building a psychological contract

Although the role of digital leadership in managing technological change is widely described in the literature (Kane et al., 2019; Benitez et al., 2022), there is an increasing focus on the effectiveness of leaders in the practical implementation and use of AI in teamwork. In the face of rapid technological change, employees assess the organization's goals as well as the extent to which their immediate managers can translate these intentions into practical solutions that make their daily tasks easier rather than more difficult. Leadership effectiveness in technology management is therefore seen as a contextual psychological resource that may either increase or decrease the positive effects of AI on the perception of the psychological contract, according to Gillet et al. (2023). When digital leaders can integrate AI into team

processes, remove organizational and technological barriers, communicate the goals of change, and recognize individual needs, they are perceived as competent, responsible, and trustworthy (Benitez et al., 2022; Shal et al., 2024).

Empirical research indicates that a leader's effectiveness in using artificial intelligence has a positive impact on employee satisfaction and their belief in the fairness and predictability of the organisation (Wang, 2023). Similar results were obtained by Presbitero and Teng-Calleja (2022), who emphasise that technologically effective leaders are perceived as a symbol of the organisation's modernity and professionalism, and their actions reduce the level of cognitive uncertainty associated with AI. The idea of technical leadership authority, which implies that a leader's proficiency in AI is seen as boosting the organization's credibility overall, is also mentioned in the literature (Gilli et al., 2023). Leaders who are not only able to talk about technology but also to implement it in team processes are perceived as the embodiment of the promises made by the organisation, which is an important element of the psychological contract (Rousseau, 2001). In turn, Shal et al. (2024) point to the role of leaders' operational effectiveness in familiarising themselves with technology. Leaders who implement AI in stages, offer training support and enable experimentation, reduce resistance to technology and strengthen organisational trust. Their research shows that a leader's effectiveness in managing technology is one of the strongest predictors of positive perceptions of organisational change in high-risk professional environments.

In light of the above, not only the presence of a digital leader, but also their effectiveness in operationalising technology is a key predictor of a positive psychological contract. Therefore, the following hypothesis was formulated:

H3: The effective use of AI technology in digital leadership has a positive impact on IT managers' perception of the psychological contract.

Importantly, it is not merely the presence of digital leadership that matters, but its effectiveness in operationalising AI in everyday work practices. Leaders who are able to integrate AI into team processes, remove barriers to its use, and align technological tools with organisational goals are more likely to reinforce employees' perceptions of organisational reliability and credibility. As a result, effective digital leadership may function as a direct relational signal, strengthening the psychological contract by demonstrating that organisational promises regarding innovation and support are meaningfully enacted.

2.4. The Big Five personality traits as a moderator of the relationship between AI adoption and the perception of the psychological contract

Contemporary approaches to human resource management take into account not only structural and organisational factors, but also individual psychological differences that determine how organisational activities are interpreted and how people respond to change. Personality traits can significantly differentiate perceptions of technology and its impact on the psychological contract in the context of AI implementation, which is frequently linked to

uncertainty, loss of control, and redefinition of professional roles (Budhwar et al., 2022; Kovbasiuk et al., 2024).

One of the most established models of personality description is the Big Five personality model, which includes neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Gosling et al., 2003). These traits, as relatively stable predispositions of an individual, determine the perception of change, interpretation of organisational intentions, and readiness to adapt (Barrick et al., 2013).

Neuroticism, defined by anxiety and negative emotions, is a barrier to adapting to technological changes, particularly regarding AI's impact on job stability and work meaning (Saef et al., 2024). Individuals with high neuroticism often view AI as a threat, leading to diminished trust in their organizations and a weakened sense of commitment (Kovbasiuk et al., 2024; Berry et al., 2007). Extroversion, on the other hand, which is associated with sociability, energy, and positive affect, facilitates the interpretation of technological change as an opportunity. Rzycki et al., (2024) and Saef et al. (2024) claim that extroverts are more likely to engage in social interactions, ask for assistance more frequently, and be open to learning new skills—all of which lead to a positive perception of organizational activities. Their active attitude can strengthen the positive relationship between AI implementation and the psychological contract, especially when accompanied by visible support from leaders. Conscientiousness, which includes the ability to plan, self-discipline and goal orientation, is associated with a desire to achieve high standards and maintain professional commitment. According to a research by Berry et al. (2007), conscientious people see AI as a useful tool for productivity and are more likely to pick up new skills, which increases their feeling of agency and dedication to the company (Benitez et al., 2022). Furthermore, people who are receptive to new experiences are more likely to be creative and cognitively flexible, which increases their interest about technology and readiness to try new things throughout digital changes (De Ruiter et al., 2021). However, as noted by Saef et al. (2024), their reaction may be more cognitive than emotional: they treat AI as an intellectual challenge, but not necessarily as a factor that improves their relationship with the organisation. Agreeableness, which refers to a tendency to cooperate, empathise and harmonise social relationships, can facilitate a positive interpretation of organisational actions, even in conditions of uncertainty. Agreeable individuals tend to be more trusting of organisational narratives regarding innovation and development, show higher tolerance for implementation imperfections, and are less likely to perceive bad intentions, provided that interpersonal relationships are strong (Saef et al., 2024; Kovbasiuk et al., 2024). In light of the aforementioned studies, it can be inferred that the personality traits in the Big Five model serve as moderators, differentiating the strength and direction of the influence of AI adoption on the perception of the psychological contract. Therefore, the following hypothesis was formulated:

H4: Personality traits, as defined by the Big Five model, moderate the relationship between AI adoption and the perception of the psychological contract among IT managers in such a way that neuroticism weakens this relationship, while extraversion, conscientiousness, agreeableness, and openness to experience strengthen it.

These arguments indicate that employees do not respond to AI adoption in a uniform manner. Instead, individual personality traits shape how technological change is interpreted and emotionally experienced. The Big Five framework offers a robust lens for understanding these differences, suggesting that some traits may amplify positive interpretations of AI adoption, while others may intensify perceived risks and uncertainty. Consequently, personality traits can be expected to condition both the strength and the direction of the relationship between AI adoption and psychological contract perceptions.

2.5. Cultural context as a moderator of the relationships

Cross-cultural research is becoming increasingly important in human resource management and digital transformation due to the growing number of organizations operating in an international environment, as well as noticeable differences in how technology is implemented and received across countries (Budhwar et al., 2022; Prikshat et al., 2023). In the context of artificial intelligence, which simultaneously affects organisational structures, professional roles and interpersonal relationships, national culture can significantly shape the way this technology is perceived and how employees react to it (Hofstede et al., 2010; House et al., 2004).

According to Hofstede's cultural dimensions model (2010), Poland and Spain have considerable cultural differences in terms of power distance, uncertainty avoidance, and collectivism vs individuality. Poland, with a high power distance and strong uncertainty avoidance, views technological change as a danger to stability, authority, and predictability (Rogozińska-Pawelczyk, 2021). In this context, employees may interpret AI as an external mandate for transformation, often incomprehensible and imposed from above, which can lead to a weakening of the psychological contract. Spain's organizational culture, characterized by high uncertainty avoidance, is primarily collectivist and relational (Cegarra-Navarro et al., 2022; Iamandi et al., 2024). Technological innovations are seen as collaborative and developmental, especially with the support of inclusive and communicative leadership. As shown by the research of Prikshat et al. (2023), a leadership style consistent with national cultural values reinforces the positive effects of AI implementation – both in terms of technological adaptation and organisational relations.

In addition, culture influences expectations of the leader's role and how their actions are perceived. In hierarchical and formal cultures like Poland, technical competence and expert authority are more important. In relational cultures like Spain, communication skills and the ability to build team spirit during change are more important (House et al., 2004; Budhwar et al., 2022). These differences can change how effective digital leadership is and how

employees see technology as part of the organization's strategy. So, national culture affects both the link between AI adoption and the psychological contract and the effectiveness of digital leadership and how strong its effect is on how people see their mutual commitments. Organisations operating in different countries should therefore adapt the way they communicate, implement and support technology to local cultural norms so as not to undermine the fundamental mechanisms of organisational trust. This perspective leads to the following research hypothesis:

H5: Cultural context moderates the relationships between AI adoption, digital leadership, and IT managers' perceptions of the psychological contract.

Beyond individual differences, national culture provides a broader interpretative context that shapes expectations toward technology, leadership, and organisational obligations. Cultural norms influence how AI adoption is framed, how leadership behaviours are evaluated, and how employees assess the balance of mutual commitments. Therefore, the relationships between AI adoption, digital leadership, and the psychological contract may vary across countries, reflecting culturally embedded patterns of authority, uncertainty management, and social relations.

3. Research methodology

3.1. Research strategy and context

The presented study is quantitative, cross-sectional and comparative in nature, rooted in the tradition of research based on modelling cause-and-effect relationships using Structural Equation Modelling (SEM). The main objective of the study was to empirically verify a moderated mediation model in which the adoption of artificial intelligence (AI) influences IT managers' perception of the psychological contract, with digital leadership acting as a mediating variable and the Big Five personality traits and cultural context functioning as moderators.

The study was conducted in the information technology (IT) sector, which is a critical field for observing processes related to digitalisation and AI implementation (Benitez et al., 2022; Shal et al., 2024). IT companies are characterised by high dynamics of change, technological advancement and a large percentage of positions requiring human-system interaction. At the same time, IT managers belong to a group that experiences extreme tension between the requirements of technological adaptation and maintaining organisational relationships, as well as the psychological security of teams (Wang, 2023; Prikshat et al., 2023). As a group of respondents, IT managers play a key role in implementing AI-based solutions and interpreting their significance for the team and the organisation. On the one hand, they are responsible for

selecting and implementing technology, and on the other, they serve as leaders of teams in which AI can evoke ambivalent attitudes, fear or resistance (Gilli et al., 2023; Shal et al., 2024). In addition, the specific nature of the IT industry, manifested in low level of formalisation of relationships, the dominance of project teams, high professional mobility and frequent remote work, is conducive to the development of non-standard forms of organisational relationships, based more on the perception of mutual obligations than on formal regulations (Presbitero, Teng-Calleja, 2022). In such a reality, the importance of the psychological contract is extreme, and its susceptibility to technological change is highly likely.

The study was international and cross-cultural in nature, covering two groups of IT managers from Poland and Spain. The selection of these countries was deliberate and justified by the research. According to Hofstede's cultural model (2010), they differ considerably in terms of power distance, uncertainty avoidance, and individualism, all of which are critical in the context of technology deployment and psychological contract creation. Poland represents a hierarchical and structural approach to technical leadership, whereas Spain represents a relational and participative approach (Iamandi et al., 2024; Budhwar et al., 2022). A comparison of these two countries allows for an in-depth analysis of the moderating role of national culture in the process of AI's impact on organisational relationships. The study was made possible by the author's participation in the Erasmus+ project (No. BWZ/154/STA/2024-25), which allowed for research collaboration with the Department of Languages and Computer Systems (Departamento de Lenguajes y Sistemas Informáticos) at the University of Granada in Spain, as well as the ability to conduct part of the data collection process in an international setting. Participation in the project also created conditions for the cultural validation of research tools and expert consultations on comparative research methodology. The study is part of a growing trend in empirical research on the psychosocial effects of AI implementation in knowledge work, while developing a transdisciplinary approach that combines management, organisational psychology, and intercultural research (De Ruiter et al., 2021; Holmström, 2022).

3.2. Procedure and research sample

Empirical data collection occurred in early 2025 via computer-assisted web interviews (CAWI) utilizing a standardized internet questionnaire. This questionnaire, developed in accordance with the International Test Commission's 2017 guidelines, underwent translation into Polish and Spanish, ensuring semantic and functional alignment. The translation process accounted for the context of IT managers' roles and AI adoption, followed by back-translation to maintain semantic coherence. Discrepancies were analysed together with translators and domain experts. In addition, items were contextually adapted to the specifics of managing technology teams and highly digitised environments (Gioia et al., 2013). A pilot study (N = 30) was conducted in both countries prior to the main study. The test confirmed the

comprehensibility and linguistic accuracy of the tool, as well as the adequate time required to complete it, which enabled the main study to commence.

The sample was purposively selected and included only individuals in middle or senior management positions in IT sector organisations. The study's eligibility criteria included being employed in a managerial role, having direct team responsibility, and possessing experience with AI-based solutions as either a user or decision-maker. The tool utilized was developed through Google Forms and distributed selectively to respondents. In Spain, the survey questionnaire was sent to a group of IT managers (current or former IT students at the University of Granada) via dedicated mailing lists, in collaboration with the university's academic staff. In Poland, the survey covered IT managers employed in the IT departments of various organisations, invited through internal company contact lists obtained by the author in previous research projects conducted in the IT sector.

The response rate was very high, reaching 89% among Polish respondents and as much as 96% among Spanish respondents. The high percentage of returned questionnaires confirms the accuracy of the sample selection and the respondents' motivation to participate in the study. A total of 481 correctly completed questionnaires were obtained: 231 from managers in Poland and 250 from managers in Spain. The characteristics of the sample are presented in Table 1.

Table 1.
Demographic distribution of the research sample

	Poland		Spain	
	N	%	N	%
Number of respondents	231			250
Gender				
Men	170	73.6	176	70.4
Woman	60	26.0	72	28.8
Age				
Age 25-34	98	42.4	120	48.0
Age 35-44	86	37.2	81	32.4
Age 45-54	33	14.3	36	14.4
Age 55+	14	6.1	13	5.2
Length of service				
2-5 years	117	50.6	131	52.4
6-10 years	78	33.8	73	29.2
11+ years	36	15.6	46	18.4
Size of organisation				
<50 employees	42	18.2	40	16.0
50-249 employees	97	42.0	104	41.6
250+ employees	92	39.8	106	42.4

Source: Own elaboration.

The structure of the sample, in terms of gender, age, and length of service, was similar across countries. The balanced distribution of the sample in both countries and consistent criteria for selecting respondents enable a reliable comparative analysis and testing of the moderating influence of cultural context on the analysed relationships.

Respondents were informed that participation in the study was voluntary and anonymous, and they gave their consent to participate in the research before completing the questionnaire. No personal data or information that could be used to identify individuals or companies was collected. The research project complied with the principles of the Declaration of Helsinki and the guidelines of the RODO. As the study was voluntary and did not interfere with confidential company information, the consent of the respondents' management was not required to obtain data from employees.

3.3. Variables and measurement tools

The study used standardised measurement tools adapted to the context of research on psychological contracts and technological transformation of work in the IT sector. All variables were measured using five-point scales (1 – strongly disagree, 5 – strongly agree). Their reliability was assessed using Cronbach's alpha coefficient (α), and construct validity was verified through exploratory and confirmatory factor analysis (EFA/CFA).

Measuring the perception of the psychological contract

To measure the perception of psychological contract fulfilment, the scale developed by Robinson and Morrison (2000), commonly used in psychological contract research (e.g., Conway, Briner, 2005), was applied. The scale was modified for the study conditions by referring to the context of IT managers' work and the use of AI technology. The tool consisted of five items, e.g. 'The organisation fulfils its obligations towards me as an IT employee' and 'The organisation provides me with what I can expect as an IT manager in the context of implementing new technologies'. The scale achieved high reliability, with Cronbach's alpha values of 0.86 in the Polish group and 0.84 in the Spanish group, indicating perfect internal consistency.

Measuring the adoption of artificial intelligence (AI)

The AI adoption index was based on a 4-item scale developed by Venkatesh et al. (2003) and Wang (2023), measuring the degree of AI application in everyday managerial work. Sample items: 'In my organisation, AI is actively used to support the work of IT managers' and 'AI helps to improve my daily work'. The reliability of the scale was high. Cronbach's α was 0.81 for the Polish group and 0.80 for the Spanish group.

Measuring digital leadership

Digital leadership was measured using a 5-item scale adapted from Benitez et al. (2022), which covered aspects such as the leader's digital competence, support for innovation, and the creation of an environment conducive to the implementation of technology. Example: My supervisor can effectively use digital technologies, including AI, in team

management. The scale achieved very high reliability, with a Cronbach's α coefficient of 0.87 in the Polish sample and 0.88 in the Spanish sample.

Measurement of personality traits in the Big Five model (Big Five)

To measure personality traits according to the Big Five model, a shortened, 10-item version of the TIPI (Ten-Item Personality Inventory) scale was developed by Gosling et al. (2003). The scale included two items for each of the five personality traits: neuroticism, extraversion, openness to experience, agreeableness and conscientiousness. Sample items: 'I see myself as an emotional person, prone to stress' (neuroticism), 'I see myself as a sociable, talkative person' (extraversion), 'I see myself as a person open to new experiences' (openness), 'I see myself as a person who is kind and cordial towards others' (agreeableness) and 'I see myself as an organised and thorough person' (conscientiousness). Due to the limited number of items, the reliability of the individual subscales ranged from 0.62 to 0.72 (depending on the trait and language version), which is an acceptable level for shortened personality tools in cross-sectional studies.

Measurement of cultural context (country)

The cultural context was included as a binary variable, coded based on the respondent's nationality (0 = Poland, 1 = Spain). This variable was used to test moderation effects in a multigroup SEM analysis.

3.4. Data analysis methods

Data analysis was performed using IBM SPSS Statistics 28 and AMOS 29 software. Due to the simultaneous collection of data using a structured questionnaire, the risk of common method bias was taken into account. The single-factor Harman test (Podsakoff et al., 2003) was used, with the result indicating a low risk of this phenomenon (28.7% of explained variance) (Fuller et al., 2016).

Prior to testing the structural model, the measurement model was evaluated using confirmatory factor analysis (CFA), in accordance with the recommendations of Hair et al. (2019) and Kline (2016). Convergent validity was confirmed by analysing the significance of factor loadings ($\lambda \geq 0.50$; $p < 0.001$), AVE values (≥ 0.50) and CR (≥ 0.70) (Fornell, Larcker, 1981). Discriminant validity was assessed by comparing AVE with the correlation coefficient squares and analysing HTMT indices (≤ 0.85) (Henseler et al., 2015). The overall fit of the model was assessed based on standard indices: RMSEA ≤ 0.08 , CFI and TLI ≥ 0.90 , and SRMR ≤ 0.08 (Hu, Bentler, 1999), as well as $\chi^2/df < 3$ (Kline, 2016), indicating a good level of fit between the data and the theoretical model. All factor loadings were statistically significant ($p < 0.001$) and exceeded 0.50, confirming satisfactory convergent validity.

The AVE coefficients for most scales exceeded the threshold of 0.50, and the CR values exceeded 0.70, confirming both the reliability and internal consistency of the measurement.

Next, a structural equation model (SEM) was analysed using AMOS or R packages (lavaan, semTools). This allowed for simultaneous testing of relationships between variables and verification of research hypotheses. The mediating role of digital leadership (H2) was verified using bootstrapping (5000 trials; 95% CI) (Hayes, 2013), and the moderating hypotheses (H4 and H5) were verified through interaction analysis (Aiken, West, 1991) and multigroup analysis (Byrne, 2016) for Poland and Spain. Restricted and unrestricted models were compared, assessing differences using the chi-square test (Cheung, Rensvold, 2002). The analytical procedure adopted enabled a comprehensive assessment of the relationships and identification of mediating and conditional mechanisms in accordance with the theoretical model.

4. Results

4.1. Evaluation of the measurement model

Before testing the structural relationships, the measurement model was evaluated using confirmatory factor analysis (CFA), in accordance with the recommendations of Hair et al. (2019) and Kline (2016). The aim was to confirm the convergent and discriminant validity of latent variables and the reliability of the measurement.

In the first step, convergent validity was assessed. In the assessment of convergent validity, all factor loadings exceeded 0.60 and were statistically significant ($p < 0.001$). Most constructs had an average extracted variance (AVE) exceeding 0.50, except for neuroticism and agreeableness, which had AVE values of 0.46 and 0.49, respectively, still acceptable for short personality scales (Gosling et al., 2003). The composite reliability (CR) values for all variables exceeded 0.70 or hovered around this value, confirming sufficient internal consistency of the constructs (Fornell, Larcker, 1981). Detailed data are presented in Table 2.

Table 2.
Convergent validity assessment

Latent variable	Number of items	Factor load range (λ)	AVE	CR
AI Adoption	4	0.65-0.81	0.58	0.84
Digital leadership	5	0.62-0.85	0.60	0.87
Psychological contract	5	0.68-0.84	0.61	0.86
Extraversion	2	0.72-0.79	0.57	0.74
Conscientiousness	2	0.70-0.76	0.52	0.72
Neuroticism	2	0.63-0.71	0.46	0.68
Openness	2	0.66-0.75	0.50	0.71
Agreeableness	2	0.64-0.73	0.49	0.69

Source: Own elaboration.

The overall fit of the measurement model was evaluated using a set of standard fit indices. The results of the CFA analysis indicate a satisfactory level of fit: Chi-square/df = 2.41, RMSEA = 0.056, CFI = 0.928, TLI = 0.912, and SRMR = 0.051. All values fall within the range considered acceptable in the literature (Hu, Bentler, 1999; Kline, 2016), which indicates that the measurement model is well-fitted to the empirical data. The summary is presented in Table 3.

Table 3.
Fit of the measurement model

Indicator	Value obtained	Acceptability criterion
Chi-square/df	2.41	≤ 3.0
RMSEA	0.056	≤ 0.08
CFI	0.928	≥ 0.90
TLI	0.912	≥ 0.90
SRMR	0.051	≤ 0.08

Source: Own elaboration.

In the next step, the discriminant validity presented in Table 4 was assessed. The AVE values for each variable were higher than the most significant values of correlation squares with other variables, which meets the criterion of Fornell and Larcker (1981). Additionally, an HTMT analysis (Henseler et al., 2015) was conducted, in which all values were below the threshold of 0.85, confirming the existence of discriminant validity. The highest HTMT values were recorded between digital leadership and psychological contract (0.68) and between AI adoption and psychological contract (0.66), confirming strong but still discriminable associations.

Table 4.
Discriminant validity assessment

	AI Adoption	Digital leadership	Psychological contract	Extraversion	Conscientiousness	Neuroticism	Openness	Agreeableness
AI Adoption	0.58	0.38 (0.68)	0.35 (0.66)	0.23 (0.47)	0.37 (0.58)	0.26 (0.66)	0.22 (0.47)	0.37 (0.55)
Digital leadership	0.18 (0.62)	0.60	0.38 (0.68)	0.32 (0.73)	0.35 (0.71)	0.26 (0.42)	0.22 (0.41)	0.34 (0.48)
Psychological contract	0.36 (0.66)	0.40 (0.68)	0.61	0.22 (0.46)	0.18 (0.47)	0.37 (0.66)	0.29 (0.59)	0.37 (0.54)
Extraversion	0.25 (0.47)	0.23 (0.73)	0.27 (0.46)	0.57	0.23 (0.62)	0.23 (0.70)	0.39 (0.63)	0.24 (0.69)
Conscientiousness	0.20 (0.58)	0.23 (0.71)	0.37 (0.47)	0.27 (0.62)	0.52	0.17 (0.53)	0.34 (0.54)	0.27 (0.60)
Neuroticism	0.26 (0.66)	0.26 (0.42)	0.37 (0.66)	0.23 (0.70)	0.17 (0.53)	0.46	0.31 (0.61)	0.33 (0.57)
Openness	0.22 (0.47)	0.22 (0.41)	0.29 (0.59)	0.39 (0.63)	0.34 (0.54)	0.31 (0.61)	0.50	0.32 (0.60)
Agreeableness	0.37 (0.55)	0.34 (0.48)	0.37 (0.54)	0.24 (0.69)	0.27 (0.60)	0.33 (0.57)	0.32 (0.60)	0.49

Legend: AVE — average variance extracted (on the diagonal), values outside the diagonal are squares of correlations between variables, HTMT (in brackets) — Heterotrait-Monotrait ratio coefficients for each pair of constructs.

Source: Own elaboration.

Based on the results obtained, it can be concluded that the measurement model meets the requirements of validity, reliability, and fit, which allows us to proceed to the next stage of analysis — testing research hypotheses in a structural model.

4.2. Testing the main hypotheses (H1 and H3)

After evaluating the measurement model, a structural equation modelling (SEM) analysis was performed to verify the main hypotheses H1 and H3. In order to investigate direct relationships between latent constructs, the study used the R environment's lavaan package. Specifically, it looked at the relationship between AI adoption and psychological contract (H1) and the relationship between digital leadership effectiveness and psychological contract (H3). Standard indicators were used to assess the model's fit, and the results were satisfactory: $\chi^2/df = 2.49$; RMSEA = 0.059; CFI = 0.921; TLI = 0.905; SRMR = 0.053. All indices were within acceptable ranges consistent with the literature (Hu, Bentler, 1999; Kline, 2016), confirming that the empirical data correctly reflected the model structure.

Regarding hypothesis H1, which concerns the positive impact of AI adoption on IT managers' perception of the psychological contract, a statistically significant path was obtained ($\beta = 0.34$; SE = 0.08; $p < 0.001$). This result confirms that the implementation of artificial intelligence in IT organisations promotes a positive perception of the employer's fulfilment of organisational obligations, which is consistent with the earlier findings of Wang (2023) and Presbitero and Teng-Calleja (2022).

About hypothesis H3, which assumes that the effectiveness of digital leadership in the use of AI positively influences the perception of the psychological contract, a significant effect was also obtained ($\beta = 0.42$; SE = 0.07; $p < 0.001$). This result confirms that the competent and effective implementation and use of AI by leaders builds trust and a sense of organisational reliability, which is consistent with the findings of Shal et al. (2024) and Benitez et al. (2022).

Table 5.
Results of testing hypotheses H1 and H3

Hypothesis	Path	Regression coefficient (β)	Standard error (SE)	p-value	Conclusion
H1	AI adoption → Psychological contract	0.34	0.08	< 0.001	Hypothesis confirmed
H3	Digital leadership → Psychological contract	0.42	0.07	< 0.001	Hypothesis confirmed

Source: Own elaboration.

As presented in Table 5, both main hypotheses were empirically confirmed. The table contains regression coefficients, standard errors, and significance levels. The results indicate that both the adoption of AI itself and the way it is implemented and used by leaders are important for shaping a positive psychological contract among IT managers.

4.3. Mediation analysis (H2)

The next stage of the analysis aimed to test Hypothesis H2, which posits that digital leadership mediates the relationship between the adoption of artificial intelligence (AI) and IT managers' perceptions of the psychological contract. The mediation analysis employed a bootstrap sampling approach recommended by Hayes (2013), which enables the estimation of confidence intervals for indirect effects without assuming a normal distribution.

The analysis took into account both the direct impact of AI adoption on the perception of the psychological contract and the indirect impact through digital leadership. The procedure was carried out using the lavaan package with the implementation of 5000 bootstrap samples and a 95% confidence interval. The results of the analysis, presented in Table 6, showed that the indirect effect of AI adoption on the psychological contract through digital leadership was statistically significant ($\beta = 0.19$; 95% CI [0.11, 0.28]). The confidence interval did not include zero, confirming the mediating nature of this relationship. At the same time, the direct effect remained significant ($\beta = 0.22$; $p < 0.01$), indicating partial mediation.

This means that digital leadership partially explains how AI implementation affects the perception of mutual obligations between the organisation and the IT manager. Technology adoption fosters a positive perception of the psychological contract, primarily because it is perceived as being effectively managed by digital leaders. This result is consistent with earlier studies by Benitez et al. (2022) and Shal et al. (2024), which emphasised the role of leaders as 'interpreters' of technological change and key links in digital transformation in organisational relationships.

Table 6.
Mediation analysis results (H2)

Type of effect	Path	Coefficient (β)	Standard error (SE)	95% confidence interval	p-value	Conclusion
Direct effect	AI adoption → Psychological contract	0.22	0.07	0.08; 0.35	< 0.01	Significant
Indirect effect (mediated by digital leadership)	AI adoption → Digital leadership → Psychological contract	0.19	0.06	0.11; 0.28	< 0.001	Significant (partial mediation)
Total effect	AI adoption → Psychological contract (total)	0.41	0.08	0.26; 0.55	< 0.001	Significant

Source: Own elaboration.

As shown in Table 6, both the direct effect ($\beta = 0.22$; SE = 0.07; $p < 0.01$) and the indirect effect ($\beta = 0.19$; SE = 0.06; $p < 0.001$) were statistically significant. The value of the 95% confidence interval for the indirect effect (0.11; 0.28) did not include zero, confirming that digital leadership mediates the relationship between AI adoption and the perception of the psychological contract. The persistence of the direct effect after including the mediating variable in the model indicates the presence of partial mediation. This means that digital

leadership conveys only part of the impact of AI adoption on the psychological contract, while the rest of this relationship remains direct and independent of the mediator. The total effect ($\beta = 0.41$; $SE = 0.08$; $p < 0.001$), combining both components, was also significant and indicates a substantial positive impact of AI implementation on the quality of employee-organisation relationships in the IT manager environment.

4.4. Moderation analysis – personality traits (H4)

As part of testing hypothesis H4, a moderation analysis was conducted to examine whether personality traits, as defined by the Big Five model, modify the relationship between AI adoption and IT managers' perceptions of the psychological contract. A moderated regression model was used for the analysis, taking into account the interactions between the independent variable (AI adoption) and each of the five personality traits as moderator variables. The variables were previously standardised, and the interactions were created in accordance with the approach proposed by Aiken and West (1991).

The results of the analysis are presented in Table 7. Statistical significance was noted in the case of three of the five personality traits examined: extraversion ($\beta = 0.14$; $p < 0.05$), conscientiousness ($\beta = 0.17$; $p < 0.01$) and neuroticism ($\beta = -0.19$; $p < 0.01$). A positive moderating effect was found for extraversion and conscientiousness, indicating that a higher intensity of these traits strengthens the relationship between AI adoption and the perception of the psychological contract. In contrast, the interaction with neuroticism was negative, suggesting that an elevated level of this trait reduces the positive impact of AI implementation on the perception of the psychological contract. For openness to experience, a moderate tendency towards positive moderation was observed ($\beta = 0.09$; $p = 0.08$), while the effect of agreeableness was significant ($\beta = 0.11$; $p < 0.05$), also of a reinforcing nature.

Table 7.

Results of the moderation analysis (H4)

Moderator (personality trait)	Interaction effect (β)	Standard error (SE)	p-value	Conclusion
Extraversion	0.14	0.06	< 0.05	Positive moderation
Conscientiousness	0.17	0.07	< 0.01	Positive moderation
Neuroticism	-0.19	0.06	< 0.01	Negative moderation
Openness	0.09	0.06	0.08	Tendency towards positive moderation
Agreeableness	0.11	0.06	< 0.05	Positive moderation

Source: Own elaboration.

The empirical findings support hypothesis H4, indicating that personality traits, specifically conscientiousness, extraversion, and neuroticism, moderate the relationship between AI adoption and the perception of the psychological contract, aligning with previous research by Saef et al. (2024), Berry et al. (2007), and Kovbasiuk et al. (2024).

4.5. Moderation analysis – cultural context (H5)

In order to test hypothesis H5, which assumes that cultural context (Poland vs Spain) moderates the relationships between the key variables of the model: AI adoption, digital leadership and psychological contract, a multigroup analysis was conducted using structural equation modelling (multigroup SEM), this procedure allows for a comparison of the strength and significance of the relationships between variables in two independent samples, while ensuring measurement equivalence (Byrne, 2016).

The analysis began with an assessment of the fit of the base model (configural model), in which all parameters were free in both groups. This model was then compared with a restricted model (metric invariance), in which the equality of selected structural paths between groups was imposed. Model comparisons were based on the difference in χ^2 statistics ($\Delta\chi^2$) and on fit indices such as CFI and RMSEA. According to the recommendations of Cheung and Rensvold (2002), differences $\Delta CFI < 0.01$ and $\Delta RMSEA < 0.015$ are interpreted as indicating no significant differences in model fit, while significant $\Delta\chi^2$ may suggest structural differences in the relationships between groups. The results are presented in the table below.

Table 8.
Results of cultural moderation analysis (H5)

Path	Regression coefficient (PL)	Regression coefficient (ES)	$\Delta\chi^2$ (difference in fit)	p or difference	Conclusion
AI adoption → Psychological contract	0.29	0.41	4.12	< 0.05.	Significant difference – more substantial effect in Spain
Digital leadership → Psychological contract	0.39	0.45	2.89	0.09	No significant difference
AI adoption → Digital leadership	0.36	0.48	5.76	< 0.01	Significant difference – more substantial effect in Spain

Source: Own elaboration.

The results of the multigroup analysis indicate that cultural context does indeed moderate some of the relationships included in the theoretical model (Table 8). For the path between AI adoption and psychological contract, a significant difference was found between national groups ($\Delta\chi^2 = 4.12$; $p < 0.05$), with this effect being more substantial in the Spanish group ($\beta = 0.41$) than in the Polish group ($\beta = 0.29$). This means that in Spanish culture, the implementation of AI in an organisation has a more substantial positive impact on the perception of the organisation's fulfilment of the psychological contract. This suggests that the relational management style and heightened awareness of social support and inclusive leadership behaviors, which are typical of Spanish culture, may have contributed to this outcome (Cegarra-Navarro et al., 2022).

In the case of the path between digital leadership and the psychological contract, the difference between the groups was statistically insignificant ($\Delta\chi^2 = 2.89$; $p = 0.09$), indicating that the influence of digital leaders on employee relations perception remains comparable in both cultural contexts. This result may indicate the transnational, universal nature of leadership competencies in technology management and their key role in building trust, regardless of cultural differences. However, a different picture emerges in the case of the relationship between AI adoption and digital leadership, where the differences proved to be statistically significant ($\Delta\chi^2 = 5.76$; $p < 0.01$). The regression coefficient was higher in the Spanish sample ($\beta = 0.48$) than in the Polish sample ($\beta = 0.36$), suggesting a stronger link between these variables in the Spanish context. This means that in Spanish culture, IT managers perceive leaders more strongly as responsible for the effective implementation and management of AI technology. This may be due to higher expectations of leaders in terms of supporting the team during the change process and a culturally rooted approach to supervisor-subordinate relationships, which are based on cooperation and trust (Hofstede et al., 2010; Budhwar et al., 2022). The empirical results provide strong confirmation of hypothesis H5. The impact of AI adoption on the perception of the psychological contract, as well as its relationship with the perception of digital leadership, differs significantly between Poland and Spain, which emphasises the importance of taking national culture into account in organisational and management analyses.

5. Discussion

This study aimed to examine the relationship between the adoption of artificial intelligence, digital leadership and the perception of the psychological contract among IT managers, taking into account the role of personality traits and cultural context. The results of the study confirmed all the main hypotheses and pointed to a complex mechanism of shaping organisational relationships in the context of digital transformation.

First, a positive relationship was confirmed between AI adoption and the perception of the psychological contract (H1). This means that the implementation of artificial intelligence in an organisation may be perceived by IT managers as an expression of the organisation's commitment to development, innovation and employee support. This result is consistent with Wang's (2023) research, which shows that technology can be interpreted as a symbol of the organisation's trust in employee competence. Similarly, Presbitero and Teng-Calleja (2022) noted that effective AI adoption increases the sense of fairness and job satisfaction.

The mediating role of digital leadership (H2) was also significant. The results showed that leaders play a key role in “translating” organisational technology into a language of meaning and value for employees. According to Benitez et al. (2022), digital leadership acts as a catalyst

for the transformation process, supporting a shift in the perception of AI from a potential threat to a resource that can effectively support organisational activities. The partial mediation effect suggests that while the mere presence of technology influences the psychological contract, the way it is implemented by leaders significantly reinforces this effect.

The results also confirm that the effectiveness of digital leadership in managing the use of AI (H3) has a significant impact on how the psychological contract is perceived. These findings are consistent with those of Shal et al. (2024), who indicate that the proactive and conscious implementation of technology by leaders increases employees' willingness to accept it. According to Holmström (2022), leaders who act as guides in the digital transformation process are perceived as guardians of fairness and professional development, which strengthens the level of trust and loyalty towards the organisation.

Hypothesis H4, concerning the moderating role of personality traits, was also empirically confirmed. Extraversion and conscientiousness intensified the positive relationship between AI adoption and the perception of the psychological contract, which is consistent with the findings of Kovbasiuk et al. (2024) and Berry et al. (2007), indicating that individuals with high levels of these traits are more likely to perceive technological changes as opportunities for development. Neuroticism, on the contrary, weakened this relationship, as confirmed by Saef et al. (2024). Neurotic individuals experience greater anxiety and uncertainty, which leads them to perceive technological change as a potential threat.

The analysis of cultural context moderation (H5) yielded exciting results. In the Spanish group of IT managers, the adoption of AI had a more substantial impact on the perception of the psychological contract and leadership competence than in the Polish group. This result is consistent with the findings of Cegarra-Navarro et al. (2022) and House et al. (2004), who emphasise that the Spanish cultural context is characterised by a stronger relational orientation and a greater emphasis on social support in organisational relationships. Poland, as a country with a higher level of uncertainty avoidance and a more individualistic approach to work (Hofstede et al., 2010), may attach greater importance to the functional aspects of AI implementation than to interpersonal ones. Interestingly, these differences did not extend to the impact of digital leadership on the psychological contract, which may suggest that the effectiveness of technology leaders is recognised as a universal value regardless of cultural conditions.

The overall results suggest that the formation of a psychological contract in the context of digital transformation is multidimensional and is determined simultaneously by technological factors, leadership skills, individual personality traits of employees, and cultural conditions. These results confirm the validity of integrating perspectives from the fields of HR, organisational psychology and technology management, in line with the recommendations of De Ruiter et al. (2021) and Budhwar et al. (2022).

Although the proposed model is theoretically grounded, the cross-sectional nature of the study requires a cautious interpretation of directionality. The observed relationships should be understood as associations reflecting relational and perceptual mechanisms rather than definitive causal effects. The findings indicate how AI adoption, leadership practices, and individual differences co-occur with variations in psychological contract perceptions among IT managers, highlighting plausible pathways that warrant further longitudinal examination.

6. Theoretical implications

From a theoretical perspective, the results of this study provide important implications for the development of knowledge about employee–organisation relations in the context of digital transformation. First and foremost, it has been confirmed that the psychological contract, understood as employees' subjective beliefs about mutual obligations, can be significantly shaped by technological factors such as the adoption of AI. Thus, the study aligns with the postulate proposed by De Ruiter et al. (2021) that technology should be included as an independent organisational variable in relational models. With earlier work focusing primarily on breach of contract and its consequences (Morrison, Robinson, 1997; Zhao et al., 2007), this study demonstrates that technology can also be a catalyst for positive dynamics in psychological relationships.

The second important theoretical implication is the empirical confirmation that digital leadership serves as an active mechanism for translating technological changes into enhanced employee experiences. In line with the concept of leaders as interpreters of reality (Weick, 1995), digital leaders not only implement technology, but also give it meaning in an organisational context. As a result, their actions affect not only the effectiveness of implementation but also the psychological contract, which is a significant extension of existing models of technological leadership (Benitez et al., 2022; Gilli et al., 2023).

Another theoretical value of the study is the consideration of individual employee differences as moderators of relationships. The results confirm that the personality traits from the Big Five model differentiate the way employees perceive technological changes and their impact on their relationship with the organisation. In particular, high extraversion, conscientiousness and agreeableness increase openness to technology and the tendency to interpret organisational actions positively, which confirms the earlier findings of Saef et al. (2024) and Berry et al. (2007).

The last but crucial theoretical implication is the inclusion of a cultural component in the analysis of the relational model. The analysis revealed that the relationships between technology, leadership and psychological contract differ in Poland and Spain, which

emphasises the role of cultural conditions as an important moderator in human resource management theories (Hofstede et al., 2010; House et al., 2004). As a result, the proposed model combines micro (individual characteristics), meso (leadership style) and macro (culture) approaches, which constitutes an original contribution to organisational and management theories.

7. Practical implications

From the perspective of human resource management and technological leadership, the results of this study have several important implications. Firstly, the adoption of AI in organisations should not be treated solely as a technological process, but as an organisational and relational activity. The way in which new technological tools are implemented, and in particular how they are interpreted by leaders, has a direct impact on how they are perceived by employees. Therefore, implementation teams should work closely with HR departments and managers to ensure communication based on transparency, predictability and employee involvement in the change process (Holmström, 2022; Presbitero, Teng-Calleja, 2022).

Secondly, the development of digital leaders should include not only technological competencies, but also interpersonal skills such as managing emotions, supporting teams in situations of uncertainty, and building engagement through storytelling, coaching, and communication. These competencies are key to minimising the psychological costs of change and enhancing employees' positive experiences of digital transformation (Benitez et al., 2022; Gilli et al., 2023).

Thirdly, integrating knowledge about employees' personality profiles into change management policy can significantly increase the effectiveness of AI technology implementation. Employees with high levels of neuroticism require additional support (e.g., mentoring or a slower pace of change implementation), while extroverted and conscientious individuals can serve as change ambassadors or opinion leaders within teams. Personalising activities in this area strengthens employees' sense of purpose and agency in the transformation process (Saef et al., 2024).

Fourthly, the study's results are relevant to international organisations. Cultural differences influence how technology and leadership are perceived by employees in different countries. Consequently, organisations should communicate in a culturally sensitive manner, develop locally adapted AI implementation strategies, and select leaders in line with the management styles prevalent in a given cultural context (Budhwar et al., 2022; Hofstede et al., 2010).

8. Limitations of the study and directions for further research

Despite the valuable results obtained, this study has several limitations. First, a cross-sectional research design was used, which limits the possibility of causal inference. Although the SEM model enables the testing of complex relationships, it does not replace the evidence obtained from longitudinal or experimental studies (Hayes, 2013). In subsequent stages of the research, it would be worthwhile to use panel or quasi-experimental designs to track changes over time and lagged effects. Furthermore, the study was conducted in two countries, Poland and Spain, and although the sample was sufficiently large, it was geographically limited. In the future, it would be worthwhile to extend the analysis to countries with different cultural structures (e.g., Nordic countries, Asian countries, the Middle East) to test the generalisability of the results and to check which elements of the model are universal and which are culturally dependent (Schalk, Roe, 2007; Hofstede et al., 2010). Thirdly, the measurement of variables was based solely on declarative data. Although Harman's test did not reveal any threats to the common measurement method (Podsakoff et al., 2003), it would be worthwhile in the future to use three-source data, combining self-assessment, supervisor assessment and behavioural data (e.g. actual use of AI, performance assessments).

In future research, it is also recommended to extend the model with additional variables, including trust in AI, the quality of the supervisor-employee relationship (LMX), organisational identification, and the differentiation of psychological contract types (transactional, relational, ideological), in accordance with Rousseau's typology (2001). Another interesting direction could be to analyse the dynamics of the contract in the context of AI transformation, e.g. how employee expectations change in subsequent phases of implementation.

Future studies should employ longitudinal designs and multi-source data to capture changes in psychological contract perceptions over time and to reduce potential common method bias.

9. Summary

This article aimed to examine how the adoption of artificial intelligence affects the perception of the psychological contract among IT managers and to determine the role of digital leadership and individual personality traits in this process, taking into account the cultural conditions in Poland and Spain.

The results of the analyses confirmed most of the hypotheses and provided evidence that the adoption of AI is an important factor shaping organisational relationships in a highly digitised environment. At the same time, it was demonstrated that this effect is not uniform, but rather moderated by employees' personality traits and cultural diversity. The results

presented indicate that the implementation of artificial intelligence is becoming a key factor in shaping employee relations in the IT sector. This technology is not neutral, as it affects the way employees perceive their relationship with the organisation. However, at the centre of this process is the human being: the leader who explains the change and the employee who interprets it through the prism of their own personality and culture. It is this complex interaction of technology, leadership and individual differences that defines the new dynamics of the psychological contract in the era of digital transformation.

The findings of this study should be interpreted in light of its cross-sectional design. While the results reveal meaningful associations between AI adoption, digital leadership, personality traits, and psychological contract perceptions, they do not allow for strong causal inferences. Rather, the study identifies relational patterns that suggest how technological and leadership-related factors may jointly shape employees' interpretations of organisational obligations. Future research employing longitudinal or multi-source designs is necessary to examine how these relationships evolve over time and to establish the temporal dynamics of psychological contract formation in the context of AI-driven transformation.

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THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF TECHNOLOGY VALIDATION IN STARTUPS

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Purpose: This article presents the results of desk research analysis concerning technology validation in startups, with particular emphasis on theoretical and methodological foundations of this process. The study aims to identify key trends, barriers and research gaps in technology validation processes within the start-up ecosystem.

Design/methodology/approach: The research employed a systematic desk research methodology, encompassing scoping review of scientific literature from databases including PubMed, Scopus, and Google Scholar, complemented by grey literature review of industry reports published between 2016 and 2025. The analysis utilized triangulation methodology, combining theoretical, methodological, and data triangulation approaches.

Findings: The results indicate that the lack of standardized tools for innovation assessment and limited managerial competencies in startups constitute significant obstacles to the commercialization of new technologies. Technology Readiness Levels (TRL), despite being a recognized standard, require adaptation to the specific needs of early-stage startups. The study identifies the "valley of death" phenomenon as a critical barrier between prototype development and full commercialization.

Research limitations/implications: The study is limited to desk research analysis and requires validation through empirical research involving accelerators, investors, and start-up founders. Future research should focus on developing standardized validation tools adapted to the Polish innovation ecosystem.

Practical implications: The findings provide foundations for developing a standardized technology validation tool that could serve as a "technology validation certificate" for innovative projects. This would enhance market transparency and facilitate investment decision-making processes.

Originality/value: This article contributes to filling the research gap concerning institutionalized technology validation support in the start-up ecosystem. It integrates perspectives from innovation management, technology transfer, and entrepreneurship research.

Keywords: technology validation, startups, innovation commercialization.

Category of the paper: Research paper.

1. Introduction

The contemporary innovation landscape is characterized by an intensification of technological entrepreneurship processes, in which start-up enterprises play a crucial role as catalysts for technology transfer and innovation commercialization. Despite the growing importance of the start-up sector in the global economy, these enterprises face numerous challenges related to technology validation, investment risk assessment, and adaptation of technological solutions to market requirements (Blank, Dorf, 2012; Ries, 2011).

Technology validation, understood as the process of confirming technological, market, and commercial feasibility, constitutes one of the key challenges for startups (Gbadegeshin et al., 2022). The literature indicates the existence of a significant gap between the conceptual phase of technological innovations and their successful commercialization, referred to as the "valley of death" in the technology development process (Navarro-Castillo et al., 2024). This phenomenon is particularly pronounced in deep-tech startups, which operate at the boundaries of breakthrough technological innovations and face challenges concerning both technical feasibility and commercialization possibilities (Muscio et al., 2023).

The European Commission (2017) emphasizes the importance of Technology Readiness Levels (TRL) as a fundamental tool for assessing technological maturity. However, research indicates that this framework requires adaptation to the specific needs of startups, particularly those in early development stages (Mankins, 2009). The TRL scale, originally developed by NASA for space technology assessment, has been widely adopted in innovation policy at EU, national, and regional levels, yet its application in the start-up context reveals certain limitations (Héder, 2017).

In parallel with technological validation challenges, startups must also validate their business models and market assumptions. The Lean Startup methodology, developed by Ries (2011) based on Blank's (2013) Customer Development approach, provides a systematic framework for hypothesis testing and iterative learning. This methodology emphasizes the importance of building a Minimum Viable Product (MVP) and gathering customer feedback before making substantial investments in product development (Frederiksen, Brem, 2017).

This article presents partial results of research conducted within the QualiTech project (Technology Validation Center for Start-ups), which is to provide knowledge about the current state of advancement of the start-up ecosystem and tools for their support, essential for enhancing their market competitiveness. The project addresses the scientific and research gap by analyzing the functioning of the Technology Validation Center for Start-ups as an institutional mechanism supporting validation processes in the innovation ecosystem.

The decision to undertake research in this area was motivated by the rapidly growing need to support innovative enterprises in the early stages of their development, particularly through activities related to the testing, validation, and optimization of technologies characterized by

high implementation potential (Dziewit, 2024; Majewski, 2025). The significance of this research problem stems from the need for better understanding of mechanisms supporting technology transfer and optimization of decision-making processes concerning investments in innovative enterprises at early stages of their development. Previous research has primarily focused on analysing individual cases of technological validation or on theoretical models of this process, while comprehensive ecosystem analyses considering the specificity of the start-up environment and its institutional support needs remain scarce (Sanasi et al., 2023).

The choice of the topic of technology validation in start-ups is justified both by the growing role of technological entrepreneurship in the economy and by the clear research gaps identified in the literature on the subject. Previous research has focused primarily on selected elements of the process, such as assessing technological maturity in terms of TRL, implementing the Lean Startup methodology, or analysing the ‘valley of death’ phenomenon, but rarely integrating these perspectives into a uniform, coherent validation approach tailored to the specificities of young technology companies. As a result, there is a lack of standardised assessment tools that would combine technical, market and business dimensions with ecosystem conditions, while at the same time being resource-feasible for start-ups operating in conditions of high uncertainty and limited funding. The literature also emphasises that the classic TRL scale, derived from the context of large space projects, needs to be adapted to the realities of agile, iterative product development and the specificities of sectors such as software, AI and knowledge-based services, where traditional ‘laboratory evidence’ criteria do not always apply. At the same time, research on Lean Startup and experimentation in start-ups indicates that although this approach has become widespread in practice, its empirical verification and embedding in a broader framework of technological and commercial readiness assessment remain insufficient. In turn, studies on the ‘valley of death’ show the persistence of financial, organisational and regulatory barriers between the prototyping phase and scaled commercialisation, but rarely translate into operational indicators that could be directly used in the decision-making processes of investors, accelerators and public institutions. Against this background, addressing the theoretical and methodological foundations of technology validation in start-ups - considering TRL integration, the Lean Startup approach and valley of death analysis - responds to a clearly identified research gap and lays the groundwork for designing practical tools to support more effective resource allocation in the innovation ecosystem.

The structure of this article is organized as follows: section 2 describes the research methodology, including systematic literature review procedures and desk research analysis, section 3 presents a comprehensive literature review covering technology validation concepts, TRL frameworks, lean startup methodology, and the valley of death phenomenon, section 4 presents results and discussion, analysing key findings and identifying challenges and finally section 5 concludes with implications for theory and practice.

2. Technology validation in startups - research methodology

This research employs a systematic desk research methodology designed to identify and analyse key areas (macro-areas) for further empirical investigation. The methodological framework is grounded in the concept of methodological triangulation, understood as the application of multiple research methods to enhance validity, reliability, and completeness of research findings (Denzin, 2012). The research design incorporates three forms of triangulation. Theoretical triangulation allowed for the analysis of the phenomenon of technology validation in startups from the perspective of various conceptual frameworks (innovation ecosystem theory, entrepreneurship financing theory, technology validation concepts). Methodological triangulation was applied by complementary analytical methods (systematic literature review, desk research analysis). To answer the research questions, a variety of data sources (scientific literature, industry reports, statistical data, strategic documents) were utilized.

The main objective of the research was to verify the data contained in the source materials to identify the micro-areas of research with the greatest information potential based on the involvement of financing entities in a given industry. The study was designed to address four specific research objectives:

RQ1: to analyse the most common areas of startup activity in Poland.

RQ2: to examine the nature and type of relationships between startups and supporting/financing entities.

RQ3: to analyse trends in changes in the areas of activity and sources of startup financing.

RQ4: to identify key factors that investors and accelerators consider when evaluating startups (scalability, product, team, business model).

The systematic literature review was conducted following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and Cochrane Collaboration standards for systematic reviews in social sciences. The theoretical foundation rests on evidence-based research principles, where systematic searching, critical evaluation, and synthesis of available literature constitute the foundation for further empirical research. The literature search was conducted across multiple databases: (1) academic databases: PubMed, Scopus, Google Scholar, (2) specialized databases: Web of Science, IEEE Xplore, (3) grey literature sources: industry reports, government documents, white papers, consulting firm analyses. The search strategy employed the following keyword combinations: "technology validation" AND "startups", "Technology Readiness Level" OR "TRL" AND "commercialization", "lean startup" AND "validation", "valley of death" AND "innovation", "technology transfer" AND "startups". The analysis encompassed publications from 2016 to 2025, allowing capture of evolving realities in the innovation ecosystem and changing needs of young technology firms. This timeframe was selected to balance contemporaneity of findings with sufficient longitudinal perspective for trend analysis.

Materials were included if they met the following conditions: (1) published in peer-reviewed academic journals or by recognized research institutions, (2) addressed technology validation, start-up development, or innovation commercialization, (3) published in English, Polish, or German, (4) available in full-text format, (5) available in open source, (6) possessed clear methodological framework and empirical basis. Materials were excluded based on: (1) insufficient methodological rigor or unclear research design, (2) focus exclusively on non-technology sectors, (3) Lack of relevance to start-up or early-stage venture context, (4) unavailability of full text despite database access, (5) published prior to 2016 unless seminal works providing theoretical foundations.

The desk research component involved systematic analysis of secondary sources, including industry reports, statistical databases, and organizational documentation from key ecosystem stakeholders. This approach aligns with established methodologies for secondary data analysis in entrepreneurship research (Morse et al., 2002). Grey literature sources were identified through: (1) systematic searches of major accelerator, incubator, and venture capital websites, (2) government agency and policy document repositories, (3) industry association publications and reports, (4) conference proceedings and white papers. Each source underwent quality evaluation considering authorship credibility and institutional affiliation, methodological transparency and rigor, sample size and representativeness (for empirical reports), currency and relevance to research questions and consistency with findings from peer-reviewed sources.

Following recommendations regarding research methodology impact on data quality, systematic verification procedures were applied to ensure reliability and validity of desk research findings. This included cross-referencing multiple sources for key claims, distinguishing between empirical findings and opinion-based statements, and noting limitations and caveats in source materials.

The multi-method approach combining systematic literature review with comprehensive desk research enables robust identification of research gaps and formulation of research questions for subsequent empirical investigation. This methodological design supports the development of grounded research instruments while maintaining scientific rigor and replicability.

3. Technology validation in startups - theoretical foundation

Technology validation represents a multidimensional process encompassing technical, market, and commercial verification of innovative solutions. According to Wieringa (2014), technology validation requires empirical research methods that enable scaling up requirements engineering approaches. This process involves systematic assessment of whether a technology

meets specified requirements and can function effectively in its intended operational environment.

Dean et al. (2022) emphasize the role of complexity in technology validation, particularly concerning radical innovations. Their research demonstrates that higher levels of complexity in innovative technologies correlate with greater challenges in crossing the valley of death, necessitating more sophisticated validation approaches. The authors argue that effective validation must address both technical performance and market acceptance dimensions simultaneously. Muscio with the research team (2023) specifically examine technology validation in the context of renewable energy innovations, demonstrating how inadequate validation processes can create systemic barriers to innovation deployment. Their study highlights the importance of institutional support structures that facilitate validation across multiple dimensions: technical feasibility, economic viability, regulatory compliance, and social acceptance. The concept of validation extends beyond mere technical testing to encompass business model validation and market validation. Sanasi et al. (2023) investigate experimentation practices in technology-based startups after achieving initial market validation, revealing that validation is not a one-time event but rather an ongoing process requiring systematic approaches throughout the start-up lifecycle. Their research identifies specific patterns of experimentation that distinguish successful scaling ventures from those that plateau after initial validation.

The Technology Readiness Level framework, originally developed by NASA in the 1970s, provides a systematic methodology for assessing technology maturity across nine distinct levels, from basic principles observation (TRL 1) to proven system operation in actual environments (TRL 9) (Mankins, 2009). This framework has become widely adopted across government agencies, funding organizations, and research institutions as a common language for discussing technology maturity (Héder, 2017). Each TRL represents specific development milestones and evidence requirements. TRL 1-3 cover basic research and proof-of-concept activities conducted in laboratory settings. TRL 4-6 involve validation and demonstration phases, first in laboratory environments, then in relevant operational contexts. TRL 7-8 encompass prototype demonstration in operational environments and system qualification through testing. TRL 9 represents full-scale deployment and proven operation (European Commission, 2017). Salvador-Carulla et al. (2024) demonstrate that the original TRL framework requires adaptation for different contexts, particularly in implementation science and health research. Their study developed a modified TRL for Implementation Science (TRL-IS) that addresses limitations of the original framework for non-hardware technologies. This adaptation work highlights an important insight: while TRL provides valuable structure, its application must be contextualized to specific domains and technologies. For startups, several challenges emerge with TRL application. First, many startups operate in highly dynamic environments where rapid iteration and pivoting are necessary, potentially making rigid TRL progression impractical (Ghezzi, 2019). Second, startups often lack resources for

comprehensive testing required to advance through TRL levels systematically. Third, the TRL framework focuses primarily on technical maturity while underemphasizing business model viability and market readiness - factors critically important for start-up success (Leatherbee, Katila, 2020). Current studies have proposed complementary frameworks to address these limitations. The Market and Technology Readiness Level (MTRL) framework integrates both technical maturity and market readiness dimensions, recognizing that commercial success requires advancement on both axes (Bruno et al., 2020). Similarly, Lavin et al. (2022) adapted TRL concepts for machine learning systems, acknowledging that different technology domains require tailored maturity assessment approaches.

The Lean Startup methodology, articulated by Ries (2011) and building upon Blank's (2013) Customer Development framework, represents a fundamental shift in entrepreneurial practice toward systematic, hypothesis-driven experimentation. This methodology addresses the high uncertainty inherent in start-up environments by providing structured approaches to learning and adaptation (Ghezzi, 2019). At its core, the Lean Startup methodology consists of several interconnected components. First, it emphasizes the Build-Measure-Learn feedback loop, which structures the process of hypothesis testing through rapid experimentation cycles (Ries, 2011). Second, it advocates for the development of a Minimum Viable Product (MVP), the simplest version of a product that enables validated learning about customers' needs and preferences (Bocken, Snihur, 2020). Third, it introduces the concept of "pivoting" making fundamental strategic changes based on validated learning rather than persisting with initial assumptions (Shepherd, Gruber, 2021). Additionally, analysis of Frederiksen and Brem (2017) reveals that while the methodology draws on established concepts from lean manufacturing, customer development, and agile software development, its integration into a coherent entrepreneurial framework represents a meaningful innovation. However, they also note that scientific validation of the methodology's effectiveness remains limited, with much evidence being anecdotal or based on practitioner experience.

Recent research has examined how entrepreneurs implement Lean Startup practices. Ghezzi (2019) investigates digital startups' adoption of Lean Startup approaches, finding that entrepreneurs employ principles of effectuation and bricolage alongside lean practices, creating hybrid approaches adapted to their specific contexts. Leatherbee and Katila (2020) demonstrate that the method works best for early-stage teams when combined with appropriate governance structures and decision-making processes. Bocken and Snihur (2020) extend Lean Startup concepts to sustainable business model innovation, arguing that the methodology's emphasis on experimentation and iteration makes it particularly suitable for addressing complex sustainability challenges. Their research demonstrates how Lean Startup principles can be applied beyond traditional technology startups to enterprises pursuing environmental and social objectives. Critical perspectives on Lean Startup have also emerged. Some researchers question whether the methodology's emphasis on quick pivoting and minimal initial investment might lead to premature abandonment of promising but challenging innovations (Shepherd, Gruber,

2021). Others note that the approach may be less suitable for hardware-intensive or highly regulated industries where rapid iteration is constrained by physical or regulatory factors (Mansoori, Lackéus, 2020).

The "valley of death" metaphor describes the critical period in the development of innovation, located between the transition from prototype validation to initial pilot implementations and the achievement of repeatable, scalable commercialisation, in which the risk of start-up failure is highest due to the mismatch between the logic of research funding and the requirements of investors and the market, as well as the accumulation of technological, market and institutional barriers (Beard et al., 2009; Ford et al., 2007; Muscio et al., 2023; Navarro-Castillo et al., 2024).

It constitutes a complex and multidimensional phenomenon encompassing interrelated financial, organizational, institutional, and network-related barriers, whose effective mitigation necessitates coordinated and concurrent interventions across the domains of public policy, managerial practice, and innovation processes. This phenomenon represents a fundamental challenge in innovation systems, occurring at the intersection between research and development activities and commercial deployment. As Beard et al. (2009) point out this phenomenon results not from inherent market failures in R&D investment, but rather from misalignment between early-stage research funding (often government-supported) and later-stage commercialization requirements. Their economic analysis suggests that the valley of death emerges when initial research investments are made without sufficient attention to subsequent stages' investment requirements and criteria.

Based on the analysed literature, three interrelated stages of the 'valley of death' can be distinguished: (1) the transition stage from high levels of technological readiness (TRL 4-6), in which it is necessary to move from proof of concept and validation in laboratory conditions to demonstration in a relevant operational environment and to build credible technical evidence with limited resources (European Commission, 2017; Mankins, 2009; Salvador-Carulla et al., 2024), (2) the commercial gap stage, in which technologies with relatively high TRL encounter low market and business readiness - lack of a verified business model, insufficient market traction and incomplete problem -solution or product-market, despite earlier positive technical validation results (Gbadegeshin et al., 2022; Muscio et al., 2023; Sanasi et al., 2023), and (3) the scaling gap stage, in which start-ups, after achieving initial market validation, face barriers related to building organisational capacity, obtaining bridge financing between the seed and Series A rounds, developing demonstration infrastructure, and complying with complex regulatory requirements, which is particularly evident in the deep-tech and renewable energy sectors (Barron, Amorós, 2020; Dean et al., 2022; Muscio et al., 2023; Navarro-Castillo et al., 2024). The operationalisation of these stages therefore requires the distinction of at least three types of indicators: first, indicators of technological maturity, measured, among other things, by the TRL level and the scope of tests and demonstrations carried out (number of tests completed in laboratory and real-world conditions, existence of a prototype operating in the

target environment, compliance with minimum regulatory requirements) (European Commission, 2017; Heder, 2017; Lavin et al., 2022); secondly, market validation and business model indicators, referring to the Lean Startup logic - the number of iterations of the Build-Measure-Learn cycle, the presence and quality of the Minimum Viable Product (MVP), the number of tested hypotheses regarding customer segments and value propositions, early traction indicators (e.g., pilot agreements with customers, retention rate, willingness to pay) and the presence or absence of a 'pivot' decision (Blank, 2013; Ries, 2011; Frederiksen, Brem, 2017; Ghezzi, 2019; Leatherbee, Katila, 2020); thirdly, indicators of organisational and ecosystem capabilities, including the structure and complementarity of the founding team's competencies (balance of technical and business competencies), access to a network of partners and complementary resources (accelerators, incubators, industrial partners, open innovation strategies), the level of funding obtained at subsequent stages (proof-of-concept grants, bridge financing, capital rounds) and the intensity of institutional support (mentoring, testing infrastructure, validation programmes) (Barron, Amorós, 2020; Gbadegeshin et al., 2022; Navarro-Castillo et al., 2024; Dziewit, 2024; Majewski, 2025). In this perspective, the 'valley of death' is not synonymous with the technology validation process itself or the TRL framework, but refers to a specific section of the innovation development path where the disproportion between growing requirements for technical, market and organisational requirements and the availability of capital, managerial competence and ecosystem resources leads to an increased likelihood of project failure; thus, TRL provides a measure of 'what' has been achieved in technical terms, Lean Startup describes 'how' iterative market validation takes place, while the concept of 'valleys of death' determines 'where' along this path the risk of failure is greatest and what configurations of indicators (technological, market and organisational-institutional) signal the approach of critical points. Adopting such a distinction between concepts and indicators, based on the analysed research, allows for an in-depth analysis of validation mechanisms in start-ups: it enables the identification of projects that are 'stuck' at high TRL levels, but with low market validation and weak organisational capabilities, as well as those which, despite their lower technological maturity, are strongly embedded in the ecosystem and have a better-prepared business model, and thus have a better chance of successfully crossing the 'valley of death'.

For young companies requires the simultaneous development of technology, a business model, and organizational capabilities. Gbadegeshin et al. (2022) develops a comprehensive model for helping high-tech startups overcome the valley of death, identifying several critical success factors. These include: securing adequate early-stage funding, developing strong entrepreneurial team capabilities, establishing strategic partnerships with industry players, and maintaining clear focus on customer needs throughout development. The author emphasizes that crossing the valley of death requires simultaneous attention to technological development, business model refinement, and resource mobilization. Additionally, Barron and Amorós (2020) examine entrepreneurial programs designed to bridge the valley of death,

analyzing specific mechanisms through which accelerators and incubators help startups navigate this critical period. Their research identifies key support elements including mentorship, networking opportunities, structured validation processes, and phased funding approaches. However, they also note significant variation in program effectiveness, with success depending heavily on quality of mentorship and relevance of industry connections.

Muscio et al. (2023) specifically investigate the valley of death in the EU renewable energy innovation system, demonstrating how regulatory fragmentation, lack of demonstration facilities, and insufficient bridge financing create systemic barriers to innovation deployment. Their research highlights the need for coordinated policy interventions addressing multiple dimensions of the valley of death simultaneously. From this perspective, the study conducted by Navarro-Castillo et al. (2024), which examines open innovation strategies as critical mechanisms for overcoming the valley of death in new technology-based firms, constitutes a valuable contribution to the field. Their qualitative research with Spanish startups reveals that successful firms actively leverage external knowledge sources, strategic partnerships, and ecosystem relationships to compensate for internal resource limitations. The study emphasizes that crossing the valley of death increasingly requires ecosystem-level capabilities rather than solely firm-level resources.

4. Findings and discussion

The systematic literature review revealed several critical insights regarding technology validation in startups, organized around four thematic areas: TRL operationalization and validation tools, commercialization challenges despite positive validation, limited managerial competencies in startups and methodological challenges in innovation research.

Despite TRL being a recognized standard for technology assessment, significant challenges emerge in its application to start-up contexts. The literature consistently indicates that the TRL framework, designed originally for large-scale NASA projects with substantial resources and long development cycles, requires substantial adaptation for resource-constrained start-up environments (Mankins, 2009; Héder, 2017). Salvador-Carulla et al. (2024) demonstrate that TRL adaptations are possible and can improve framework utility for specific contexts. Their work on TRL-IS (TRL for Implementation Science) shows that successful adaptation requires removing inappropriate elements (such as laboratory testing requirements for non-hardware innovations) and adding context-specific criteria. For startups, similar adaptations might include: (1) adjusting evidence requirements to reflect resource constraints, (2) incorporating business model validation alongside technical readiness, (3) allowing for iterative, non-linear progression through levels, (4) integrating market feedback mechanisms at earlier stages.

However, such adaptations remain largely theoretical, with limited empirical validation of modified TRL frameworks specifically designed for start-up ecosystems. This represents a significant gap between policy requirements (many funding programs require TRL assessment) and practical applicability for early-stage ventures.

A recurring pattern in the literature indicates that positive technological validation (high TRL) does not guarantee commercial success. Multiple studies document instances where technically mature technologies fail to achieve market adoption (Muscio et al., 2023; Gbadegeshin et al., 2022). This disconnect highlights the multidimensional nature of innovation success. The "valley of death" phenomenon manifests precisely at this juncture - between prototype development and full commercialization (Barron, Amorós, 2020). Research by Beard et al. (2009) suggests this gap results from fundamental misalignment between technical development logic and commercial deployment requirements. Technologies may achieve technical readiness without achieving market readiness, regulatory compliance, or business model viability. Sanasi et al. (2023) provide nuanced understanding of post-validation experimentation, demonstrating that even after achieving initial market validation, startups face substantial challenges in scaling. Their research identifies specific patterns: successful scaling ventures continue systematic experimentation focused on operational efficiency and market expansion, while plateauing ventures often revert to ad-hoc decision-making.

The literature consistently identifies managerial capability gaps as significant barriers to effective technology validation. Young firms often lack experience in validation processes, impeding collaboration with research institutions and navigation of commercialization pathways (Gbadegeshin et al., 2022; Navarro-Castillo et al., 2024). Specific competency gaps identified include limited understanding of R&D funding mechanisms and application processes, insufficient knowledge of intellectual property protection strategies, inadequate financial management capabilities for phased development, weak strategic planning skills for long-term technology development and limited ability to effectively communicate technical concepts to non-technical stakeholders (investors, customers, partners).

These gaps are particularly pronounced in university spin-offs and deep-tech startups, where founding teams typically possess strong technical expertise but limited business experience (Muscio et al., 2023). The literature suggests that accelerator programs, mentorship, and entrepreneurship education can partially address these gaps, though effectiveness varies significantly across programs (Barron, Amorós, 2020).

Multiple studies acknowledge fundamental methodological challenges in researching innovation and validation processes. Innovation represents a complex, multidimensional construct that resists simple measurement (Shepherd, Gruber, 2021). Key challenges are presented in the graph below.

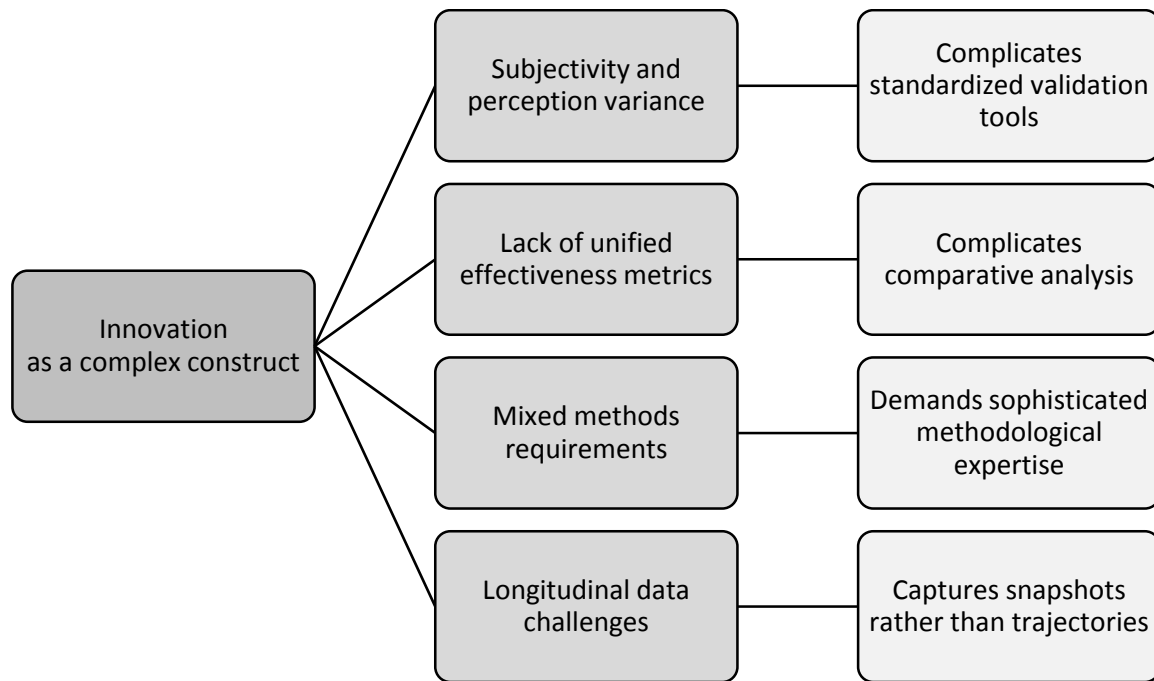


Figure 1. Methodological challenges in innovation research and validation processes.

Source: own elaboration.

Subjectivity and perception variance: assessments of innovation degree, market potential, and technological maturity often vary substantially across evaluators (Ghezzi, 2019). What one investor considers breakthrough innovation; another may view as incremental improvement. This subjectivity complicates development of standardized validation tools.

Lack of unified effectiveness metrics: the literature reveals absence of consensus regarding appropriate metrics for assessing validation effectiveness: should success be measured by subsequent funding raised? Survival rates? Revenue generation? Patent awards? Different stakeholders prioritize different metrics, complicating comparative analysis (Frederiksen, Brem, 2017).

Mixed methods requirements: effective innovation research typically requires integration of quantitative and qualitative approaches - triangulation that demands sophisticated methodological expertise and substantial resources (Denzin, 2012). Many studies rely on single-method approaches, potentially missing important nuances.

Longitudinal data challenges: understanding validation effectiveness requires tracking ventures over extended periods, yet such longitudinal data remain scarce. Most studies capture snapshots rather than developmental trajectories (Sanasi et al., 2023).

The TRL framework provides several valuable contributions to technology validation. It provides a unified tool for assessing technological maturity, enabling risk management and resource allocation, and is widely accepted by funding agencies and investors, allowing for project comparison at different development stages. It facilitates communication among stakeholders and creates a structured pathway from basic research to commercialization. However, the TRL model does not always work well for startups: resource requirements,

especially at higher TRL levels, often exceed start-up capabilities, and the linear progression conflicts with the iterative, pivot-oriented approach typical of startups. The system primarily focuses on technical validation, neglecting business model and market readiness. Evidence requirements designed for large organizations may be impractical for resource-constrained ventures, and the classic TRL does not address projects typical for software, AI, or services. An alternative is the Lean Startup methodology, which emphasizes experimentation, rapid prototyping, and the Build-Measure-Learn cycle. It allows for continuous validation, integration of customer feedback, and pivot-or-persevere decisions based on real data. Its value lies in minimizing resource expenditure, testing key hypotheses, and enabling fast business adaptation. Combining TRL with Lean Startup may constitute a comprehensive validation tool, integrating technical assessment with market readiness. Such integration enables development based on both technological evidence (TRL) and market tests (Lean Startup), benefiting both dimensions of innovative project development.

The analysis identifies significant challenges and barriers to technology validation in startups, operating at both ecosystem and individual levels. At the ecosystem level, institutional fragmentation is a key issue: accelerators, incubators, and government programs often operate independently, applying inconsistent criteria and requirements. This creates confusion and administrative burdens for startups, hindering their access to support and validation resources (Muscio et al., 2023). Despite the growth in early-stage funding, systematic financing gaps persist, especially between seed funding and Series A investment, forming a "valley of death" that corresponds to critical validation stages (Gbadegeshin et al., 2022). Regulatory uncertainty is another major barrier, as rapidly evolving technologies often outpace regulatory frameworks. This leads to ambiguity about compliance, making it difficult for startups to validate their products and achieve commercialization, particularly when relevant regulations are unclear or absent (Navarro-Castillo et al., 2024).

At the start-up level, several common challenges impede effective validation. Resource constraints, both financial and human, limit the ability to conduct comprehensive validation activities, forcing startups to prioritize which validations to pursue (Leatherbee, Katila, 2020). Capability gaps further complicate the process: technical founders may lack business development skills, while business-oriented founders may not fully grasp technical validation requirements. Additionally, pressure for rapid progress, driven by investor expectations and competitive pressures, often creates tension between thorough validation and the need for quick market entry. This can result in premature commercialization or insufficient validation (Shepherd, Gruber, 2021).

Knowledge and information asymmetries are also significant. Investors struggle to assess the true validation status of early-stage technologies, particularly in emerging domains, and startups may overstate their progress or maturity (Ghezzi, 2019). Early-stage customers face uncertainty about product reliability and company viability, and inadequate validation evidence can impede initial customer acquisition. Furthermore, limited information sharing among

support organizations means that validated best practices and lessons learned often remain localized, rather than diffusing across the ecosystem, which limits collective learning and improvement. These barriers collectively undermine the effectiveness of technology validation processes and hinder the successful scaling and commercialization of innovative start-up projects.

5. Conclusions

This systematic review of literature and desk research analysis reveals that technology validation in startups represents a complex, multidimensional challenge requiring integration of technical, market, and business model assessment approaches. While existing frameworks such as TRL and Lean Startup provide valuable foundational tools, significant gaps persist between these frameworks and the practical needs of early-stage technology ventures.

In light of the identified research gaps, the development of future empirical research on technology validation in start-ups, focused on a multidimensional, integrated approach to TRL, market validation and the ‘valley of death’ phenomenon, is of particular importance. Firstly, it is reasonable to conduct longitudinal studies tracking validation paths from the early stages of technology development to scaling attempts, which will allow for the identification of critical points, risk factor configurations and patterns of transition through successive ‘valleys of death’ in various sectors, including in particular deep-tech (Muscio et al., 2023; Navarro-Castillo et al., 2024; Sanasi et al., 2023). Second, research is needed on the design, testing, and quasi-experimental evaluation of integrated validation tools that combine a modified TRL framework with Lean Startup methodology and additional dimensions of market, organisational, and regulatory readiness (Bruno et al., 2020; Lavin et al., 2022; Ries, 2011; Shepherd, Gruber, 2021). Third, the ecosystem conditions for effective validation require further analysis - comparative studies between countries and regions could reveal best practices in the coordination of accelerators, incubators, funds and public institutions, as well as the role of open innovation strategies in bridging resource and information gaps (Barron, Amorós, 2020; Gbadegeshin et al., 2022; Dziewit, 2024; Majewski, 2025). Another important trend is in-depth research into the structure and dynamics of managerial competencies in founding teams, considering the specific nature of academic spin-offs and their relationship with validation and investment decisions (Ghezzi, 2019; Leatherbee, Katila, 2020; Muscio et al., 2023). Finally, studies on the actual decision-making practices of investors are needed - comparing declared criteria with the actual use of validation evidence - which will enable better alignment of the designed validation tools with the needs of the capital market and increase their usefulness for stakeholders in the innovation ecosystem.

This study contributes to entrepreneurship and innovation management literature in several ways. It provides integrated analysis of technology validation across multiple theoretical perspectives, bridging traditionally separate literature streams on technology assessment (TRL), entrepreneurial methodology (Lean Startup), and innovation financing (valley of death). The research identifies specific gaps where existing validation frameworks inadequately address start-up needs, particularly concerning resource constraints, iterative development approaches, and business model validation alongside technical assessment. It establishes methodological foundation for further empirical research on technology validation in start-up ecosystems, utilizing triangulation approaches that enhance validity and reliability.

For startups, validation should be recognized as an ongoing, multidimensional process that goes beyond technical testing. Combining adapted TRL approaches with Lean Startup principles for business model validation is recommended. Start-ups should actively seek ecosystem support from accelerators, incubators, and research institutions, and systematically document validation evidence to facilitate communication with investors and secure future funding. For investors and accelerators, developing nuanced assessment frameworks that incorporate both technical and business dimensions is crucial. Structured support for validation activities, not just funding, should be provided, with clear criteria and expectations for validation evidence. Sharing validated assessment approaches across the ecosystem can help reduce information asymmetries. Policymakers should support the development of standardized validation tools tailored to start-up contexts, facilitate greater coordination among ecosystem support institutions, address financing gaps at critical validation stages, and invest in validation infrastructure such as testing facilities, demonstration environments, and proof-of-concept funding. The study's limitations - reliance on secondary sources, geographic focus on European and North American contexts, and exclusion of very recent developments - suggest the need for further primary empirical research and broader contextual analysis.

Future research opportunities in technology validation for startups include several key directions. Empirical validation studies should be conducted, tracking startups longitudinally through their validation processes to identify success factors, common pitfalls, and critical turning points. Such research would provide actionable insights into the practical challenges and effective strategies for validation in real-world contexts. There is a need to develop and test integrated validation frameworks that combine technical, market, and business model dimensions. These frameworks should be validated through action research or quasi-experimental designs to assess their effectiveness in supporting start-up success and improving the reliability of validation outcomes. Comparative ecosystem analysis offers a valuable opportunity to examine how different national and regional innovation ecosystems structure their validation support mechanisms. By identifying best practices and transferable lessons, researchers can help harmonize and optimize validation approaches across diverse contexts. Sector-specific validation research is warranted to investigate whether validation requirements and approaches differ systematically across technology domains such as software, hardware,

biotech, and clean tech. This would enable the development of domain-adapted frameworks that address the unique challenges and opportunities in each sector. Institutional analysis should focus on the role of accelerators, incubators, and other intermediary organizations in facilitating validation. By identifying organizational practices that most effectively support start-up validation needs, researchers can provide evidence-based recommendations for improving the design and delivery of ecosystem support services. Finally, investor decision-making research should examine how investors assess validation evidence when making funding decisions. Comparing stated criteria with revealed preferences will help clarify the real-world impact of validation activities on investment outcomes and inform the development of more effective validation tools and processes. These research directions collectively promise to deepen our understanding of technology validation and enhance its practical application for startups, investors, and policymakers.

Technology validation represents a critical yet undertheorized aspect of start-up development. As innovation ecosystems mature and competition intensifies, systematic approaches to validation become increasingly important for both start-up success and efficient resource allocation across the ecosystem. This study provides foundation for developing such systematic approaches, grounded in theoretical frameworks while addressing practical needs of entrepreneurs, investors and support organizations.

The path forward requires collaboration among researchers, practitioners, and policymakers to develop, test, and refine validation approaches that balance rigor with resource efficiency, standardization with contextual adaptation, and technical assessment with market and business model validation. Only through such comprehensive, integrated approaches can the innovation ecosystem effectively support the transition of promising technologies from concept to commercial reality.

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MANAGING VIRTUAL TEAMS – A NEW MODEL OF COMPETENCE

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Purpose: Model of competence describing the specifics of relationships in virtual organizational teams after 2020 (the research was conducted in 2024). The final model was obtained on the basis of our own research.

Methodology: The methodology of own research included in the following order: systematic literature review; construction of an original research tool (questionnaire based on the results of a literature review); surveys (virtual team managers and virtual team members).

Findings: On the basis of our own research, a completely new competency model was built to describe the behavior of virtual team leaders.

Research implications: The most interesting result in the obtained model of competence can be considered that among the 14 indicators of behavior confirmed in the research process, as many as 11 of them refer to aspects of people or relationships in the team. Therefore, although we are talking about virtual teams, paradoxically, aspects of functioning related to the characteristics and behaviors related to building and maintaining interpersonal relationships come to the fore.

Practical implications: The results of the research may be useful for virtual teams leaders, for people leading teams working remotely for part of the working days, and for superiors managing employees working from home (WFH). In addition, the results of the research may be useful for the daily practice of HR departments, and especially HR of partners involved in developing the competencies of future managers. We hope that the text of the articles contains a ready-made set of competencies along with behavioral indicators key to effective teamwork in the digital environment. Thus, they may have an impact on updating the shape of managerial competency programs and shaping evaluation systems relating to people in managerial positions.

Social implications: The dissemination of this competency model may change societal expectations of people leading virtual teams towards presenting more soft skills instead of prioritizing technical agility.

Originality/value: The model can bring new value to the area of research on organizational leadership, competencies and the functioning of virtual teams. The model also complements research in the field of individual differences describing the management of virtual teams.

Keywords: Virtual team management, virtual teams, competencies, competency models.

Category of the paper: Research paper.

1. Introduction

The rapid development of remote work after 2020 has shown the high importance of people in the organization. As Higgins and Bianzino (2020) state when describing organizations after 2020: "[...] People are not anonymous elements of many layers of a large organization. People are an organization – its most important and powerful resource. [...] human ingenuity, resourcefulness and diversity of experience – combined with technological tools – can create solutions, ideas and business models for the future". Therefore, it can be said that in the current reality of organizations, it is the human being who is supported by technology in their functioning.

Analyzing the basic components of the digital transformation of enterprises, we see that digital transformation begins with people. Even if we talk a lot about data during the changes towards digitization and ultimately build a strongly data-oriented organization, it should be remembered that there are always people "at the end of the data" (Chamorro-Premuzic, 2021).

While remote work in teams was previously a feature of international virtual teams (the so-called Global Virtual Team - GVT) working in globally distributed locations, it became common after 2020: for example, in 2021, based on a Gartner report, we can estimate that 70% of relationships between supervisor and subordinate in 2021 were asynchronous or remote (Turner, 2022; Kropp et al., 2021).

Paradoxically, due to the universality of use and the loss of the "exclusivity" feature of remote group work, the limitations of this form of task implementation have been realized. In other words, remote work and hybrid forms of work have become commonplace, but only to a certain extent so effective previously provided by direct work. Extensive research, verifying and operationalizing the above statements, has shown a high potential for some jobs to perform them remotely. On the other hand, such tasks have been distinguished that are much more effective in person than remotely (Lund et al., 2020).

The universality of remote work and at the same time the awareness of its limitations leads, m.in, to the search for those elements in management and teamwork that allow to increase the effectiveness of joint work conducted in a virtual environment. This article summarizes and structures in the form of a competency model the results of own research in the field of behavior indicators that increase the effectiveness of a leader leading a virtual team.

The large number of virtual teams was not only an episode of the COVID-19 pandemic, but is a phenomenon that continues (Murphy, 2024). It is estimated that almost 50% of meetings are still held remotely, and employees spend an average of 23 hours in meetings per week (Aliman et al., 2024). Thus, about 1/4 of the weekly working time is taken up by working in teams through digital technologies.

Therefore, an important question becomes the question: What skills of the team leader to build and maintain to support the functioning of the team working virtually (Murphy, 2024). The matter is not easy, as we are also talking about basic (universal) competencies, but related to the efficiency of functioning in the digital environment and, consequently, to the effectiveness of the team (Heubeck et al., 2024).

Virtual teams are different from classic task-based teams working in face-to-face contact and hybrid teams (Grobelyny, 2023). Hence, it seems, the way they are managed or the specifics of the leader's functioning may also emerge. However, the difference is not only in the scope of: classic – hybrid – virtual, but also in the area of virtual teams in the timeline. As in the case of virtual teams, when we talk about leadership in virtual teams, the pandemic caesura is a kind of marker. Of course, we have texts from before 2020 pointing to analyses of leadership carried out virtually (Avolio et al., 2014), but after 2020 we are dealing with both quantitative and qualitative change.

As we know, in 2020-21, working and leading virtual teams (the abbreviation often used in the scientific literature is: VT) has become a standard in many, diverse industries. Along with the quantitative change, a fundamental change in the narrative can be noted. Before 2020, online work was perceived, for example, in reports by the International Labour Organization (ILO) as one of the biggest dangers of the decade, disrupting the balance of work and leisure. On the other hand, the situation after 2020, with the mass emergence of VT, posed challenges for both traditional and virtual teams, organizations and their leaders (Bagga et al., 2022; Afrianty et al., 2022; Herath, Herath, 2020; Bekirogullari, Thambusamy, 2020). Currently, we are not focusing on difficulties and threats, as in publications before 2020, but on answers to the question of how to work in VT with greater efficiency. Texts published since 2020 change the narrative: they do not show risks, they talk about the challenges and benefits of working at VT and leadership at VT (Raffoni, 2020). Even if texts published after 2020 speak directly about the difficulties of working in virtual teams, they indicate the reasons for this and give suggestions for neutralizing negative phenomena (Mortensen, 2023). The reason for the change in narrative may be prosaic: Between 2018 and 2022, the results generated by team leaders working with digital tools differed significantly and were higher than those of leaders working with the same tools to a negligible extent (Lamarre et al., 2023). However, digital transformation is not only about increasing the results achieved, it also brings disappointments. One of them is the scale of the results achieved in relation to expectations. It is estimated that 89% of large companies around the world are undergoing transformation with the use of digitalization and artificial intelligence, they only get 31% of the expected revenue growth and 25% of the expected cost savings through effort (Lamarre et al., 2023).

Therefore, while digital transformation is a common phenomenon, the results achieved are discussed. Therefore, it is worth looking not only at the level of the entire economy or individual business models chosen by organizations (which was done in earlier chapters). Currently, when writing about organizations, we analyze processes that take place simultaneously at the

level of employee teams and individual people who make up the team and thus organizations (Preller et al., 2023; Hashemi et al., 2022).

2. Methods

From the perspective of the changes that have taken place in the implementation of work after 2020, it seemed reasonable to check whether working in virtual teams requires a specific set of competencies of the person leading such a team.

Therefore, the aim of the research was defined: to establish a set of competencies with behavioral indicators adequate for leading virtual teams.

The methodology of our own research included in the following order:

1. Systematic literature review.
2. Construction of an original research tool (questionnaire based on the results of a literature review),
3. Surveys (virtual team managers and virtual team members).

In the field of a systematic review of literature, a review of issues appearing in the literature on the subject over the years 1998-2024 was carried out, followed by a detailed review of the topics from 2020 – 24. On the basis of the two aforementioned analyses, the year 2020 was identified as the borderline moment of the change in the narrative in terms of describing the functioning of virtual teams and interpreting research topics differently (constantly present over the course of 35 years).

The aforementioned detailed analysis of the literature published after 2020 allowed to distinguish 3 narrative streams on the functioning of virtual teams:

1. renewing already represented approaches in leadership thinking relating to classic teams – in other words, looking for the "fit" of the current situation with pre-existing typologies,
2. a change in the perception of virtual teams and their role in organizations – in other words, attempts to place leadership thinking in VT on the timeline set by the "pandemic milestone",
3. a change in thinking about leadership in HRM in order to restore the stability of the organization and ensure greater resilience to crises in the future - in other words, to try to define leadership in VT related to the context of the changing understanding of human functioning in the organization in order to increase the resilience of the organization.

In the next step, an original research tool was constructed. The results of a systematic literature review were used. Each of the three coexisting narratives in the post-2020 literature review was analyzed in terms of the descriptions contained in it:

- areas of work of the leader with the team,
- skills considered necessary in a leader,
- activities that a leader should take.

The extracted data were edited and piloted to make comparisons between the narratives. Editing and pilot studies included the following steps:

1. Separation and organization of elements describing work in a virtual team according to a given theory/approach.
2. Create aggregated descriptions that combine similar content within a given story and similar content between stories, if any.
3. Changing the form of aggregated descriptions: from statements to behavioral descriptions.
4. Construct an output pool of questions for a survey.
5. Expert consultations of the initial question pool.
6. Create a survey for pilot studies.
7. Pilot studies.
8. Editing of the pool of questions and the content of questions based on the results of pilot studies.

The activities in points 1-4 and 6-8 were performed by the authors of the publication. In the scope of points 1-4, the phases of individually editing the content of individual statements by both authors were alternately repeated, and then the content of individually developed solutions was agreed. The phases of individual work and content agreement were repeated 5 times. Next, the draft version of the tool (point 5 of the above list) was presented for review by both scientists – specialists in management sciences, and managers working in virtual teams. On the basis of the comments submitted by the experts (point 5), a pilot version of the test was developed by the authors (point 6). In this case (point 6), work was also carried out using the alternating use of the individual work phase and reconciliation, this process was repeated 3 times. After conducting pilot research, the authors made the final editing of the content of the set of 18 statements.

From a set of unified descriptions based on another analysis, covering the leader's areas of work and priority skills, indicators characteristic of each of the 3 narratives have been distinguished. For each of the narratives, 6 behavioural indicators were distinguished, which gives a total of 18 indicators.

Semantic analysis of the indicators in each narrative allowed us to determine a consistent motif for each of them. These were, respectively:

Narrative 1: The person of the leader and the qualities of this person.

Narrative 2: Skills in the use of individual tools or resources.

Narrative 3: Building relationships with your team.

The model of the research tool at this stage is presented in Table 1.

Table 1.

A model of statements that make up a research tool, content based on semantic analysis of data obtained as a result of a systematic review of the literature

Narration	Behavior indicators
Narrative No. 1: A person of a leader and the characteristics of that person	Mindfulness of the leader, which strengthens the commitment of team members.
	Creating trust-based relationships in the team by the leader.
	Ensuring that the leader and the team understand the goals in the same way.
	Building team interactions by the leader so that they support the group's co-creativity.
	The leader uses the diversity existing in the team (e.g. competence, cognitive, personality, etc.).
	Creating conditions for employees to cope with ambiguous tasks more easily by the leader.
Narrative No. 2: Application skills in scope of individual tools or resources	Providing access to appropriate infrastructure (e.g., devices, information tools, software, network connectivity, etc.).
	Encouraging the leader to use short text messages (e.g., chat, instant messaging, etc.) as a communication tool for the team.
	Ensuring that the leader communicates on an ongoing basis through team meetings.
	Encouraging team members to communicate the need for mutual assistance (e.g. substantive support, reduced workload) by the leader.
	Selecting the team in a way that ensures the coverage of competencies adequate to the tasks (e.g. by greater involvement of organizational experts in the work of the team).
	Setting clear divisions of tasks in the team by the leader.
Narrative No. 3: Build relationships with your team	Developing solutions (e.g. behavioural patterns for crisis situations) by management necessary for the time of crisis.
	Identification by management of possible crisis events that require a change in the way of working.
	Quick acceptance of responsibility by the leader for the challenges resulting from the crisis situation.
	Implementing patterns of behaviour (e.g. process or organisational changes) developed by management for crisis situations into the team's ongoing work.
	Ongoing support by the leader for changes in behaviour in the team's work based on the experience gained in the crisis.
	The leader uses the crisis to accelerate the development of employee independence.

Source: (own study).

As mentioned earlier, the third stage of the research, after a systematic review of the literature and the construction of the research tool, was to conduct a survey of the study. Based on the model presented in Table 1. An electronic questionnaire was constructed, in which 18 behavioural indicators were presented to the respondents in random order. The presentation of the indicator was accompanied by the same question each time:

"Based on your as a team leader (team member) who has transitioned to virtual work during the pandemic, determine how important this factor is for the transition to remote work".

Under the question, a statement was presented (one of eighteen). The screen also contained a description of the ends of the scale on which the person made the decision. For point 1, the description was presented: "It doesn't matter at all"; for point 10 it was the description: "It is essential". The task of the respondent was to decide on the meaning of a given statement (from 1 to 10) as an element relevant to the transition to remote work.

The authors assumed that the study is exploratory in nature and the entire model is tested, hence no research hypotheses relating to the tested model were formulated. Also, a review of the literature or the models existing until the research was conducted did not provide grounds

to conclude that, for example, 1 out of 3 narratives that make up the tested model will turn out to be stronger than the others.

The survey was conducted on a group of 264 employees of one of the international consulting companies, employing several thousand employees in Poland. The group invited to the study were people who switched to working in virtual teams in 2020 and continued (2024) to carry out at least part of their projects in such teams. Both team managers (in 2020 and 2024) and employees of such teams (2020 and 2024) were invited to the study. Therefore, managers and employees, at the time of the study, had at least 4 years of experience working in virtual task teams.

From such a selected group of people, the survey was finally completed by 138 managers of virtual teams and 126 employees of virtual teams working in locations throughout Poland.

The survey questions referred to working in virtual teams during the pandemic, but (as mentioned) the respondents continue to work in this way. Therefore, it can be considered that the question referred to a distinct trigger, but the individual responses in the survey were superimposed on 4 years of experience in the type of work asked about in the survey. In the end, the answers could refer not so much and not only to the situation from 4 years ago - here, due to the specificity of the functioning of long-term memory, the image could have been strongly "polluted" (Kahneman, 2022). It can be assumed that the answers refer rather to the accumulated experience of working as a manager or employee of a virtual team, over the years 2020-24.

3. Results

The collected results of the survey were subjected to statistical analyses in three stages:

1. In the first stage, the baseline model (obtained on the basis of literature review and subsequent edits) was analyzed in terms of the research data obtained.
2. In the second stage, the decision was made to re-specify the initial model and search for the optimal structural model.
3. In the third stage, the structural model selected in the 2nd stage was analyzed.

All stages and the actions taken at these stages are presented in Figure 1.

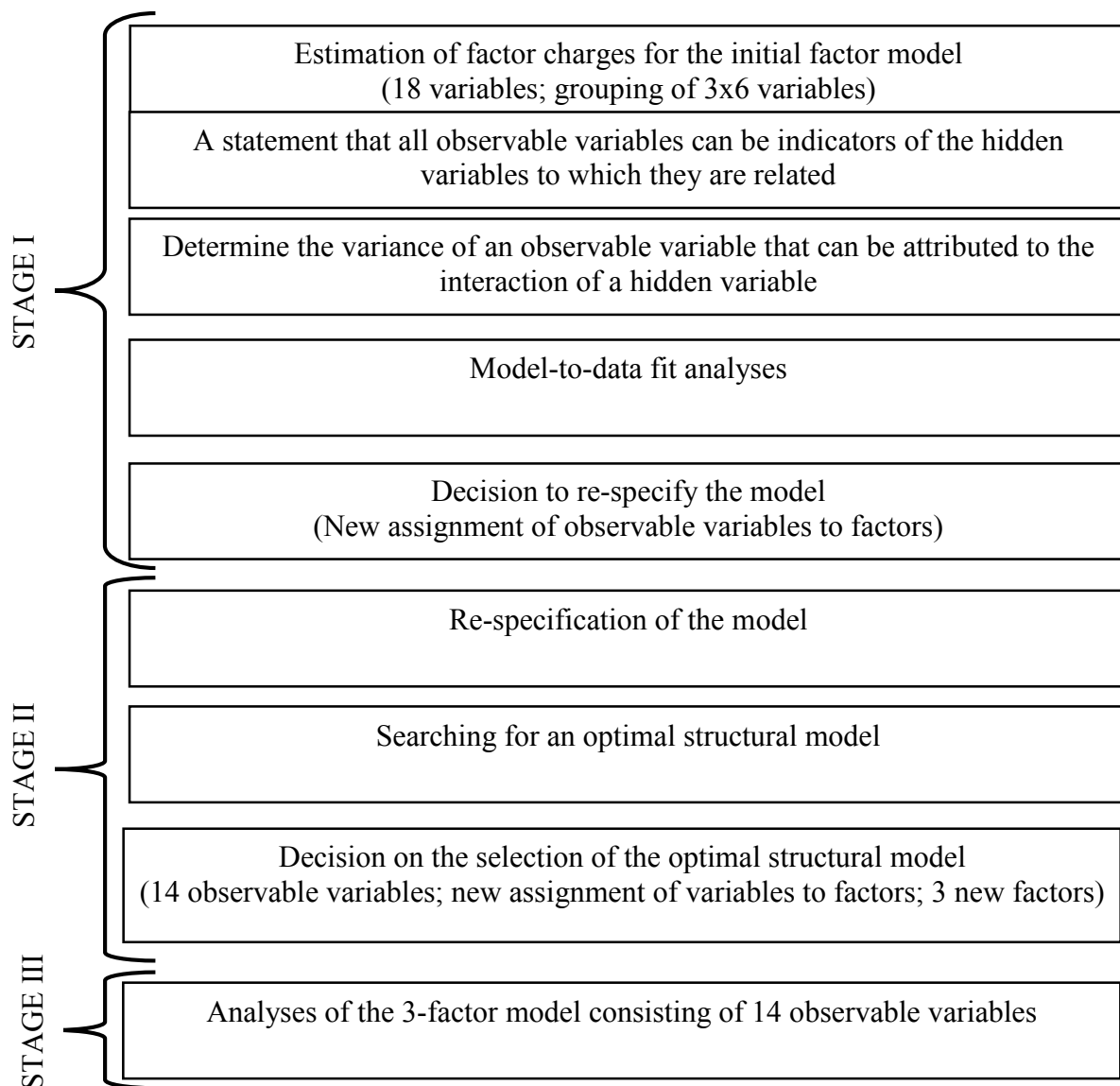


Figure 1. Stages of analysis of the obtained research data.

The first analysis of the factor model was carried out. For the purposes of this analysis, working names were given to hidden variables and observable variables. It was a necessary activity, from a technical point of view.

Starting from a survey based on 3 groups, 6 statements in each group, we had a picture of the structure before the research, as in Figure 2. The initial structural model was obtained on the basis of data from the literature review and subsequent revisions of the statements contained in the survey.

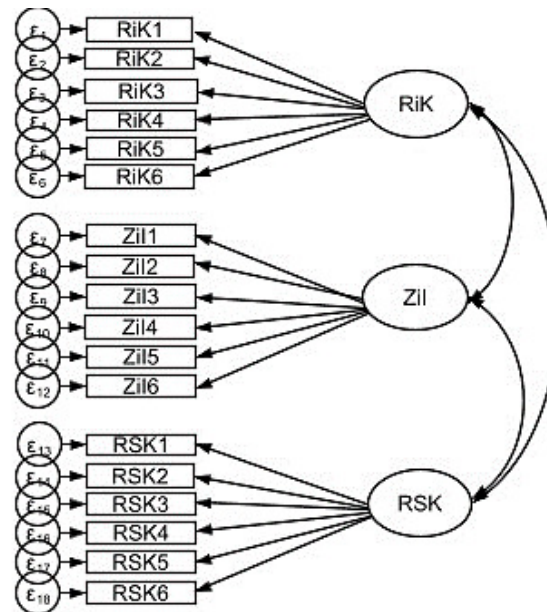


Figure 2. Initial structural model.

The first analysis was to estimate the factor charges for each of the 18 statements used in the survey. The results are shown in Figure 3 (factor charges only).

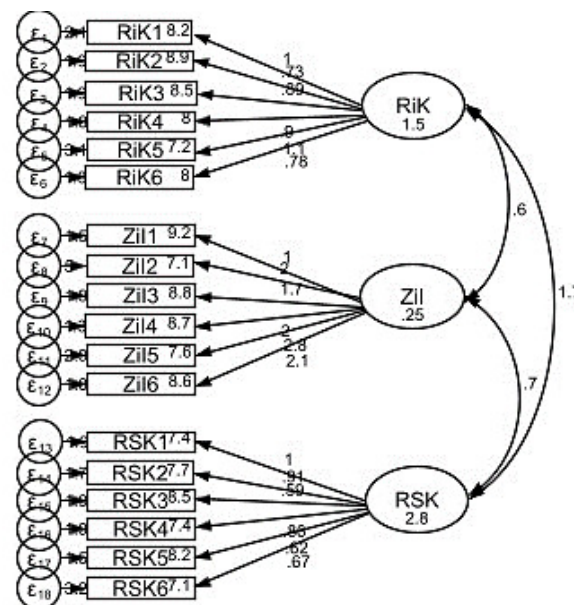


Figure 3. Factor charges obtained in studies for the initial structural model.

The data presented in Figure 3. indicated that all factor charges for the 18 survey statements were statistically significant at < 0.05 . In such a case, we may be dealing with the phenomenon that:

1. All observable variables can be treated – to a greater or lesser extent – as indicators of the hidden variables to which they are related.
2. The result obtained may also be a consequence of the sample size (with a larger sample, it might not occur).

For further analyses, the first assumptions were made (all observable variables can be indicators of hidden variables to which they are related) and further analyses were performed for the collected data.

In the light of the presented data, an answer to a more basic question was also sought: Does our model reflect the data structure well and is it really the one we have theoretically adopted? Therefore, the analysis of the model's fit with the data was carried out, using a central analysis in structural equation modeling, which consisted of the following tests: Likelihood Ratio Test (*LR*), RMSEA Test (*Root Mean Square Error of Approximation*), PCLOSE Test (*Test of Close Fit*), CFI (*Comparative Fit Index*), TLI (*Tucker-Lewis Index*), SRMR (*Standardized Root Mean Square Residual*). The combined analysis of the above indicators of model match-to-data indicated that the original model (3 factors of 6 indicators each) is at the limit of acceptability or shows poor match with the data. This kind of has become a recommendation for re-specifying the model.

The first step in the re-specification of the model was to answer the question of whether the collected data allow for inferences in their order in a factor structure. For this purpose, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (Kaiser-Meyer-Olkin Measure of Sampling Adequacy; KMO) to be able to assess the usefulness of the data you have for factor analysis. Obtaining $KMO = 0.914$ allowed us to conclude that the correlation matrix between observable variables gives grounds for inferring a factor structure. Then, with the help of scree plot and parallel analysis, the optimal amount of factors for the new model was searched for. Since no unambiguous picture of the number of factors was obtained, but only an indication of the legitimacy of generating models from 1 to 4 factors, the next step of the analysis was carried out to analyze four potential solutions, i.e. the 1-, 2-, 3-, 4-factor model, respectively. Since there is no solution in this regard (1 to 4 factors) where:

- the data structure gives an unambiguous picture,
- the analysed indicators are linked to each other in a consistent manner,
- the factors are not well separated (separable).

This is a significant element for the final decision and the criterion for the substantive (qualitative) evaluation of the results.

After qualitative analysis, a 3-factor model was selected, which is shown in Figure 4.

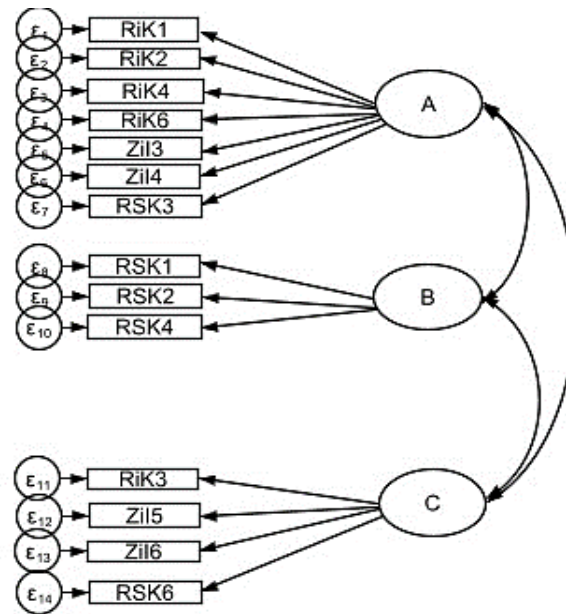


Figure 4. Structural model for a new system of factors.

The last stage of the analyses (stage III – see Fig. 1) was to subject the new structural model (14 indicators, 3 new factors) to the same analyses as the initial model in stage I (see Fig. 1). Therefore, the analysis of the model's fit with the data was carried out again, using a central analysis in structural equation modeling. Analyses of the model fit (Fig. 4) to the data showed that the new model after re-specification (14 indicators, 3 new factors) is at least acceptable, with a tendency to fit the data very well. At the same time, the result of the analyses of the model-to-data fit is different from the analyses carried out for the initial model in stage I (Fig. 2), where we were dealing with a model at the limit of acceptability with poor matching to the data and a recommendation to re-specify the model.

Final result – a model describing relevant behavioural indicators for leading virtual teams

Thus, the final model, describing the elements important for managing virtual teams, became a 3-action model, containing 14 indicators (Fig. 4). Details of the model – i.e. individual factors and indicators included in them – are presented in Table 2.

Table 2.

The final version of the model, the factors and the observable variables that comprise them

Factor	Observable variable label
Individual perspective	Mindfulness of the leader, strengthening the commitment of team members.
	Creating trust-based relationships in the team by the leader.
	Building team interactions by the leader so that they support the group's co-creativity.
	Creating conditions for employees to cope with ambiguous tasks more easily by the leader.
	Ensuring that the leader communicates on an ongoing basis through team meetings.
	Encouraging team members to communicate the need for mutual assistance (e.g. substantive support, reduced workload) by the leader.
	Quick acceptance of responsibility by the leader for the challenges resulting from the crisis situation.

Organizational perspective	Developing solutions (e.g. behavioral patterns for crisis situations) by management necessary for the time of crisis.
	Identification by management of possible crisis events that require a change in the way of working.
	Implementing patterns of behavior (e.g. process or organizational changes) developed by management for crisis situations into the team's ongoing work.
Team perspective	Ensuring that the leader and the team understand the goals in the same way.
	Selecting the team in a way that ensures the coverage of competencies adequate to the tasks (e.g. by greater involvement of organizational experts in the work of the team).
	Setting clear divisions of tasks in the team by the leader.
	The leader uses the crisis to accelerate the development of employee independence.

Expanding on the names presented in Table 2, the 3 factors that make up the current model can be understood as below:

1. Individual perspective – means focusing on the description of the behavior of the individual, which is the team leader; It is also the perspective of seeing the leader as a person with specific social competencies and focused on individual employees forming a team.
2. Organizational perspective – means focusing on the actions that should be taken by the organization; In the described model, the organization's actions are identified with the activity of the management staff of the nature of "system preparation", and not with ongoing work with the team.
3. Team perspective – means focusing on the team leader's activities aimed at the whole team as an individual; This means that a leader in his behavior, even if he refers to a single employee, the perspective of making decisions and choosing actions is the well-being and effective functioning of the entire group.

However, the final model is not completely new, as in the literature review preceding the construction of the model for research, there were 3 main narratives related to the management of the virtual team. In the perspective of the literature review, these were: the person of the leader and the qualities of this person; skills in the use of individual tools or resources; building relationships with the team. Thus, the elements from the literature review can be related to the final model obtained as a result of the research. The similarities that appear at the stage of literature review and in the final model are presented in Table 3.

Table 3.

Factors identified in the literature review and obtained as a result of the research

Factor	
In the literature review	In the model obtained as a result of the research
Leader person and characteristics of this person	Individual perspective
Skills in the use of individual tools or resources	Organizational perspective
Build relationships with your team	Team perspective

Similar divisions into: the characteristics of a leader, the area of activity of the organization and the relationship between the leader and the team appear in contemporary publications on management in the digital age – these results will be discussed in more detail in the section devoted to the discussion of the results obtained.

4. Discussion

Discussion: Chosen path of interpretation as too focused on people instead of technology

In the final model, we note 3 factors and 14 observable variables. Valuable information, although at the same time it may arouse discussions, is the fact that 3 out of 14 variables refer to the perspective of the organization, and 11 out of 14 variables refer to the characteristics of a person or the way of building relationships in a task team. Looking at the final model, it can also be said that it emphasizes social competences of a universal nature (50% of all observable variables included in the model refer to this range). **Isn't this perspective too focused on people instead of technology and benefits for organizations?**

To indicate that the tendency to emphasize social factors also takes place in other models created after 2022, a model by D. Ellström et al. (2022) will be presented, this model, on the one hand, contains indications regarding organizational support (see narrative 2 out of 3 in the original model – compare Table 1), on the other hand, it contains numerous references to relational aspects. Therefore, it is difficult to assign the model of D. Ellström et al. (2022) unambiguously to 1 of the 3 initial narratives obtained on the basis of literature analyses (compare Table 1). Rather, it presents a comprehensive attempt to describe the situation.

It is worth referring to the point of view that D. Ellström et al. (2022). They notice in a radical way that **digitization has no value in itself. What is important is how digitization will change the ways of working, the habits of employees and whether it will support the achievement of the company's goals** (Ellström et al., 2022).

Importantly, the final statement results from the analysis of the construction and analysis of the model of organizational support for digital transformation in a given company (see Figure 5).

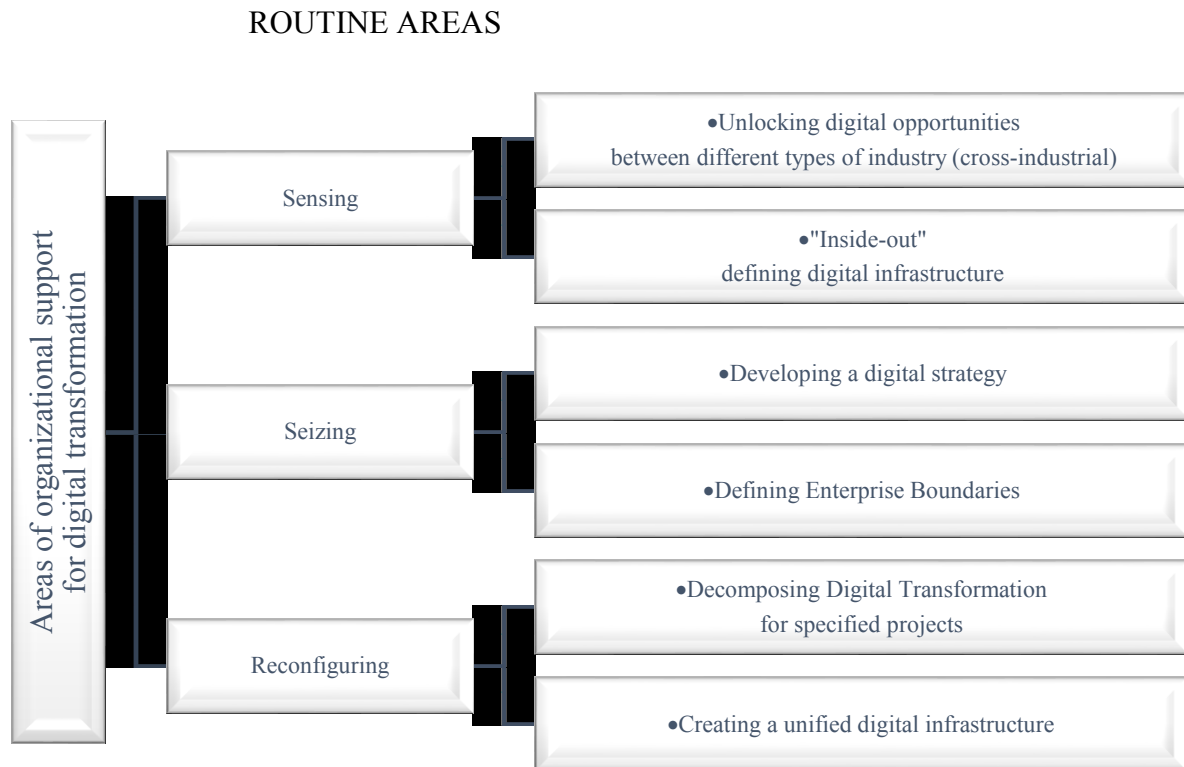


Figure 5. Areas of organizational support for digital transformation and key routines for each of the areas.

Source: (own study based on: Ellström, Holtström, Ber, Josefsson, 2022).

Although the model is oriented towards the areas of organizational support, the **6 routines for the designated 3 areas referred to not only to technological and organizational aspects, but also to areas of competence and attitudes of employees.**

The analysis of the descriptions (referred to in this study as: "idea in the background") for each 6 routines indicates a significant reference to social aspects in the model of organizational support.

In the area: *Seizing*, both routines: Digital strategy development and Defining company boundaries refer to people working in the company. The authors of the model directly draw attention to the need to build awareness among employees in the field of priorities and strategies for digital development. At the same time, they emphasize that this is crucial for the success of the entire digital transformation (routine: Digital strategy development – "Idea in the background").

In the second routine (routine: Defining the boundaries of the company – "Idea in the background") we have the decision to depend on the level of competence of employees and indicate the development of competences as an optimal state.

In the Reconfiguration area, *we have references:*

- *to the limited resources of people involved in projects* (routine: Decomposition of digital transformation into specified projects – "Idea in the background"),
- *employees' concerns about collecting digital data in one place and sharing it* (routine: Creating a unified digital infrastructure – frequently mentioned risks).

Thus, in the model relating to the organizational aspects of technological development, one of the three areas [*Seizing*] directly focuses on people, the other of the three [*Reconfiguring*] refers to the human aspects as significant for the success of the entire process. Therefore, it should not be surprising that in the model describing the leadership of virtual teams, we are dealing with the predominance of references to people and relationships.

A discussion of the model of D. Ellström et al. (2022) from Figure 6 is presented below, as a source material for the above reasoning.

1. Sensing

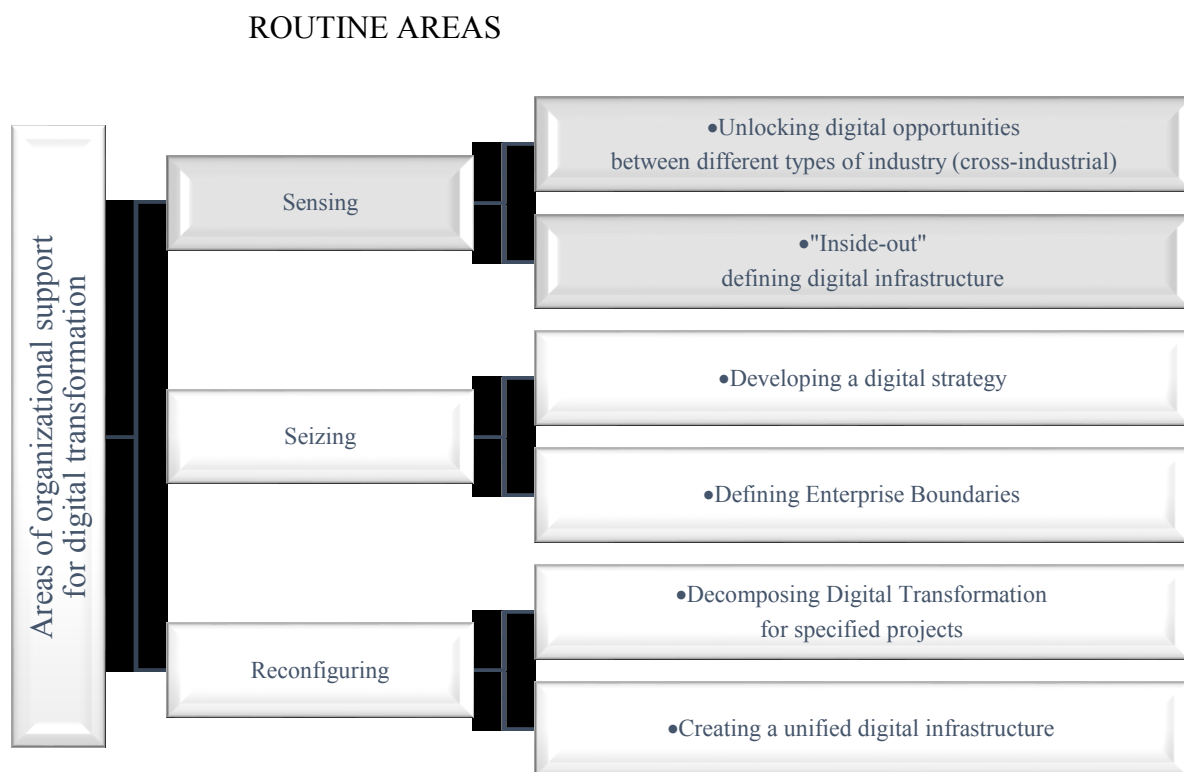


Figure 6. Areas of organizational support for digital transformation and key routines for each of the areas - highlighted area Detection.

Source: (own study based on: Ellström, Holtström, Berg, Josefsson, 2022).

- Detecting digital opportunities between different types of industry (cross-industrial):
 - Identifying new digital opportunities, also outside the network of existing partner companies.
 - **„Idea in the background“**: digital innovations do not have to be revolutionary and do not have to be pioneering; You can just as well copy something that was done elsewhere or use something old in a new way. This approach reduces the pressure to create a pioneering solution, and thus reduces the risk of implementing unproven solutions.
- "Inside-out" definition of digital infrastructure:
 - Procedures for assessing the demand for digital infrastructure and searching for new solutions.
 - **"Idea in the background"**: In the development of digital infrastructure, the starting point is the specificity of the functioning and needs of the company, not what is technically feasible. We start by checking what systems are currently in place in the company. We gain an understanding of how they meet the needs of the company and how they can be better utilized. We are trying to understand how current digital solutions implement the company's routines and how they bring added value to the company. So, in the first step, we try to understand the company's routines and the related demand of the organization for digital technologies. We then describe the future requirements of the company and the necessary functions of the digital system. We immediately apply a layer on top of this, describing whether and how infrastructure changes will bring added value to the company. By comparing both states of infrastructure and meeting the company's needs, comparing it with the necessary resources (e.g. time, budget, people), we get an answer as to whether the change in infrastructure is justified, and if so - to what extent. Thanks to this approach, it may turn out that, for example, a system used in one department can be implemented in other departments or it is possible to use the existing system in a new way.
 - A frequently raised risk is wasting the potential of digital transformation. This means implementing a costly technological change that does not change the way employees work and habits and/or does not support the achievement of the company's goals.
- Creating a unified digital infrastructure.

2. Seizing

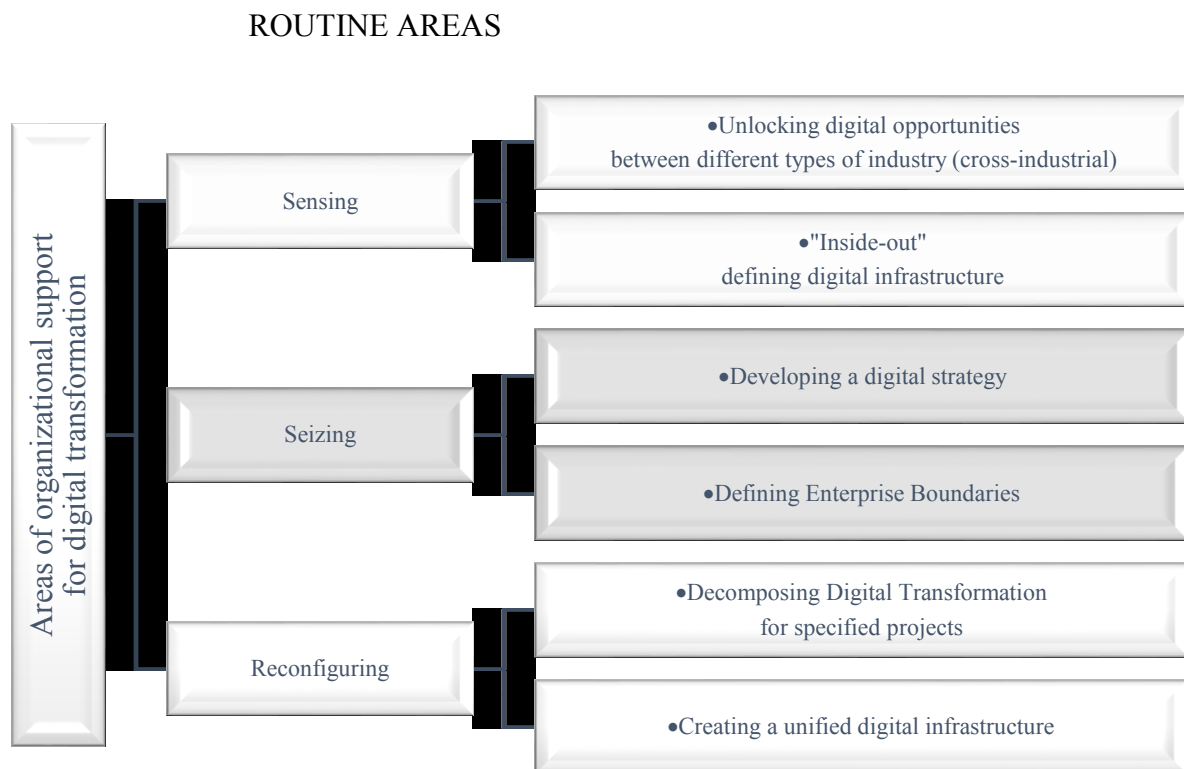


Figure 7. Areas of organizational support for digital transformation and key routines for each of the areas - the distinguished area of Acquisition.

Source: (own study based on: Ellström, Holtström, Berg, Josefsson, 2022).

- Development of a digital strategy:
 - Semi-continuous adaptation of an increasingly digitized strategy, adapted to the (changing) environment and (flexible) overall business goals.
 - **"Idea in the background":** For a digital transformation to be successful, it must be clear to all employees what the company's digital development strategy or priorities are and what the goal of the next digital transformation is. Without a clear digital development strategy/priorities, there will be confusion within the organization about what competencies need to be developed so that teams can take advantage of new digital opportunities. Lack of employee awareness of the company's overall digital strategy and business transformation goals is one of the most common obstacles to digitalization.

Only another aspect of developing a digital strategy is balancing the predictability of the strategy and specific business goals in a situation where the environment of digital transformation and its environmental conditions may change rapidly. Therefore, in addition to the sustainability and readability of strategies and goals, flexibility and adaptation to new opportunities become a requirement. A skillful solution to this dilemma (constancy – flexibility) becomes important for employee engagement.

One solution is to add a dimension of time and create alternating phases in the development of the company. Exploration phases, where flexibility is a priority, and exploitation phases, where we pursue a fixed strategy. Another solution is to add a dimension that describes the responsibilities of employees and describes permanent duties and such duties that may change.

- A frequently raised risk is the resistance or inertia of employees to change.
- Defining the boundaries of the enterprise:
 - Procedures for determining what should be done in-house and what should be carried out as part of outsourcing; These procedures are based on an understanding of the current competencies in the company and the competencies necessary for the implementation of the digital strategy.
 - **"Idea in the background"** As part of the implementation of digital transformation, we determine which routines to implement internally and which to outsource. It should be remembered that outsourcing is not always the best solution:
 - In a situation where there is no competence to implement routine in the company, it may be more beneficial to develop the necessary competencies within the company than to outsource routine.
 - In the case of competence shortages, outsourcing can be used at the initial stages of transformation, before the company has developed the necessary competencies.
 - Outsourcing tasks that are critical to a company's digital strategy can create high uncertainty in the company.

3. Reconfiguring

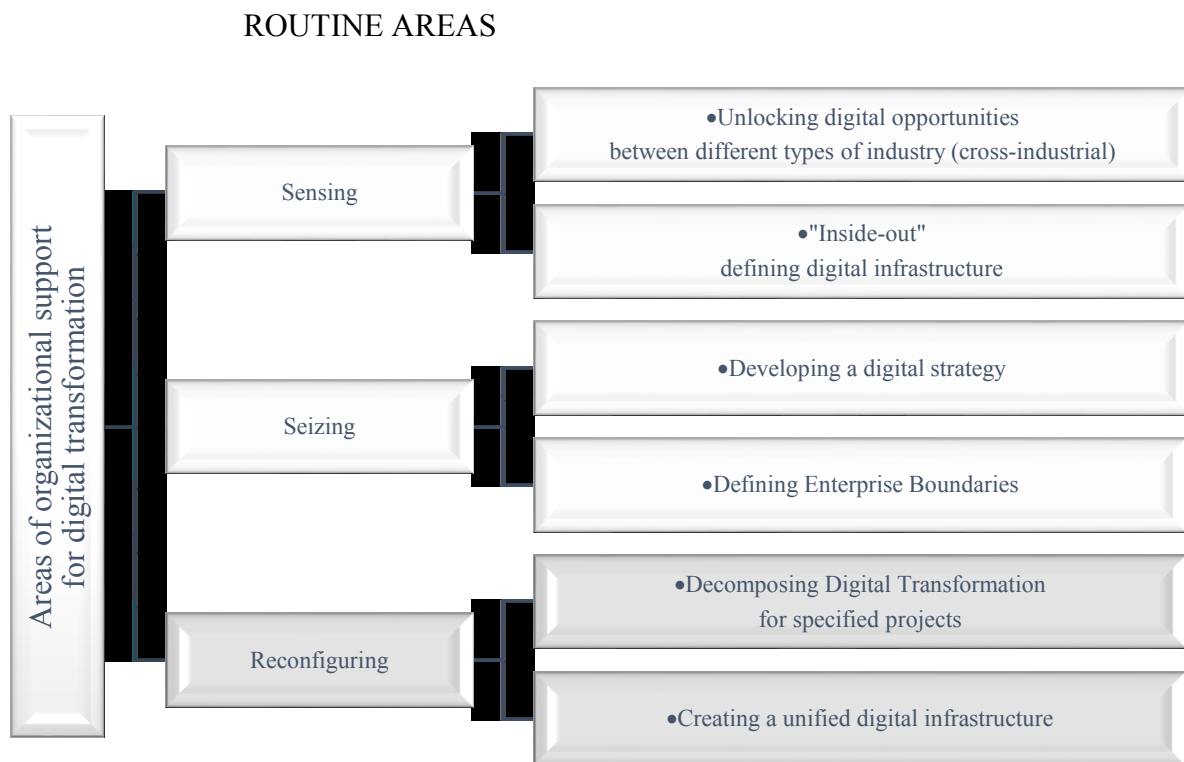


Figure 8. Areas of organizational support for digital transformation and key routines for each of the areas - the distinguished area of Acquisition.

Source: (own study based on: Ellström, Holtström, Berg, Josefsson, 2022).

- Decomposition of digital transformation into specified projects:
 - Prioritization of digitalization projects based on a digital strategy and assessment of resources (technical and human).
 - **"Idea in the background"**: Separating sets of short-term and long-term projects to ensure sufficient resources for long-term digital transformation endeavors. It is important to limit smaller projects to the exploration phase and disband project teams if the evaluation of a given project phase shows a lack of results. Thanks to such activities, we receive resources for further projects.
- Creating a unified digital infrastructure:
 - Integrate digital solutions into a unified digital infrastructure and make it available to the entire organization.
 - **"Background idea"**: Deciding which company-wide information is collected in one place and made available to all employees (e.g., device manuals, document templates) so that they can find and, if necessary, relevant information collected in the same place.
 - A frequently raised risk is that digital systems provide data security requirements. This aspect cannot be limited to one-off actions during the implementation of the change, but it is important that the security aspects have been continuously developed and regularly evaluated.

Conclusion

Presentation of an extensive model of implementing digital transformation in the organization: (Ellström D. et al., 2022) indicates that in each of the routines of this type of implementation, we refer to aspects describing the functioning of employees in the organization. From a specific point of view, the functioning of employees can be described as crucial for the timely implementation of digital transformation in the assumed scope.

Therefore, it seems that the model presented in this text – the effect of our own research – indicating that 11 out of 14 variables refer to the characteristics of a person or the way of building relationships in a task team as important, is not a model "excessively" focusing on relational aspects and omitting technological aspects of digital transformations in organizations.

Discussion: Results obtained for individual variables – missing differences

The most important difference between variables is the lack of differences in response between team leaders and team members. It can be considered that the lack of difference between employees and managers indicates that both groups are equally assessed by individual components. Therefore, another conclusion may be that the behavioral indicators that make up the individual factors of the test are universal – they are equally important for managers and employees. This lack of difference seems to be crucial due to the future independent use of the tool, as well as to the comparison with other tools used to assess the functioning of task forces in organizations.

The above-mentioned universal nature of the indicators may also be emphasized by the lack of differences in answers occurring for individual geographical locations of respondents) and the lack of differences due to the department in which the respondents worked.

The universality of the model can support the result obtained at the same time, as in the studies presented above. Interestingly, a similar result was obtained despite the use of a slightly different research procedure. According to F.B. Tigre et al. (2025), digital leadership has two main aspects:

- The first aspect is business-related and is focused: on strategy and execution.
- The second is related to the person of the leader and refers to: personal characteristics and orientation towards interpersonal relationships.

Therefore, we have two basic dimensions of a leader's functioning in the digital environment (the way the business is carried out and personal qualities). Each of these dimensions has 2 areas. This means that ultimately the model has 4 areas: 2 related to business and 2 related to the leader. The four areas captured by this model are presented in Figure 9.



Figure 9. Conceptual Model: Digital Leadership Capabilities.

Source: (own study based on: Tigre, Henriques, Curado, 2025).

The four areas mentioned above are similar to those obtained as a result of our own research (3-factor model, 14 indicators). The similarities of the model from our own research and the model of F.B. Tigre et al (2025) are compared in Table 4., below is also a detailed description of the inference leading to the final shown in this Table 4.

Table 4.

Factors identified in own research and factors identified in the study by F.B. Tigre et al. (2025)

Factor	
In the model obtained as a result of our own research	In the model obtained by F.B. Tigre et al (2025)
Individual perspective	Orientation towards interpersonal relationships Personal attributes
Organizational perspective	Focus on strategy
Team perspective	Relationship with implementation

Source: (own study).

The area "Orientation to interpersonal relationships" refers to social interactions between leaders and subordinates such as establishing relationships, communicating, being trustworthy, coaching, inspiring, empowering and engaging people.

In turn, the area: "Personal attributes" informs about how leaders manage themselves and their emotional reactions to situations; It consists of constructs concerning the characteristics of leaders in the area of the so-called individual differences: curiosity, initiative, autonomy and self-awareness (Tigre et al., 2025). The first and second areas correspond to the factor described in the final model (Table 2): Leader person and qualities. This factor refers to similar aspects as the areas from the F.B Tigre et al. (2025) model and others.

The third area from the F.B. Tigre et al. (2025) model: "Focus on strategy" defines how leaders formulate and implement strategic decisions towards the future goals of the organization. In other words, this area refers to leadership skills that affect the organization's long-term goal and response to change. This area is similar to the "Organizational Perspective" factor from the final model obtained in our own research (Table 2), as it refers to long-term activities at the organizational level related to the response to organizational change. It must be admitted that despite the similarity of the scope of this area, we have differently distributed accents and a different level of their detail. In the model of F.B. Tigre et al. (see Figure 9), we have general formulations relating to whole issues, such as: Calculated risks. Change Management, Innovation, Diversity, Knowledge Sharing, Vision/Direction. On the other hand, the same area in the model derived from our own research is described by terms at the level of performance of activities (see Figure 9), such as: Development by management of solutions necessary for the time of crisis; Identification by management of possible crisis events requiring a change in the way of working; Implementing the behaviour patterns developed by the management for crisis situations into the team's ongoing work.

The fourth area from the F.B. Tigre et al. model: "Relationship with Execution" refers to the leadership ability to manage the team towards the desired outcome. This area is similar to the "Team Perspective" factor, as it refers to the actions taken by the leader in relation to the team. In other words, the areas "Relationship with implementation" and "Team perspective" refer to the leader's actions towards the team, and not to the individual characteristics of the leader and possibly resulting from this style of communication. The areas "Relationship with implementation" and "Team perspective" refer to expert knowledge in the field of team management, writing down the actions that a leader should take towards colleagues who make up the team. As in the case of the "Focus on strategy" area and the "Organizational perspective" factor, we are dealing with differently distributed accents and with a different level of their detail (see Table 2).

Conclusions

The occurrence of similar aspects in models obtained with the help of different research procedures and by different authors seems to confirm the universality of the model obtained in our own research (see Table 2).

5. Summary

Conclusion

The finally obtained model of the behavior of the virtual team leader, containing 3 factors consisting of 14 observable variables, seems to be a model of a universal nature. This can be evidenced not only by the lack of differentiation due to location, role in the organization or department of the company. Also, the results of other research on leadership in the age of digitalization show similar areas as the 3 essential factors of the model. This is despite the use of other research procedures and other tools.

For the model finally obtained, an important characteristic is the focus on social skills (*soft skills*). This is a paradox, because we are talking about leading teams in which the use of advanced digital technologies is significant. However, it seems that this is a direction consistent with the way of understanding the relationship between man and technology defined in Industry 5.0.

The differences shown for the gender of people leading virtual teams are significant and developmental. This diversity seems to be a possible contribution to changes in the virtual labor market.

Limitations

The size of the group of people tested should certainly be included among the limitations, there is a risk that the current findings may not be confirmed when examining a larger number of people. The size of the group results from its specificity (people managing virtual teams and employees of the same teams), but it is also worth taking into account the observable variables rejected in the current study in subsequent studies. It is possible to return or delete individual observable variables from the 14 currently forming the model.

While the limitation may apply to individual observable variables, it seems that in the scope of 3 factors describing the management of virtual teams, we are dealing with a model of a universal nature. The universality of the model in terms of 3 factors is confirmed by other studies and seems to indicate that we can have an unchanging picture as far as the general findings (3 factors) are concerned.

The second limitation is the fact that working in virtual teams has been forced by the COVID-19 pandemic. Hence, the themes relating to work in virtual teams overlap with motifs referring to work in a situation of organizational change or task-based activity in a crisis situation.

However, the organization where the research was conducted maintained remote work even after the pandemic and the respondents were asked for their opinion in 2024, so with experience of working in virtual teams after the pandemic ended. Hence, it can be assumed that they

responded on the basis of (not so much) experiences related to change, but on the basis of experience from current work in virtual teams, which has become a standard in this company.

Practical recommendations

The model of leadership in virtual teams obtained in the research emphasizes social competences of a universal nature (50% of all observable variables captured by the model refer to this range). Next, we have the behaviour of the manager related to the management of the task force and the areas relating to the activities undertaken by the organisation represented by the senior management. As you can see, although the model describes functioning in an environment with a high degree of digitization, it does not refer to specialist competences related to the use of digital tools. So, in terms of recommendations for management, we have:

1. Focusing the organization's resources on the diagnosis and development of social competencies of people managing virtual teams. At the same time, a reduction in the development focus on digital competences (perhaps they are sufficiently well developed) could be considered. The freed up time and financial resources can be allocated to the development of competencies related to building leader-team relationships.

This recommendation results not only from the obtained model, but also from the observation that the technology supporting virtual work is becoming more and more user-friendly, and expectations in terms of relational issues (trust, way of communication, presence of a leader in the team's work) remain unchanged or are intensifying.

Further recommendations result from the connection of the results obtained in own research (leadership model in virtual teams) with the model describing the areas of organizational support for digital transformation by Ellström et al. (2022). On the one hand, this model can complement the presented own research in the area of the model called: "Organizational perspective". On the other hand, the model itself by Ellström et al. (2022), as indicated earlier, is saturated with aspects related to people management (e.g. eliminating resistance, developing competencies, building awareness of strategies and priorities) referring to observable variables specified in own research in the final version of the model.

From the common part of both models [the final model from our own research and the model of Ellström et al. (2022)], useful (as it seems) managerial tips are created:

2. It is important to remember that digitization has no value in itself. What is important is how digitization will change the ways of working, the habits of employees and whether it will support the achievement of the company's goals (Ellström et al., 2022). Thus, paradoxically, in technology-focused transformations, the critical factor is the area related to people: the characteristics of the manager, the style of building relationships, the way of issuing and communicating management decisions (see the set of 14 indicators in the final model from our own research).

3. Digital transformation is a situation where major changes are introduced. In such cases, there is a high risk of resistance or inertia of employees before change (Ellström et al., 2022). It is worth taking into account that digital transformation requires the involvement of highly specialized employees, so it seems advisable to choose a participatory way of managing change and take into account the fears that arise in the team as a source of resistance to the individual stages of implementing organizational change. A separate issue is the selection of appropriate means.
4. A frequently raised aspect of digital transformation is the provision of data security requirements by digital systems (Ellström et al., 2022). On the one hand, digitization makes work easier, as it involves digitizing physically existing information resources and at the same time facilitating access to them. On the other hand, we have concerns about the security of our own work products and personal data. Hence, it is necessary to build a system "in the default configuration of excessively secure" and at the same time communicate in a way that is readable to an individual employee the way in which access to data will be secured.

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MANAGERIAL COMPETENCIES IN THE MEDICAL DEVICE INDUSTRY — GENDER AND NATIONALITY PERSPECTIVE

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Purpose: The aim of the present study is to identify and assess managerial competencies in the medical device industry, taking into account differences between women and men. The analysis addresses the issue of women in management positions in a sector traditionally identified as typically male.

Design/methodology/approach: The research was conducted between 2018 and 2020 using a diagnostic survey among 130 managers representing 130 companies. The sample was selected purposively, and collaborating companies from four European countries were invited to participate: Poland, Germany, France, and the United Kingdom.

Findings: Analysis of the research results showed differences in the self-assessment of women and men. Women significantly more often pointed to their strengths in interpersonal skills, communication, and diversity management, while men rated their technical and strategic skills higher. The international analysis also showed differences in self-assessment – managers from Poland rated their skills higher than respondents from other countries.

Research limitations/implications: Limitations include the relatively small sample of 130 respondents from four European countries and the fact that the study is based on self-assessment of respondents, which limits the generalizability of the results.

Practical implications: Based on the research findings, future initiatives could include designing tailored development programs for women and men in the medical device sector.

Originality/value: The study adds new value to the literature by combining a gender perspective with international analysis in a male-dominated industry.

Keywords: managerial competencies, medical device industry, women and men in management, international context.

Category of the paper: Research paper.

1. Introduction

Managerial competencies are the foundation of effective leadership and efficient management in any industry, but in the medical device sector, they take on special importance. Due to the high dynamics of technological development, strict regulations and the interdisciplinary nature of the business – combining elements of engineering, medicine and business – managers in this sector must demonstrate not only strategic and operational capabilities, but also the ability to adapt, manage innovation and make decisions in an environment of high accountability (Mylyanyk, 2022; Olafenwa et al., 2021). Digital, trans-professional, and leadership competencies are particularly important to effectively respond to changing market conditions and implement modern technological solutions (Denend et al., 2020). In the context of women's managerial competencies, it also becomes crucial to recognize the structural, cultural, and perceptual barriers that affect how these competencies are developed, perceived, and used in management practice (Denend et al., 2020; Perez, 2022; Elkhwesky et al., 2023; Crimmins et al., 2023).

Within the framework of this study, a four-element competency model was adopted, which takes into account both subject matter knowledge and personal and social aspects crucial for effective management in complex structures. The competency groups analyzed include: (1) knowledge – understood as a body of information on management, industry regulation, innovation and finance (15 competencies assessed); (2) personal skills – such as work organization, mental toughness, self-reliance and reflexivity (9 competencies assessed); (3) interpersonal skills, including communication, collaboration, situational leadership, conflict resolution and relationship building (25 competencies assessed); and (4) competencies and attitudes related to diversity management – including sensitivity to gender equality, cultural inclusion, anti-discrimination and fostering an inclusive organizational culture (12 competencies assessed). This cross-cutting model captures both hard and soft aspects of competencies, which research shows can be developed and used differently for women and in different settings and structures than for men (Denend et al., 2020; Perez, 2022).

The article is based on a quantitative research approach and forms part of a broader project on managerial competencies and diversity management in the medical device sector. The aim of the study is to identify and assess the declared level of competencies among managers employed in this industry, with particular attention to gender and national differences. The article adds new value by comparing the self-assessment of managerial competencies of women and men in the medical device sector in four European countries, which has not been widely analyzed in the literature to date.

The article consists of several interrelated parts. The first part presents a theoretical framework for managerial competencies in the context of gender and their significance in management. Then, the empirical research methodology is presented, followed by the results

of studies conducted in four European countries. The article concludes with a discussion of the research results from the literature on the subject and a summary containing practical implications for management practice and recommendations for further study.

2. Literature Review

The subject matter of this article concerns the competencies of managers in the medical device industry. This sector was chosen for research due to its innovative and interdisciplinary nature. The functioning of the medical device industry at the intersection of biotechnology, engineering, information technology, and regulatory sciences, combined with a high level of social responsibility, means that managerial competencies are of particular importance here (Shet, Pereira, 2021). Managers operate in an environment characterized by rapid technological progress and digitization processes, growing legal requirements, and intense international competition (Bondarenko et al., 2021). Europe is currently the global center of the medical device industry (MedTech Europe's Facts & Figures 2023, 2023), with the most significant employment in Germany and strong positions in France, the UK, and Poland. Germany is Europe's largest and most mature market, accounting for over 25% of EU exports in this sector (The Medical Technology Industry in Germany, n.d.). France is intensively developing innovation thanks to strong state support, including through the "France 2030" strategy, which aims to double the value of the MedTech market within a decade (Market, 2024). The United Kingdom stands out for its dynamic development of digital and remote technologies in healthcare, which are significantly changing the profile of desired managerial competencies (Newsdesk, 2024). Although smaller in terms of market value, Poland is one of the fastest-growing MedTech markets in Europe, with projected growth to USD 6.9 billion in 2031 and the growing importance of exports (6Wresearch, 2024; ReportLinker, 2024).

Various classifications are used in research on managerial competencies. Bakanauskienė and Martinkienė (2015) distinguished three basic groups: professional competencies (specialized knowledge and skills), social competencies (adaptability and interpersonal skills), and personal competencies (individual characteristics and self-awareness). This model has been verified in studies of manufacturing companies and can also be successfully applied in the context of the medical device industry.

The literature emphasizes that effective management in high-tech sectors requires an adaptive approach and transprofessional competencies, combining traditional management skills (planning, control, delegation) with digital competencies, innovation, and the ability to manage change (Mylyanyk, 2022). Particular importance is also attached to lifelong learning and leadership capital development, which translates into a competitive advantage for the organization (Olafenwa et al., 2021).

At the same time, it is essential to emphasize the importance of digital and innovative competencies, which, in the light of the Industry 4.0 concept, include, among others, decision-making efficiency, systems thinking, readiness to implement innovations, and the ability to manage geographically and technologically dispersed teams (Shet, Pereira, 2021). These competencies complement traditional managerial skills and are key to effective functioning in digital transformation.

Another important approach is the GLOBE model, which indicates that managerial competencies are strongly culturally conditioned. Depending on the country, different competencies, e.g., interpersonal, strategic, or diversity management, may be considered key (House et al., 2004; Bücken, Poutsma, 2010). An effective global manager should develop universal competencies and adapt to specific cultural and institutional expectations.

In the context of this study, it is impossible to ignore the concept of relational demography, which is how similarities and differences in relation to other group members shape an individual's experiences in an organization. In environments where a particular characteristic (such as gender, age, or ethnicity) makes an individual “different” from the majority, their actions become more visible and evaluations often more critical (Rakowska, 2021). In the male-dominated medical device industry, female managers often function as a minority, which affects how their competencies are perceived, their career development, and their access to key strategic roles (Fitzsimmons et al., 2014; Perez, 2022).

This approach justifies the analysis of gender differences in managerial competencies. Studies on self-assessment of competencies presented in the literature indicate that women tend to underestimate their competencies, while men tend to overestimate or assess them more accurately. Such patterns have also been observed in technical and high-tech fields. According to researchers, this may significantly impact employees' promotion and professional development (Elkhwesky et al., 2023; Bodard et al., 2024; Syzmanowicz, Furnham, 2011). Studies indicate that women often develop and declare higher interpersonal and diversity management competencies, while men usually emphasize technical and strategic competencies (Zhang et al., 2022; Thelma, Ngulube, 2024).

In the context of this study, it is also worth noting that the high-tech ecosystem (including MedTech) draws its workforce from STEM/ICT, where women are still underrepresented (e.g., in 2024, women accounted for approximately 19.5% of ICT professionals in the EU; in R&I, they were a minority among researchers/engineers). This is still a significant factor limiting the influx of female talent into management roles (European Commission: Directorate-General for Research and Innovation, 2025; Eurostat, 2025).

Analyzing these differences from the perspective of relational demography theory provides a better understanding of why women, despite their high competence, still encounter barriers in accessing top management positions in the MedTech sector (Denend et al., 2020; Entradas, 2023; Chandra, 2020; Berlin et al., 2019). It also provides a starting point for consideration of the research presented in this article.

3. Methods

The presented article is based on a quantitative approach to identify and assess the competencies of managers representing the analyzed companies. The presented study is part of a broader research project on the competencies of managers in the medical device industry and diversity management in the companies they represent. The study aimed to identify and assess managerial competencies in the medical device industry.

The specific objectives of the presented research are the answers to the formulated research questions:

RQ1: What is the respondents' declared level of competence concerning gender?

RQ2: What are the differences in the declared level of competence between men and women?

RQ3: What specific differences in self-assessed competencies can be observed between Polish managers and those from Germany, France, and the UK?

The empirical study was conducted in 2018-2020 using a diagnostic survey method with a questionnaire technique. The research questionnaire was constructed on the basis of an analysis of the literature on the subject, followed by qualitative research in the form of in-depth individual interviews. During these interviews, we asked participants to identify key competencies relevant to their industry, assess their importance in the context of the role of a medical device manager, and provide feedback on the content of the survey. The selection of the sample was purposeful. We targeted experienced managers to ensure their relevant expertise. We systematically coded and analyzed the qualitative data collected to identify patterns and insights that influenced the final structure and content of the survey tool used in the second stage of the research.

The questionnaire covered four competency areas: (1) knowledge – understood as a body of information on management, industry regulation, innovation and finance (15 competencies assessed); (2) personal skills – such as work organization, mental toughness, self-reliance and reflexivity (9 competencies assessed); (3) interpersonal skills, including communication, collaboration, situational leadership, conflict resolution and relationship building (25 competencies assessed); and (4) competencies and attitudes related to diversity management – including sensitivity to gender equality, cultural inclusion, anti-discrimination and fostering an inclusive organizational culture (12 competencies assessed). Respondents rated the degree to which they possessed the analyzed competencies on a scale of 1 to 7, where 1 represented the lowest and 7 the highest rating. The quantitative survey was conducted in English, face-to-face. Only the survey of managers of Polish nationality was presented in their native language. The questionnaire was translated from Polish to English and vice versa to Polish to ensure conceptual equivalence and clarity.

The survey covered managers of medical device companies. They were mainly senior and middle managers, mainly of small and medium-sized enterprises, due to the structure of the industry, in which about 95% of employees work. These are small and medium-sized enterprises. It is assumed that the structure of the survey sample in terms of gender, age, and nationality reflected the structure of the sector.

The survey was conducted in selected European countries, namely Germany, France, the UK, and Poland, using a purposive sample of cooperating companies from the medical devices sector. In addition to Poland, countries with high activity in the medical device industry were selected for the study. Germany, France, and the United Kingdom are among the six countries with the largest number of registered medical device businesses, as well as the highest percentage of people employed in the industry in Europe. Poland, Germany, France, and the UK were selected for this study due to their strong positions in the European MedTech sector and contrasting market profiles. Germany leads in scale (€43 billion; GTAI, 2023), France is rapidly expanding (Market Research Future, 2024), the UK excels in digital innovation (IoT World Magazine, 2024), while Poland represents a fast-growing emerging market (6Wresearch, 2023). This diversity enables a multidimensional analysis of managerial competencies across varying levels of maturity, innovation, and regulatory complexity.

There are an estimated twenty-six thousand companies operating in Europe. The survey included 130 managers, which is about 0.5% of the population. The survey was conducted among 130 managers from 130 different organizations. Of the respondents, 21% work in micro companies, 46% in small companies, 25% in medium-sized companies, and 8% in large companies. At the same time, 71% of these companies operate globally, 18% in European theaters, and 11% in national stadiums. The structure of the origin of the surveyed organizations is as follows: 29% are registered in Germany, 16% in the UK, 25% in France, 19% in Poland, and 11% in other countries. 38 women (29%) and 91 men participated in the study, while one person refused to provide information about their gender. Of the surveyed managers, 11% work at a low management level, 67% at a medium or high management level, 18% on a management contract, and 5% did not answer. The survey provided empirical material, which was analyzed statistically. The data obtained were entered into a database created in an Excel spreadsheet. Relationships between qualitative variables were assessed using the Chi-square test of independence.

4. Results

Differences in the self-assessment of competencies of women and men

The problems of the presented article concern the competence of women in managerial positions in the medical device industry. Respondents were asked to assess the competencies they possess, divided into four areas. Given the problematic nature of the article, the self-assessment of women's and men's competencies was analyzed.

As for the area of knowledge, it turned out that the level of these competencies in the self-assessment of women and men was similar. This is particularly evident in the case of the so-called hard competencies, i.e., English language skills, strategic management, marketing, and industry knowledge, as well as knowledge of legislation. Among the 15 competencies assessed in this group, only one had a statistically significant difference. Male respondents report having higher knowledge of corporate financial management than female respondents (difference of 0.95).

The next area analyzed was the respondents' personal skills. As in the case of knowledge, only one competence (out of the 9 assessed) showed statistically significant gender differences in self-assessment. These concern the ability to process large data sets and translate them into abstract concepts ($p = 0.01$; $p < 0.05$). The average level achieved by female managers was 4.41, while that achieved by men was 5.12.

The next area analyzed was the interpersonal competence of the respondents. In this group, the largest number of items was assessed – 25 competencies. Statistically significant differences were observed in the case of three evaluated areas. It is interesting to note that this time the situation is reversed, with women declaring a higher level of competence than men. Statistically significant differences were observed for the following competencies: teamwork (women: 6.26; men: 5.67; difference: 0.59; $p = 0.01$), ethical behavior (women: 6.46; men: 5.88; difference: 0.58; $p = 0.01$), and the ability to identify sources of conflict (women: 5.51; men: 4.96; difference: 0.56; $p = 0.01$).

The last area assessed was competencies and attitudes related to diversity management (12 items). Analysis of the results of the surveys conducted in this area shows that women generally declare a higher level of these competencies than men. It can be assumed that it is women who are more sensitive to areas related to the presence of differences that can lead to inequality, since, as analysis of the literature shows, they are more likely to be victims of discrimination. However, there are statistically significant differences for two of them. Women report significantly higher sensitivity and empathy for diversity (mean score: 6.21) than men (mean score: 5.36, difference: 0.85; $p = 0.00$) and for fair and impartial treatment of diversity (women: 6.13; men: 5.54; difference: 0.59; $p = 0.02$).

In summary, for 11% of competencies, statistically significant differences were diagnosed in the degree to which men and women possess them. At the same time, men declare a higher level for two competencies (knowledge of corporate financial management and the ability to process large data sets and translate them into abstract concepts), while women declare a higher level for five (teamwork, ethical behavior, ability to identify sources of conflict, sensitivity and empathy to diversity, and fair and impartial treatment of diversity). These differences are presented graphically in Figure 1.

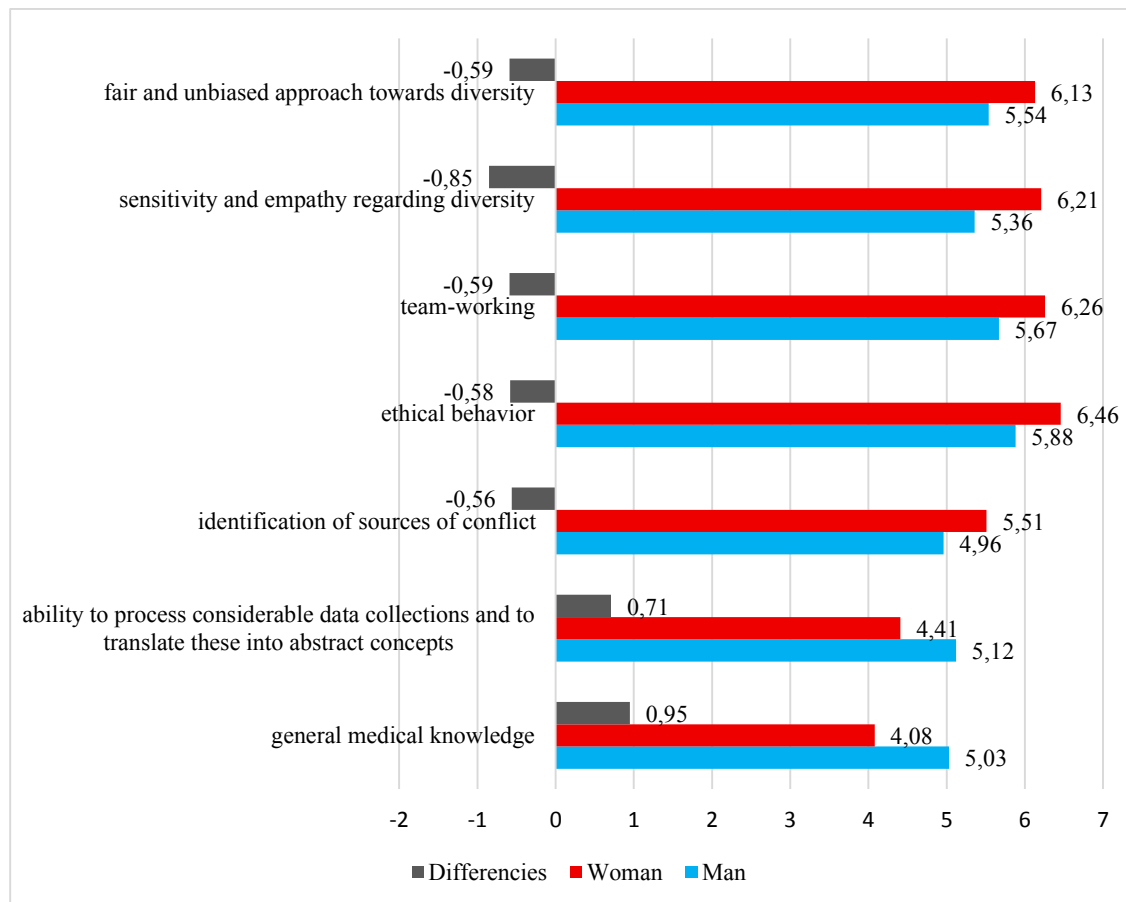


Figure 1. Self-assessment of competencies by gender (n = 129, statistically significant differences only, $p < 0.05$).

Source: own study results.

Competencies vs. the nationality of respondents

It was of interest to the authors of this article to find out the differences in competencies declared by managers from different countries. To this end, we conducted a statistical analysis of the collected empirical material. We compared the competencies declared by managers from Poland and managers from other countries. Due to the smaller proportion of women in the group of managers surveyed, this time the analysis was not carried out by gender.

Interestingly, for all competencies assessed, Polish managers declared that they had a higher level of a given competence than their foreign counterparts. Table 1-3 presents the results of the comparative analysis of managers from Poland, Germany, France, and the UK. They include

information only on statistically significant differences. The most statistically significant differences were identified when comparing the results of managers from Poland and Germany. These differences concerned 11 assessed competencies.

Table 1 shows a comparison of self-assessed competencies between Poles and Germans. There were statistically significant differences for 11 of the assessed areas, with Poles rating their competencies higher than Germans.

Table 1.

Competencies of Poles vs. Germans (statistically significant differences only, $p < 0.05$)

Competencies	Poles N = 24	Germans N = 38	Difference in the declared competence level	p
K: other foreign languages knowledge	4.00	3.08	0.92	0.04
K: human resources management knowledge	5.33	4.35	0.98	0.01
PS: development and application of new forms of communication and the ability to critically process such content	5.13	4.27	0.85	0.04
IS: ability to create a vision and pass it on	5.58	4.81	0.77	0.04
IS: identification of sources of conflict	5.54	4.89	0.65	0.05
IS: prioritizing objectives	5.85	5.05	0.78	0.02
IS: change management	5.48	4.22	1.26	0.00
IS: effective virtual team-working	5.48	4.43	1.05	0.01
IS: efficient decision-making skills	5.96	4.92	1.04	0.00
DM: ability to apply differences emerging from diversity	5.87	5.06	0.81	0.04
DM: learning when at work	6.30	5.53	0.78	0.02

Source: own study results.

The most significant differences occurred in the areas of interpersonal skills (IS): change management (a difference of 1.26), effective virtual team-working (1.05), and efficient decision-making skills (1.04). Other notable differences included human resources management knowledge, critical information processing skills, and learning when at work. Overall, the results indicate that Poles tend to have a higher self-assessment of their competencies compared to Germans, especially in soft and management skills.

Table 2 presents the results of statistically significant differences identified by comparing the self-assessment of competencies between Polish and French managers surveyed. Ten statistically significant areas were identified, and in all of them, Poles rated their competencies significantly higher than the French.

The largest differences were observed in the areas of: sector-related IT software knowledge (a difference of 1.08), assertiveness (0.95), influencing others' skills (0.86), and human resource management knowledge (0.85). Differences were also found in decision-making skills, motivating employees, managing change, and creating and communicating a vision. No statistically significant differences were identified in the self-assessment of Poles and French in the area of competencies related to diversity management.

Table 2.*Competencies of Poles vs. French (statistically significant differences only, $p < 0.05$)*

Competencies	Poles N = 24	French N = 32	Difference in the declared competence level	p
K: sector-related IT software knowledge	4.63	3.55	1.08	0.04
K: human resources management knowledge	5.33	4.48	0.85	0.01
PS: proficiency in thinking and developing solutions other than those already existing	5.83	5.13	0.71	0.03
IS: ability to create a vision and pass it on	5.58	4.78	0.80	0.01
IS: identification of sources of conflict	5.54	4.91	0.64	0.04
IS: impacting others' skills	5.45	4.55	0.86	0.03
IS: change management	5.48	4.90	0.58	0.04
IS: motivating employees- selection of tools	5.63	4.78	0.84	0.04
IS: efficient decision-making skills	5.96	5.25	0.71	0.01
IS: assertiveness	5.50	4.55	0.95	0.02

Source: own study results.

Table 3 shows a comparison of the self-assessment of competencies between Poles and Brits, where statistically significant differences occurred in only three competencies. It is worth noting that in two of the three areas analyzed, Poles rated their competencies significantly higher than the British, while in one case, they rated their competencies lower ($p < 0.04$), which did not occur in the comparison of self-assessment of Polish managers against any of the other nationalities. The biggest difference in favor of Poles was in industry-related knowledge (a difference of 1.17), as well as in learning when at work (0.99). Only in resourcefulness did the British rate themselves higher than the Poles (a difference of -0.64).

In summary, Poles rated their technical and adaptive competencies higher, while Brits rated their own resourcefulness better. Again, no statistically significant differences were noted in the area of diversity management in this comparison.

Table 3.*Competencies of Poles vs. British (statistically significant differences only, $p < 0.05$)*

Competencies	Poles N = 24	British N = 21	Difference in the declared competence level	p
K: sector-related knowledge	3.17	2.00	1.17	0.03
PS: resourcefulness	5.58	6.22	-0.64	0.04
IS: learning when at work	6.30	5.31	0.99	0.01

Source: own study results.

5. Discussion

The research showed that differences in the self-assessment of competencies between women and men in the medical device industry are concentrated in selected areas. Women often indicated higher interpersonal, ethical, and diversity management competencies, while men

rated their analytical and financial skills higher. The results are consistent with the findings of Eagly and Carla (2009) and Fischer et al. (2018), who emphasize that women more often demonstrate competencies related to empathy and cooperation, while men focus on technical and strategic competencies. This also confirms the thesis of gender competency complementarity, which, as Fitzsimmons et al. (2014), can be a source of organizational strength.

Interpreting the results from the perspective of relational demography theory (Rakowska, 2021) allows for a better understanding of the dynamics of these differences. Women, being a minority in the MedTech sector, operate in conditions of greater "visibility" and often stronger evaluation, which may explain their greater focus on interpersonal and ethical competencies. Conversely, men, as the dominant group, are more likely to declare confidence in areas of strategic and technical knowledge. Similar correlations are indicated by the research of Szymanowicz and Furnham (2011), which shows that women are more likely to underestimate their competencies, while men tend to overestimate them.

The results of international studies further confirm the importance of cultural factors. Managers from Poland rated their competencies significantly higher than respondents from Germany, France, and the United Kingdom. This can be interpreted in the light of the GLOBE model (House et al., 2004), which indicates that achievement-oriented cultures (such as Poland) place greater emphasis on competencies related to decision-making and effectiveness (Komor, Schumann, 2015). At the same time, as noted by Gunkel, Schlaegel, and Taras (2016), there is a tendency in Central and Eastern Europe to overestimate managerial competencies, which is also reflected in this study.

The results can also be compared with the literature on women's presence in management positions in high-tech industries. Although women constitute the majority of employees in the healthcare sector, their share on the boards of MedTech companies is only 25-30% (Perez, 2022; Fitzsimmons et al., 2014). As Denend et al. (2020) and Entradas (2023) point out, this results from women's limited access to strategic roles and informal networks that shape managerial careers. The results of this study confirm this context – women declare key competencies for collaboration and diversity management. However, men are more likely to occupy positions that require financial and analytical competencies.

6. Summary

This article aimed to identify and evaluate managerial competencies in the medical device industry, considering gender differences and the international context. In response to the research questions, it can be concluded that:

(RQ1) The managers surveyed generally rated their level of competence highly, but gender differences emerged. Women more often declared higher interpersonal and diversity management competencies, while men pointed to their strengths in financial knowledge and analytical skills. These results confirm observations from the literature, indicating different emphases in the development and self-assessment of competencies between the two genders (Eagly, Carli, 2009; Fitzsimmons et al., 2014).

(RQ2) Analysis of the differences in the self-assessment of competencies between women and men showed that they are selective but significant from a management practice perspective. Interestingly, in many studies, women rate their competencies lower than men (Szymanowicz, Furnham, 2011; Bodard et al., 2024), while in this study, women reported higher skills related to relationship building, cooperation, and ethics. Other authors also obtained similar results, indicating the advantage of women in the area of interpersonal skills and diversity management (Eagly, Johannesen-Schmidt, van Engen, 2003). Conversely, men rated their strategic and technical competencies higher, which emphasizes the complementary nature of the competencies of both genders in management teams.

(RQ3) The results of international comparisons show that managers from Poland consistently declared a higher level of most competencies than their counterparts from Germany, France, and the United Kingdom. The most significant differences concerned change management skills, effective decision-making, and working in virtual teams. This can be interpreted in the light of the GLOBE model (House et al., 2004) and the literature pointing to a culturally conditioned tendency towards higher self-esteem in Central and Eastern European countries (Gunkel, Schlaegel, Taras, 2016).

In summary, the study confirms that differences in the self-assessment of managerial competencies between women and men in the medical device industry are selective but significant. In light of relational demography theory, they can be seen as the result of structural imbalances and different gender experiences in a sector traditionally dominated by men. At the same time, the results point to the potentially complementary nature of these competencies, which may foster the development of diverse, innovative teams in the MedTech industry.

Analysis of the research results enabled the formulation of practical recommendations for mixed-gender leadership training programs. In this context, it is worth noting:

- encouraging participation in training courses that complement areas in which a given gender is usually rated lower (e.g., finance, analytics, empathetic communication, teamwork),
- creating mixed-gender pairs and teams to learn from each other in practice,
- include women in strategic and financial projects, and men in initiatives requiring strong interpersonal skills,
- use mentoring and mutual feedback to identify and strengthen different leadership styles,
- ensure equal access to career paths and “visible” projects, regardless of gender.

At the same time, the limitations of the study should be emphasized. The analysis covered only four European countries, which limits the possibility of generalizing the results. In addition, the sample included a relatively small number of women (38 people), which requires caution in concluding. Finally, using self-assessment as the only data collection tool may involve the risk of overestimating or underestimating one's own competencies (Kruger, Dunning, 1999). The study's results can contribute to discussing managerial competencies in the innovative medical device industry and serve as a starting point for further in-depth research in this area. It would be worthwhile to use triangulation of methods (e.g., 360-degree feedback, supervisor assessments, case studies) and extend the analysis to other countries to capture cultural and institutional diversity better.

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MEASUREMENT OF ORGANIZATIONAL CULTURE IN HEALTH CARE UNITS – A LITERATURE REVIEW

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Purpose: The aim of this article is to review the national and international literature on the measurement of organizational culture in healthcare entities. The work focuses on identifying the most commonly used models, research tools, and methodological approaches used to analyze organizational culture and patient safety culture.

Design/methodology/approach: This article is a literature review. Polish and international scientific publications on organizational culture in healthcare were analyzed. They included empirical articles, review articles and descriptions of research tools. Qualitative and quantitative approaches to the topic were analyzed. Reviewed papers presented also research on standardized questionnaires and qualitative methods.

Findings: Literature analysis indicates that organizational culture is a key factor influencing the quality of healthcare services and patient safety. Both in Poland and globally, research using standardized quantitative tools predominates. At the same time, the lack of a single universal measurement instrument and the need to combine quantitative and qualitative methods are emphasized.

Practical implications: The review results can support healthcare management in selecting appropriate tools for diagnosing organizational culture. The article emphasizes the importance of systematically monitoring organizational culture as an element of quality and patient safety management and points to the need for conscious implementation of cultural changes in healthcare organizations.

Social implications: Researching and shaping a mature organizational culture in healthcare has significant social significance, as it influences patient safety, quality of care, and public trust in the healthcare system. Research on organizational culture supports the development of a culture of learning, open communication, and team accountability, which can contribute to reducing adverse events and improving working conditions for medical personnel.

Originality/value: This article summarizes the current state of knowledge on the measurement of organizational culture in healthcare, combining national and international perspectives. Its value lies in the compilation of research tools used and its analysis in the context of public healthcare entities. The work also highlights the need for further development of tools dedicated to the healthcare system in Poland.

Keywords: organizational culture, healthcare, patient safety, healthcare quality, literature review, measurement tools.

Category of the paper: Review paper.

1. Introduction

The healthcare system in Poland is undergoing transformation in the direction set by the Act of June 16, 2023, on Quality in Healthcare and Patient Safety. This legal regulation streamlines the rules for providing services and requires healthcare providers to implement internal quality management systems and monitor adverse events. Thus, the legislator has shifted the focus from the medical procedure itself to patient safety, making organizational culture a central element of effective healthcare facility management.

Organizational culture in healthcare is characterized by exceptional complexity resulting from the coexistence of numerous professional groups with differing norms and hierarchies. As Davies et al. (2000) point out, it can be analyzed as a social phenomenon based on relationships, but also as a measurable variable influencing clinical outcomes. In the era of new legal regulations, this complexity and the presence of subcultures (Scott et al., 2003) require a thoughtful research approach that will allow for the identification of cultural barriers that may hinder the achievement of statutory safety goals. In this context, the use of the Competing Values Model (OCAI) proves particularly valuable, allowing for the precise identification of organizational culture profiles (e.g., hierarchical or clan-based) and understanding how they impact quality processes (Świtała, Mościcki, 2016).

A significant challenge for quality in the context of the new law is the transfer of information between staff and patients. Jończyk (2011) rightly notes that patients, although often lacking the competence to assess the technical aspects of medicine, are precise observers of interpersonal relationships and service standards. In light of the statutory requirement to survey patient opinions, understanding this relationship becomes crucial for a comprehensive assessment of the quality of care.

The main goal of this study, inspired by the provisions of the law, is to analyze organizational culture as a mechanism for enhancing quality in healthcare and patient safety, thereby preventing adverse events. Transitioning from the archaic "blame culture" to the "just culture" promoted by modern standards and legislation requires the use of proven diagnostic tools. International literature highlights standardized questionnaires, such as the Safety Attitudes Questionnaire (SAQ) or the Hospital Survey on Patient Safety Culture (HSOPSC) (Sexton et al., 2006; Pronovost, Sexton, 2005), which allow for an objective assessment of an organization's condition. Researching organizational culture in the era of the new quality law is

no longer merely a theoretical research option but a necessity. It allows for the building of lasting safety foundations consistent with both current global trends and the stringent requirements of Polish law, ultimately translating into higher quality services and greater patient protection in the healthcare system.

2. Methods

This study is a literature review and focuses on the analysis of scientific achievements regarding organizational culture in healthcare institutions. The objective of the article was to identify the most commonly used research approaches, measurement tools, and key dimensions of organizational culture described in the literature. The literature review included scientific publications available in databases such as Scopus, Web of Science, PubMed, and Google Scholar. The literature search was based on a set of keywords in English and Polish, including: organizational culture, healthcare organizations, hospital culture, patient safety culture. The analysis included both Polish-language publications and foreign literature in English. The identified publications were subjected to qualitative analysis, including a comparison of definitions of organizational culture, research methods, and organizational contexts. Based on this analysis, a synthesis of the results was performed, which allowed for the organization of knowledge and the identification of dominant research trends and gaps in the literature.

3. Review of Polish Literature

3.1. Specificity of the Polish Healthcare System

The Polish healthcare system is based on an insurance model, in which the National Health Fund (pl Narodowy Fundusz Zdrowia, NFZ) serves as the primary payer. This single-payer dominance influences the specific operating conditions of healthcare providers, including limited market competition and strong administrative regulation. Healthcare providers in Poland are divided into public healthcare facilities (pl zakład opieki zdrowotnej, ZOZ), characterized by a high degree of formalization and bureaucratization; private healthcare facilities (niepubliczne zakłady opieki zdrowotnej, NZOZ) with greater organizational flexibility; and individual and group practices, primarily in primary care.

The system struggles with a number of structural problems that directly impact organizational culture: chronic underfunding that forces cost optimization, a shortage of medical personnel, excessive bureaucracy, long waiting lists for specialized services, and the growing demand associated with an aging population. These conditions determine the selection and adaptation of research tools used in Polish studies on organizational culture and healthcare quality.

3.2. Research in Polish Healthcare Facilities

3.2.1. Competing Values Framework in Polish Research

The most recent and comprehensive research on organizational culture in Polish healthcare facilities was conducted by Beata Domańska-Szaruga, Joanna Anna Jończyk, and Agnieszka Knap-Stefaniuk. The researchers applied the Competing Values Framework developed by Kim S. Cameron and Robert E. Quinn, using the OCAI (Organizational Culture Assessment Instrument) questionnaire.

The study, conducted in 2023, included 85 healthcare facilities (42 hospitals, 17 outpatient specialist care facilities, and 26 primary care facilities) and 372 respondents. The CATI (computer-assisted telephone interviewing) method was used. The results revealed the dominance of hierarchy and clan culture in Polish healthcare facilities, with a significant gap between the current and desired state. The desired direction of change indicates an increasing importance of clan culture at the expense of hierarchy culture and a slight increase in adhocracy culture (Domańska-Szaruga et al., 2024).

Joanna Jończyk's earlier research (2016-2017) focused on the relationship between organizational culture, human resources management in public hospitals, pro-innovation management, and negative behaviors of medical staff. This research identified barriers to innovation resulting from hierarchy culture and the potential of clan culture to support innovation.

Chuda (2017) presented a detailed method for diagnosing organizational culture using the Cameron and Quinn model, emphasizing the importance of dual measurement of the current and desired state. Świtała and Mościcki (2016) confirmed the high reliability of the tool, but the authors of the Polish study point to a significant methodological limitation. The Competing Values Model was developed primarily based on research on commercial organizations, which may not fully account for the specific characteristics of public entities. Domańska-Szaruga and co-authors (2024) advocate the development of research tools dedicated to entities operating in the public sphere, taking into account their cultural and organizational specificities.

3.2.2. *Meyer and Allen's Organizational Commitment Scale*

Polish studies on healthcare employee engagement utilize the Organizational Commitment Scale (OCS) developed by Meyer and Allen, which measures three components of commitment: affective (emotional attachment), continuance (awareness of the costs of leaving), and normative (sense of moral obligation).

Bańska, Wołowska, and Bazińska (2002) adapted and validated the Polish version of the scale using a sample of 261 employees from various professions, including medical personnel. Reverse-coded items were removed, retaining 18 items, six per component.

This scale was subsequently used in studies by Górniak (2016) on the relationship between organizational values and employee engagement, Motyka and Krzyżak (2020) examining the relationship between the satisfaction of psychosocial needs and organizational commitment, and Łaguna, Mielniczuk, and Wuszt (2015) analyzing the impact of commitment on various stages of the training process.

3.2.3. *Proprietary Patient Satisfaction Questionnaires*

Proprietary survey questionnaires, developed specifically for specific medical facilities, are widely used in Polish research. Jończyk (2011) developed a questionnaire consisting of 30 closed- and open-ended questions, focusing on non-medical aspects of healthcare. This assumption was made due to the strong information asymmetry in medical staff-patient relationships. Patients are not competent to assess strictly medical aspects, but they can objectively assess the facility's physical conditions, interpersonal relationships, waiting times, and compliance with patient rights. A pilot study was conducted on a sample of 30 patients at a hospital in the Podlaskie Voivodeship, using a five-point Likert scale.

Dziduch and Blicharz (2014) developed three separate questionnaires for different groups of respondents: employee satisfaction, hospital patients, and outpatient clinic patients. The employee satisfaction questionnaire covered 13 criteria, including material aspects (equipment, remuneration), organizational aspects (employment stability, atmosphere), relational aspects (collaboration), and developmental aspects (opportunities for development and improvement of qualifications). The study was conducted in a privatized medical facility on a sample of 130 respondents.

As Dziduch and Blicharz (2014) note, these proprietary tools have significant practical advantages. They can be adapted to the needs of a given facility and take into account specific local conditions. However, they are characterized by significant limitations: lack of psychometric validation, unknown validity, reliability, and sensitivity, and difficulty comparing results with other facilities (Dziduch and Blicharz, 2014).

Wroński and Bocian (2009) emphasize that despite the widespread use of proprietary questionnaires in Polish healthcare facilities, the primary goal of satisfaction surveys should be not only to measure satisfaction levels but also to understand the main determinants of satisfaction and dissatisfaction, to accurately identify patient expectations, and to identify the facility's strengths and weaknesses.

Świtalski, Wiśniewska, Jopek, Dykowska, and Czerw (2022) emphasize the importance of standardized questionnaires for monitoring safety culture in healthcare facilities. In addition to monitoring adverse events and patient satisfaction, these questionnaires are paramount in diagnosing the level of safety culture and implementing appropriate corrective actions.

3.2.4. Patient Request Form

Humeniuk, Pawlikowska-Łagód, Dąbska, and Mazurek (2018) used the standardized Patient Request Form (PRF), adapted from Zygfryd Juczyński's Polish version, to survey patients' expectations of their primary care physicians. The questionnaire contains 18 statements assessing expectations related to a medical visit, including the physician's involvement in explaining the disease, emotional support, information about diagnostic tests, medication instructions, course of treatment, prognosis, alternative treatment methods, side effects, and psychosocial aspects of the disease.

The study was conducted on a sample of 100 primary care patients in the Lublin macroregion, analyzing the relationships between demographic characteristics (gender, age, place of residence, education) and expectations. Despite international validation and Polish cultural adaptation, this tool has certain limitations – it only measures expectations without assessing their fulfillment and focuses on the individual visit, not taking into account long-term care.

3.2.5. Lean Management in Healthcare

Bukowska-Piestrzyńska (2018) and Szczerbak and Szczerbak (2024) present the concept of lean management as a method for streamlining operations in healthcare facilities. Lean healthcare, an adaptation of the Toyota Production System methodology, is based on eliminating waste in healthcare processes while maintaining or improving the quality of services. In the medical sector, waste includes errors requiring correction, unnecessary procedures, unnecessary patient transport, waiting times for admission, excess drug supplies, and lost employee creativity.

The basic lean tools in medicine include: value stream mapping (VSM), which identifies which stages of the treatment process create value for the patient; the 5S method, which ensures workspace organization and reduces infections; kaizen, which engages staff in continuous improvement; poka-yoke, which reduces the risk of medical errors; and the kanban system, which manages inventory (Szczerbak, Szczerbak, 2024).

Graban (2011), in the Polish edition of "Lean Hospitals" defines lean as a management system, a method of continuous improvement, and a way to solve problems relevant to all levels of a medical organization. Implementing lean in medical facilities contributes to increased savings, improved treatment quality, and enhanced patient safety, although it is associated with barriers: lack of staff awareness, resistance to change, and concerns about the impact of change on safety.

3.2.6. Case Study and Qualitative Methods

Frankowska and Głowacka (2012) used a case study method to analyze the organizational culture in two medical facilities: a complex of specialist laboratories in a public hospital and a privatized district hospital. The analysis covered levels of organizational culture according to Schein's model (assumptions, norms and values, artifacts), management styles, and relationships between employees and patients. This method, despite limitations in generalizing the results, allows for deep insight into the studied phenomenon and consideration of the organizational context.

4. Review of the International Literature

Organizational culture in healthcare facilities is an important topic of international research. Researchers analyze how organizational culture influences the functioning of hospitals and clinics, the behavior of medical staff, and the quality and safety of patient care. Organizational culture is a complex phenomenon that is difficult to define unambiguously, making its measurement difficult (Davies et al., 2000). In healthcare, organizational culture can be studied in two ways. The first, qualitative, approaches it as a phenomenon resulting from professional norms, relationships between employees, and the specific characteristics of individual professional groups within hospitals. The second, quantitative, approaches organizational culture as a variable that can be measured using questionnaires and explores its relationship with other factors, such as quality of care or management style (Davies et al., 2000). Both qualitative and quantitative approaches are used in empirical studies that utilize the research methods discussed below.

4.1. Safety Attitudes Questionnaire

The Safety Attitudes Questionnaire (SAQ) is the most commonly used tool for measuring safety culture in healthcare (Sexton et al., 2006). This questionnaire originated from the Flight Management Attitudes Questionnaire (FMAQ) in civil aviation, where it was widely used. Twenty-five percent of the FMAQ questions were used in the healthcare setting, and 75% were new questions developed through discussions with healthcare professionals and experts (Sexton et al., 2006). The SAQ consists of approximately 60 questions rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), grouped into six dimensions: teamwork climate, safety climate, management, job satisfaction, working conditions, and stress (Sexton et al., 2006). The tool has been adapted to various clinical areas through minor modifications reflecting the specificity of the area. Versions have been developed for intensive care units (ICUs), operating rooms (ORs), inpatient wards, and outpatient clinics (Sexton et al., 2006). A study using the SAQ, including 10,843 respondents from 203 clinical units conducted in three

countries (USA, UK, New Zealand), found a Raykov's ρ of 0.90, indicating strong reliability of this measurement tool. Other analyses of the SAQ have shown test-retest reliability of 0.85-0.90 and Cronbach's alpha values of 0.75-0.88 (Pronovost, Sexton, 2005). A key methodological aspect of the SAQ is the measurement of safety culture at the clinical unit level, not the entire hospital level. As Pronovost and Sexton (2005) demonstrated, in a study of 100 hospitals, "the variance between units within a hospital is greater than the variance between hospitals". In one hospital, the level of positive safety climate varied from 0% to 100% between different clinical units. Sexton et al.'s (2006) study achieved an overall response rate of 67.0%, with a range of 65.7% to 72.2% across units. Pronovost and Sexton (2005) emphasize that when response rates fall below 60%, the data represent opinions rather than culture and the results should be used with caution. The data were analyzed using factor analysis within clinical units. For each of the six factors, scores were calculated at both the between-area and within-area levels (Sexton et al., 2006).

4.2. Denison Organizational Culture Survey

Denison Organizational Culture Survey is one of the frequently used quantitative tools in research on organizational culture in the healthcare sector. One example of its application in the international literature is the empirical study conducted by Vahedi et al. (2024), which aimed to analyze the relationship between leadership competencies, organizational culture, and the quality of healthcare services in a hospital unit. In the aforementioned study, organizational culture was measured using the standardized Denison questionnaire, consisting of 36 items rated on a five-point Likert scale. The tool was applied in a classic four-dimensional framework, encompassing involvement, consistency, adaptability, and mission. Each dimension was analyzed as an area composed of three sub-dimensions, enabling a multifaceted assessment of the organizational culture of the studied healthcare unit (Vahedi et al., 2024). The involvement dimension referred to the degree of employee motivation, teamwork, and the development of staff competencies. Cohesion encompassed shared organizational values, understanding, and coordination of internal activities. The adaptation focused on the organization's ability to learn, respond to change, and focus on the needs of healthcare recipients. The mission focused on the clarity of strategic goals, vision, and direction of the organization's development. This structure of the tool allows for the simultaneous assessment of organizational culture in both operational and strategic dimensions. The study authors confirmed the high reliability of the tool, obtaining a Cronbach's alpha coefficient of 0.92 for the entire organizational culture scale. The obtained results indicated significant relationships between organizational culture and the quality of healthcare services, confirming the usefulness of Denison's tool in empirical research conducted in the healthcare sector (Vahedi et al., 2024). The presented research tool illustrates the dominant trend in the global literature of quantitative measurement of organizational culture in healthcare facilities using standardized questionnaires. At the same time, in light of the critical approaches to

organizational culture found in the literature, the results of such studies should be interpreted taking into account the complexity and multidimensionality of the phenomenon being studied (Davies et al., 2024).

4.3. Stanford PSCI Culture Survey

Singer et al. (2003) developed the Stanford PSCI Culture Survey by systematically adapting five previously validated instruments: the OR Management Attitudes Questionnaire, the Anesthesia Work Environment Survey, the Naval Command Assessment Tool, the Risk Management Questionnaire, and the Safety Orientation in Medical Facilities. The study included 15 hospitals in California (6312 employees, 47.4% response rate). The authors employed a three-phase process to adapt the instrument:

1. The initial survey questionnaire was extensively tested in pilot studies at the facilities before implementation in hospitals (Singer et al., 2003).
2. After modification, a questionnaire containing 82 questions plus demographic information was created (Singer et al., 2003).
3. Finally, a shortened version (30 questions plus demographic information) was created by eliminating overlapping questions while retaining at least one, usually two, questions for each of the 16 areas (Singer et al., 2003).

4.4. Hofstede's Model

Hofstede et al. (1990) presented the most comprehensive methodological approach, combining in-depth qualitative methods with quantitative analysis. The study covered 20 organizational units from 10 different organizations in Denmark and the Netherlands. The three-phase research model consisted of three phases:

Phase 1 – In-depth Interviews: in the first phase, in-depth interviews lasting two to three hours each were conducted with nine respondents per unit, for a total of 180 interviews. These interviews allowed us to obtain a qualitative understanding of the unit's cultural climate and gather themes for inclusion in the subsequent survey questionnaire (Hofstede et al., 1990).

Phase 2 – Interview-Based Survey. In the second phase, a standardized questionnaire containing 135 questions was used. Approximately 60 questions in the survey were taken from an earlier international research project and its subsequent extensions; the remaining questions were developed based on interviews and addressed issues that the interviewers considered to differ significantly between individuals. Validation of the Value-Behavior Distinction The distinction is present not only in the researchers' conception but also in the minds of the respondents. In a factor analysis of all 135 survey items for all 1295 respondents, the value items and behavior items consistently indicated different factors with very little overlap (Hofstede et al., 1990).

Phase 3 – Unit-Level Data: in the third phase, questionnaires followed by personal interviews were used to collect data at the unit level as a whole regarding factors such as staff numbers, budget composition, key historical facts, and key managerial data (Hofstede et al., 1990).

4.5. Studies in the AHRQ Hospital Survey on Patient Safety Culture (HSOPSC)

The AHRQ Hospital Survey on Patient Safety Culture (HSOPSC) is another widely used research tool. As Weaver et al. (2013) write in their systematic review of 33 studies on safety culture, 10 studies used the AHRQ Hospital Survey on Patient Safety. This tool focuses on 12 dimensions of safety culture and is widely used in the United States to assess safety culture in healthcare.

4.6. Manchester Patient Safety Framework (MaPSaF)

The Manchester Patient Safety Framework (MaPSaF) presents a qualitative approach to assessing safety culture. As described by Mannion and Davies (2018), the Manchester Patient Safety Framework is a qualitative tool that aims to provide insight into safety culture and how it can be improved across teams and organizations. The tool examines nine dimensions of patient safety and describes what an organization would look like at different levels of patient safety. The assessment is conducted in workshops, and the assessments can be used to reflect, discuss, and understand the organization's strengths and weaknesses. Mannion and Davies (2018) explain the methodological difference between quantitative and qualitative approaches to examining organizational culture as the following: while both perspectives use assessment tools, they do so differently. The former, e.g., the SAQ or HSOPSC, emphasizes quantitative measurement to identify goals, change, and track progress, while the latter, the MaPSaF, uses qualitative, more descriptive methods to stimulate reflection, learning, and collaborative action.

Also noteworthy is the 2003 article by Tim Scott, Russell Mannion, Huw Davies, and Martin Marshall, titled *The Quantitative Measurement of Organizational Culture in Health Care: A Review of the Available Instruments* (Scott et al., 2003). It reviews the international literature on quantitative methods for measuring organizational culture (OC) in healthcare. The information contained therein reflects the state of knowledge and available measurement tools from over twenty years ago, which should be taken into account when analyzing contemporary research. The authors reviewed the literature published up to June 2001, identifying thirteen instruments (Scott et al., 2003):

- Competing Values framework (CVF).
- Quality Improvement Implementation Survey.
- Organizational Culture Inventory (OCI).
- Harrison's Organizational Ideology Questionnaire.
- Hospital Culture Questionnaire.

- Nursing Unit Cultural Assessment Tool (NUCAT).
- Practice Culture Questionnaire.
- MacKenzie's Culture Questionnaire.
- Survey of Organizational Culture.
- Corporate Culture Questionnaire.
- Core Employee Opinion Questionnaire.
- Hofstede's Organizational Culture Questionnaire.
- Organizational Culture Survey (Scott et al., 2003).

The authors of the 2003 article reached several key conclusions that remain relevant today:

1. Researchers seeking the “ideal” instrument for measuring organizational culture in healthcare may be frustrated because all available instruments have limitations (Scott et al., 2003).
2. The choice of instrument should depend on how researchers define culture, the purpose of the study, and available resources (Scott et al., 2003).
3. The authors suggest that no single instrument will provide a valid, reliable, and trustworthy assessment of organizational culture (Scott et al., 2003). For this reason, an approach combining quantitative methods (questionnaires) with qualitative methods (interviews, observations) is optimal, allowing for the examination of various layers of culture, such as artifacts, values, and implicit assumptions (Scott et al., 2003).
4. Effective research requires consideration of professional subcultures and an adequate sample size, especially if the goal is to analyze the statistical relationship between culture and quality (Scott et al., 2003).

5. Discussion

Summing up, a review of the Polish literature indicates a growing interest in methods for measuring organizational culture in healthcare entities, with the simultaneous dominance of tools derived from commercial organizations. Cameron and Quinn's OCAI model is the most frequently used standardized tool, although researchers advocate the need to develop instruments specifically tailored to the specific needs of public healthcare entities (Domańska-Szaruga et al., 2024).

In the area of employee engagement, the Polish adaptation of the Meyer and Allen scale is a reliable and widely used tool. A parallel tradition of proprietary satisfaction questionnaires is developing, offering flexibility but characterized by limitations in psychometric validation and cross-organizational comparisons.

Directions for further research include: mechanisms of cultural transformation in healthcare entities, the impact of culture on organizational effectiveness and the ability to innovate, cross-cultural management, and the relationship between organizational culture, risk management, and patient safety (Domańska-Szaruga et al., 2024; Jończyk, 2017). A key aspect is the development of research tools that take into account the specificity of the Polish healthcare system and the public mission of medical entities.

A review of the international literature shows that researchers have developed numerous instruments to measure organizational culture in healthcare. The most commonly used are quantitative questionnaires, such as the Safety Attitudes Questionnaire (SAQ), the Denison Organizational Culture Survey, and the AHRQ Hospital Survey on Patient Safety Culture (HSOPSC). Qualitative tools, such as the Manchester Patient Safety Framework (MaPSaF), also exist for in-depth analysis of safety culture. Researchers note that there is no single ideal tool for measuring organizational culture. All research methods described in the literature have their limitations (Scott et al., 2003). The choice of method should depend on the study's purpose and available resources. The best results are achieved by combining quantitative and qualitative methods, which allows for the examination of various layers of organizational culture. It is also important to consider professional subcultures occurring in medical facilities and ensure an adequate sample size (Scott et al., 2003).

The literature review not only provided a synthetic summary of the tools used to measure organizational culture in healthcare but also identified significant research gaps and directions for further analysis. The new contribution of this study is the organization and comparison of solutions used in Polish and international studies.

The literature analysis confirms the findings of other authors, according to which there is no single universal tool for comprehensively measuring organizational culture in healthcare. As in international studies, Polish studies also tend to be dominated by a quantitative approach based on standardized questionnaires, while qualitative methods are insufficiently utilized. A difference visible in the national context, however, is the relatively limited number of tools created specifically for public healthcare entities. This distinguishes the Polish reality from some healthcare systems in Western countries, where more specialized research instruments are being developed.

The conclusions drawn from this review indicate that further development of research on organizational culture in healthcare should focus on designing tools that take into account the systemic context, the public mission, and the complexity of professional relationships within healthcare facilities. Combining quantitative and qualitative methods seems particularly important, allowing for a better understanding of both declared employee attitudes and implicit organizational norms, values, and practices.

In light of the presented analyses, it can be concluded that the research objective was achieved, and the results support the need for further research in this area. Future research plans should include empirical validation of the proposed tools in various types of healthcare

facilities, analysis of the relationship between organizational culture and clinical outcomes, and in-depth comparative studies between healthcare systems in different countries. This approach can contribute to a better understanding of the role of organizational culture as a factor supporting the quality, safety, and efficiency of healthcare facilities.

6. Conclusions

This article addresses the topic of organizational culture in healthcare facilities. The authors conducted a literature review on the measurement of organizational culture in healthcare. The first part of the review cited articles related to research in Polish healthcare facilities, while the second part focused on solutions found in international publications. The results of the review of Polish and international literature suggest that organizational culture is a key factor in determining the quality of healthcare and patient safety. Currently, there is a shift away from a "blame culture" towards a "learning culture". Such changes are associated with the use of appropriate methods and tools, which are described in the relevant literature.

A culture of hierarchy and clan culture dominates Polish healthcare facilities. At the same time, a discrepancy between the current and desired state is indicated. There is also potential for change toward greater employee participation, teamwork, and support for innovation. However, implementing change is not easy; it takes time, and it is worth emphasizing that resistance to change is a natural phenomenon. The review results reveal a growing interest in methods for measuring organizational culture, with Cameron and Quinn's OCAI model being the most commonly used tool. However, based on the literature analysis, it can be concluded that there is a need to develop instruments specific to public healthcare facilities that take into account the characteristics of the Polish healthcare system.

Regarding the review of the international literature, considerable methodological maturity was noted in research on organizational culture in healthcare. Standardized quantitative tools such as the Safety Attitudes Questionnaire, the Denison Organizational Culture Survey, and the AHRQ Hospital Survey on Patient Safety Culture are most frequently used. These enable comparability of results and monitoring of changes over time. Quantitative methods should be supplemented with qualitative methods, which will allow for capturing deeper layers of organizational culture.

A significant conclusion drawn from the literature review is the lack of a single universal instrument enabling an in-depth and reliable assessment of organizational culture in healthcare facilities. A mixed-method approach, combining standardized questionnaires with qualitative methods, offers the greatest cognitive value. Developing research tools that take into account the specific characteristics of public entities in the context of the Polish healthcare system seems particularly important. Systematic research on organizational culture is crucial for quality

management and safety in healthcare. Therefore, it is justified to conduct research on developing a tool that will allow for the measurement of organizational culture in healthcare facilities and then apply it in practice.

The research demonstrates certain limitations. The analyzed articles examine only selected aspects of organizational culture, as it is difficult to capture deeper, informal aspects of organizational culture, such as unwritten norms, power relations, or professional subcultures. Organizational culture encompasses more elements. Furthermore, many studies are characterized by small sample sizes, a lack of comparative analyses, and limited validation of the developed measurement tools. The international literature also highlights the difficulties in comparing results between countries due to systemic, cultural, and organizational differences, which poses a significant methodological challenge.

At the same time, the review adds new cognitive value by organizing the current state of knowledge and revealing both similarities and differences between studies conducted in Poland and abroad. The accumulated knowledge can be further utilized in both empirical research and management practice, supporting the development of systemic solutions in the area of organizational culture in healthcare.

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HUMAN FACTORS IN TELEMEDICINE: PATIENT SATISFACTION IN PRIVATE HEALTHCARE AFTER COVID-19

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Purpose: This paper explores patient satisfaction with telemedicine services in a private healthcare setting in Poland after the COVID-19 pandemic, emphasizing the role of human and technological factors in shaping digital healthcare experiences.

Design/methodology/approach: An exploratory case study was conducted using a pilot survey of 30 patients who used teleconsultations, chat consultations, and a mobile healthcare application between 2020 and 2023. The analysis applied a three-dimensional satisfaction model encompassing substantive, procedural, and psychological needs.

Findings: Respondents valued telemedicine for its accessibility, convenience, and time efficiency. Lower satisfaction was reported regarding waiting times, application usability, and the perceived level of physician engagement. The results suggest that remote medical services require not only reliable digital tools but also empathetic and attentive communication to support a positive patient experience.

Research limitations/implications: The small, single-case sample limits generalizability. Further research should include larger and more diverse patient populations.

Originality/value: The study adds to existing Polish research by examining telemedicine satisfaction in the private healthcare sector, an area less frequently analyzed than public or hospital-based services.

Keywords: telemedicine, patient satisfaction, private healthcare, service quality, digital care.

Category of the paper: Research paper.

1. Introduction

The COVID-19 pandemic significantly accelerated the adoption of telemedicine, transforming digital consultations from a supplementary option into a routine mode of delivering healthcare services. Remote interactions allowed providers to maintain continuity of

care while limiting infection risk and addressing access challenges during lockdowns (Byrne, 2020; Wrześniewska-Wal, Hajdukiewicz, 2020). In Poland, similar patterns were observed, with patients reporting increased use of telemedicine solutions across private and public healthcare sectors (Korneta et al., 2021; Zygo et al., 2020). As pandemic conditions subsided, telemedicine remained an important component of service delivery, prompting renewed interest in evaluating the quality and patient experience associated with remote care.

Patient satisfaction constitutes an essential element of healthcare quality, influencing adherence, trust, and long-term use of services (Małecka, Marcinkowski, 2007). Telemedicine introduces additional determinants of satisfaction, as patients must not only evaluate clinical competence but also the usability of digital platforms, clarity of communication, and emotional comfort during remote interactions (Biesok, Wyród-Wróbel, 2016; Maconko et al., 2016). In private healthcare settings, where patients exercise greater choice and expect high-quality service, understanding these dimensions becomes particularly important.

Although research conducted in Poland has recognized both benefits and limitations of telemedicine, majority of the existing evidence focuses on public-sector solutions or on legal and technological considerations (Zygo et al., 2020; Zgliczyński et al., 2013). Studies addressing how patients in private healthcare evaluate digital services remain comparatively limited. Moreover, relational and psychological aspects of telemedicine, such as empathy, the feeling of being heard, or physician engagement, are not consistently explored, despite evidence that these factors play a critical role in shaping patient experience (Maconko et al., 2016).

This study addresses these gaps by analyzing patient satisfaction with telemedicine in a private healthcare organization in Poland. Drawing on the triadic model of satisfaction (Moore, 2014), the study evaluates substantive, procedural, and psychological aspects of remote care. The findings provide exploratory insight into how digital services are perceived in a private setting and highlight areas where improvements may strengthen patient-centered telemedicine.

2. Literature review

2.1. Telemedicine in contemporary healthcare

Telemedicine is widely recognized as a key component of contemporary medical technologies and digital health systems. In the classical definition proposed by the World Health Organization, telemedicine is understood as the provision of healthcare services where distance is a critical factor, delivered by healthcare professionals using information and communication technologies to exchange information for diagnosis, treatment and prevention of diseases and

injuries, as well as for research, evaluation and continuing education of healthcare providers (WHO, 1998, p. 10). A similar perspective is adopted by the Health Resources and Services Administration (2025), which defines telemedicine as the use of electronic and telecommunication technologies to support and promote long-distance clinical care, patient and professional health-related education, public health and health administration.

Ingenerf (1999, p. 92) proposes a broader and still valid definition, describing telemedicine simply as the use of information and telecommunication technologies in medicine. Although general, this definition deliberately encompasses a wide spectrum of digital tools and applications used in clinical practice, from remote diagnostics to integrated telehealth platforms. On this basis, telemedicine can be conceptualized as a mode of delivering healthcare services in which medical care is provided at a distance through information and communication technologies. Patients may receive consultations, diagnoses, prescriptions and health monitoring using devices such as telephones, tablets and computers. Telemedicine also supports remote psychotherapy, nutritional counselling and other specialized services, and has an important educational function for patients (Zgliczyński et al., 2013).

To characterize telemedicine more precisely, it is useful to distinguish between different forms of technology-mediated care. One basic distinction relates to the synchronicity of information exchange. Mahar et al. (2018) differentiates between synchronous and asynchronous telemedicine programs. Synchronous telemedicine refers to real-time, two-way communication between the patient and the healthcare provider (e.g. telephone or video consultations). Asynchronous telemedicine involves “store-and-forward” transmission of medical data through an application or online portal, such as laboratory results, diagnostic images, electronic prescriptions or written recommendations.

A complementary categorization is proposed in the report of the Polish Chamber of Commerce (2016), which distinguishes telemedicine services according to the type of function they perform (see Table 1). This typology is particularly relevant for analyzing the scope of services offered by healthcare organizations and for understanding which segments are most closely related to patient satisfaction with remote care.

Table 1.

Categories of telemedicine services according to the Polish Chamber of Commerce (2016)

Type of telemedicine service	Description
Telecare	Remote care and monitoring of chronically ill patients using dedicated devices, such as blood pressure monitors, ECG, pulse oximeters or hydration sensors.
Tele-diagnostics	Description and interpretation of diagnostic tests based on digitally recorded medical data.
Teleconsultation	Real-time consultation with a physician using telecommunication tools (e.g. telephone or video).
Tele-education	Education of medical professionals and patients using online platforms that provide access to medical knowledge and treatment-related information.
Tele-procedures and tele-operations	Medical procedures and surgical operations performed at a distance using a surgical robot controlled remotely by the surgeon.

Source. Own elaboration based on the Polish Chamber of Commerce (2016).

A common feature of all these categories is the provision of medical services at a distance through various technological devices. However, the context in which telemedicine operates is not uniform. From a financial and organizational perspective, it is important to distinguish between the public healthcare market, financed largely from public funds, and the private market, where services are paid for directly by patients or through employer-sponsored medical packages (The Polish Chamber of Commerce, 2016). The present study focuses on the latter, examining telemedicine in a private healthcare organization operating on the Polish market.

The development of telemedicine is closely linked to broader technological trends in healthcare. Early forms of distance medicine can be traced back to the nineteenth century, when telegraph, telephone and later radio were used to transmit medical information and coordinate care in remote settings (Zundel, 1996; Mahar et al., 2018). In subsequent decades, telemedicine evolved alongside advances in imaging technologies, satellite communication and the Internet, enabling remote transmission of radiological images, real-time video consultations and continuous monitoring of patients in geographically distant locations (Glinkowski, 2006; Martyniak, 2015). Telemedicine has been used in demanding contexts such as rural and remote areas, maritime medicine or military operations, where it supports decision-making and reduces the risks and costs associated with patient transport (Boots et al., 2012; Zundel, 1996).

In Poland, telemedicine began to develop institutionally at the beginning of the 2000s, including the establishment of the Telemedicine Section of the Polish Medical Society and the design of advanced systems such as the Robin Heart surgical robot (Wrześniewska-Wal, Hajdukiewicz, 2020). Over time, digital tools have been implemented in many specialties, particularly in radiology, neurology and chronic disease management (Mahar et al., 2018). Despite this progress, public awareness and trust in e-medicine remained limited for many years, as evidenced by surveys conducted in the mid-2000s, which indicated low familiarity with telemedical solutions and cautious attitudes towards their use (Zygo et al., 2020).

The COVID-19 pandemic fundamentally accelerated telemedicine adoption. In response to lockdowns, physical distancing requirements and infection risks, healthcare providers widely implemented remote consultations via telephone, video and mobile applications (Byrne, 2020; Korneta et al., 2021). Telemedicine became a primary mode of delivering care, particularly for patients with chronic conditions requiring ongoing monitoring (Bitar, Alismail, 2021). At the same time, the pandemic revealed challenges related to digital infrastructure, legal regulations, data protection and the preservation of interpersonal aspects of care (Wrześniewska-Wal, Hajdukiewicz, 2020; Nittari et al., 2022).

Looking beyond the pandemic, many authors argue that telemedicine should remain an integral component of healthcare systems due to its potential to improve access, reduce waiting times and enhance convenience for patients, especially in underserved or remote regions (Korneta et al., 2021; Nittari et al., 2022). These developments raise important questions about the quality of telemedicine services and the determinants of patient satisfaction in digital care settings, particularly in private healthcare organizations where competitive pressure and patient expectations are especially high.

2.2. Patient satisfaction as a dimension of healthcare quality

Patient satisfaction is a complex and inherently subjective construct, situated at the intersection of psychological, social and service-related processes. In general terms, satisfaction can be linked to the Latin word *satis*, meaning “enough” or “sufficient”, and refers to the degree to which an experience fulfils an individual’s needs and expectations (Maconko et al., 2016). In consumer behavior research, satisfaction is often defined as an emotional response resulting from a comparison between prior expectations and perceived value after consumption of a product or service (Mazurek-Łopacińska, 2003).

Within healthcare, patients are simultaneously recipients of medical interventions and clients of health services. Patient satisfaction may therefore be understood as the subjective evaluation of the quality of medical care, relationships with healthcare personnel and organizational aspects of service delivery. It encompasses such elements as accessibility of services, clarity and usefulness of medical advice, and the empathy and communication style of healthcare professionals. One of the most widely cited definitions, proposed by Risser (1975), conceptualizes patient satisfaction as the degree of congruence between a patient’s expectations of an ideal service and the care actually received.

Measuring satisfaction is challenging because preferences, needs and perceptions are dynamic and heterogeneous (Bebek, 2020). Nevertheless, various conceptual models have been developed to operationalize this construct. In the field of negotiation and mediation, Moore (2014) conceptualizes satisfaction as comprising three categories of interests:

- substantive,
- procedural,
- emotional.

This perspective, further elaborated in the applied work of Furlong (2005), highlights that evaluations of any service or interaction extend beyond outcomes to include perceptions of process and interpersonal experience. A comparable logic lay under Donabedian’s (1980, 1988) structure–process–outcome model, which is widely recognized as a foundational framework for assessing quality in healthcare. Both approaches indicate that individuals form judgements not only on the basis of measurable or technical results, but also through their appraisal of procedural aspects and relational dynamics. This theoretical compatibility provides a coherent background for situating Moore’s (2014) triadic model within the analysis of patient satisfaction in telemedicine.

Substantive needs encompass the quality of the product or service, the adequacy of expert advice and the extent to which the solution addresses the client’s goals. Procedural needs refer to the ease, speed and flexibility of processes such as obtaining information, receiving support, navigating procedures or lodging complaints. Psychological needs relate to the relational dimension: respectful treatment, kindness, individualized attention, willingness to help, empathy and mutual trust. Full satisfaction is achieved only when needs in all three categories are adequately met (Moore, 2014; Furlong, 2005).

In the context of healthcare, the triadic model can be directly applied to patients as customers of medical services. Substantive needs include professional medical assistance, accurate diagnosis, appropriate treatment and clear guidance on further management. Procedural needs concern the organization of care, including ease of booking appointments, waiting times, availability of specialists and efficient communication of test results. Psychological needs encompass the quality of the doctor–patient relationship, the feeling of being listened to, the clinician’s engagement, empathy and the level of trust in the provider. A deficit in any of these areas may lower overall satisfaction, even if other dimensions perform well (Maconko et al., 2016).

The link between patient satisfaction and quality of care can also be viewed through the broader lens of service quality. Classic contributions in this field emphasize that quality must be understood from the user’s perspective. Definitions focused on the user describe quality as meeting or exceeding customer requirements (Suarez, 1992), while multidimensional service-oriented definitions highlight tangibles, reliability, responsiveness, competence and empathy as constitutive elements of quality (Parasuraman et al., 1988). Strategic perspectives stress that higher quality differentiates an organization from its competitors and shapes how it is perceived in the market (Czubala, 2012). In private healthcare, these issues are particularly salient: patients actively choose providers, and their evaluations influence the organization’s market position and reputation (Małecka, Marcinkowski, 2007).

2.3. Determinants of satisfaction in telemedicine

The rapid expansion of telemedicine during the COVID-19 pandemic created a unique context for studying patient satisfaction with remote healthcare services. On a global scale, telemedicine became a dominant or at least essential mode of care provision, particularly during periods of strict lockdowns and restricted access to stationary facilities (Byrne, 2020; Nittari et al., 2022). As a result, many empirical studies have examined how patients perceive the quality of teleconsultations, video visits and other digital services under pandemic conditions.

Ramaswamy et al. (2020) conducted one of the largest studies on patient satisfaction with telemedicine in New York, analyzing data from more than 38,000 visits at a university medical center, including both in-person consultations and video visits. Their analysis showed a dramatic increase in the share of video visits during the pandemic and revealed that satisfaction with online consultations was high and, in many cases, comparable to or slightly higher than satisfaction with traditional visits. These results suggest that, when implemented appropriately, telemedicine can meet patients’ expectations and does not necessarily lower perceived quality of care.

Systematic reviews also point to generally positive evaluations of telehealth. Kruse et al. (2017) report that patients frequently appreciate the convenience, time savings and reduced travel burden associated with remote consultations. However, they also identify perceived barriers and concerns, including technological difficulties, limited opportunities for physical

examination, and apprehensions about privacy and data security. Nittari et al. (2022) emphasize that ethical and legal challenges, such as responsibility for errors, the confidentiality of medical data and cross-border provision of services, require ongoing attention to ensure that telemedicine remains both safe and acceptable for patients.

In Poland, Korneta et al. (2021) examined patient experiences with telemedicine in primary care during the pandemic. Their study, conducted in four primary care clinics, showed that a majority of patients assessed teleconsultations positively. More than half of respondents felt comfortable during telephone visits and considered the care received via teleconsultation equivalent to that provided during in-person visits. Technical aspects of teleconsultations were evaluated favorably by approximately 80% of patients. At the same time, specific areas of dissatisfaction were identified, such as limited access to medical documentation and difficulties in some organizational processes, highlighting the importance of both procedural and informational dimensions of telemedicine quality.

These findings are consistent with earlier observations on the benefits and constraints of telemedicine. Teleconsultations can reduce waiting times, support continuity of care for chronic patients and lower the risks and costs associated with travel, particularly in rural or remote areas and for individuals with reduced mobility (Boots et al., 2012; The Polish Chamber of Commerce, 2016; Sierdziński, Sierdzińska, 2018). They may also enhance access to specialist expertise and facilitate multidisciplinary collaboration between clinicians (Jumreornvong et al., 2020). However, concerns about data security, the quality of interpersonal communication and the impossibility of performing physical examinations in many cases may negatively affect satisfaction, especially when patients perceive remote care as less personal or less thorough than face-to-face visits (Wrześniewska-Wal, Hajdukiewicz, 2020; Zygo et al., 2020).

From the perspective of the triadic satisfaction model, telemedicine can satisfy substantive needs by providing competent medical advice and effective treatment, particularly when supported by appropriate diagnostic information and follow-up procedures. It can also address procedural needs by offering flexible and time-efficient access to services. At the same time, psychological needs—such as feeling heard, respected and emotionally supported—may be more difficult to fulfil in remote interactions, especially when technological or organizational constraints disrupt communication (Maconko et al., 2016).

In light of these developments, the present study focuses on patient satisfaction with telemedicine in a private healthcare organization in Poland, applying the three-dimensional satisfaction framework to assess how substantive, procedural and psychological aspects of teleconsultations, mobile applications and chat services are perceived by patients in the post-pandemic context.

3. Methods

The study adopts an exploratory case study design aimed at gaining preliminary insights into patient satisfaction with telemedicine services in a private healthcare organization in Poland. Case studies may serve descriptive, explanatory, exploratory or evaluation purposes (Woodside, Wilson, 2003), and in this instance the exploratory orientation reflects the limited scope and small sample size, which position the research as a pilot study providing indicative rather than generalizable results. The selected organization represents a large private healthcare provider offering digital medical services such as teleconsultations, online chat with physicians, and a mobile health application. The study was designed to assess the level of patient satisfaction with telemedicine, identify the main determinants of satisfaction across substantive, procedural and psychological dimensions, and explore which aspects of remote care patients perceive as strengths or areas for improvement.

Data were collected using an anonymous online questionnaire distributed to patients who had used the organization's telemedicine services between 2020 and 2023. Participation was voluntary, and responses were gathered through the provider's internal communication channels. A total of 30 valid responses were obtained. The survey consisted of 17 questions- 13 related to satisfaction factors and 4 capturing demographic characteristics such as age, gender, and frequency of telemedicine use. The instrument was developed based on existing patient satisfaction studies and adapted to the telemedicine context. Respondents evaluated their experiences using a five-point Likert scale, ranging from 1 ("very dissatisfied") to 5 ("very satisfied"), with optional open-ended items for qualitative feedback.

The collected data were analyzed using descriptive statistics to explore patterns in patient perceptions. The study drew on Moore's (2014) three-dimensional model of satisfaction as an overarching conceptual framework, with the substantive, procedural and psychological dimensions operationalized in this research as follows: substantive needs (competence, clarity and professionalism of medical staff), procedural needs (waiting time, accessibility and system usability) and psychological needs (empathy, attentiveness and quality of communication). Each dimension was examined separately and then compared to highlight key drivers of satisfaction and dissatisfaction. The analysis was performed using Microsoft Excel, with results presented in the form of summary tables.

The main limitation of the study is its small sample size and single-case focus, which restrict the generalizability of results. Additionally, the reliance on self-reported data may introduce subjective bias. Nevertheless, the exploratory character of this research provides valuable initial evidence on how patients evaluate telemedicine services in private healthcare. The findings offer a foundation for more extensive studies applying larger samples or comparative approaches across different healthcare systems.

4. Results

4.1. Characteristics of the respondents

A total of 30 respondents participated in the survey. The sample was dominated by men (70%), with women accounting for 26.7% and one respondent not disclosing gender. Most respondents were of working age: 46.7% were between 18 and 29 years old, 50% between 30 and 49 years, and one respondent was 50 years or older. The educational profile was characterized by a high proportion of individuals with higher education (83.3%), followed by secondary (13.3%) and vocational education (3.3%).

The majority of respondents lived in a large city, with a smaller group residing in villages and small or medium-sized towns. Access to private healthcare services was predominantly employer-based: 80% used the services as part of an employee benefit package and 20% through a family program, while none of the respondents declared purchasing an individual subscription.

Regarding telemedicine use between 2020 and 2023, 80% of respondents used the mobile application, 86.7% had at least one teleconsultation, and 50% used the medical chat with a doctor. The characteristics of the respondents and their use of telemedicine services are summarized in Table 2.

Table 2.
Characteristics of the respondents (N = 30)

Category	Subcategory	n	%
Gender	Male	21	70.0
	Female	8	26.7
	No answer	1	3.3
Age	18-29 years	14	46.7
	30-49 years	15	50.0
	≥ 50 years	1	3.3
Education	Higher	25	83.3
	Secondary	4	13.3
	Vocational	1	3.3
Place of residence	Large city	24	80.0
	Village	3	10.0
	Other (small/medium towns)	3	10.0
Type of access to services	Employee benefit	24	80.0
	Family program	6	20.0
	Individual subscription	0	0.0
Use of telemedicine services	Used the mobile application (2020-2023)	24	80.0
	Used teleconsultations (2020-2023)	26	86.7
	Used medical chat (2020-2023)	15	50.0

Note. Percentages may not always sum exactly to 100 due to rounding.

Source: Own elaboration.

4.2. Use and assessment of the mobile application (procedural aspects)

The mobile application was widely used and generally assessed as intuitive and easy to navigate. Most users rated its usability at 4 or 5 on a five-point scale, which indicates that the interface and basic functions are largely aligned with user expectations. However, satisfaction with the availability of visits booked via the application was clearly lower. Access to stationary visits was rated predominantly at 1 or 2, and telephone visits most often at 3, suggesting that scheduling and capacity constraints remain a significant source of dissatisfaction among patients using private telemedicine services.

Awareness of the prescription renewal functionality was universal among respondents; all participants knew that e-prescriptions could be renewed without an in-person visit. More than half (52%) used the feature successfully, whereas 8% reported an unsuccessful attempt and 40% did not use it despite awareness. Although the questionnaire did not differentiate the reasons for unsuccessful renewal, this outcome indicates the presence of procedural obstacles that may stem from system-related factors (e.g., unclear navigation pathways, temporary technical errors), patient-related uncertainties regarding the correct procedure, or clinical decisions such as a physician's refusal to renew a prescription without additional consultation. These possibilities suggest that, despite its perceived value, the functionality is not yet experienced as fully reliable or seamless by all users.

In an open-ended question, respondents identified several missing or insufficiently developed functionalities. These included notifications about newly available appointments and released time slots, automatic booking of follow-up visits in chronic care, clearer information on payments for out-of-package visits and contract conditions, the possibility to book visits directly from the referrals view, biometric login for multiple accounts, and greater stability of the application, including fewer technical errors. These comments point to procedural and usability issues that affect patients' comfort and sense of control when using the application.

4.3. Satisfaction with teleconsultations (substantive and psychological aspects)

Teleconsultations were the most used form of remote contact with physicians. Almost 87% of respondents reported using them at least once between 2020 and 2023. From a technical perspective, teleconsultations were evaluated positively: respondents most often indicated that they "always" or "often" experienced clear sound, stable connections, and an overall smooth technical course of the visit. Technical problems such as interruptions or inability to hear the physician were rare.

Substantive aspects of teleconsultations were also rated relatively favorably. Many respondents stated that physicians explained further treatment in an understandable way, that they received necessary prescriptions and referrals, and that the main purpose of the visit was achieved. At the same time, responses to some statements revealed variation in perceived substantive quality. Items related to reviewing the medical history, resolving the health

problem, and reaching the visit objective exhibited a broader distribution of responses, including “sometimes”, “rarely”, or “never”. This suggests that while substantive quality is generally satisfactory, the consistency of care across physicians and cases may be uneven.

Psychological aspects of teleconsultations were more differentiated. Courtesy and respectful treatment were evaluated highly, but respondents were less unanimous regarding the time devoted to them, the feeling of being fully heard, trust in the physician, and the perceived level of engagement. A notable number of respondents indicated that the physician’s engagement in their problem was only sometimes or rarely sufficient. These results point to potential shortcomings in relational aspects of remote consultations and confirm that empathy and attentiveness can be harder to convey in a teleconsultation than in an in-person visit.

The overall evaluation of teleconsultations was cautiously positive. Most respondents agreed that teleconsultations saved time and, to a slightly lesser extent, costs, and did not feel discomfort when discussing their health by phone. However, when asked whether teleconsultations provided care at the same level as stationary visits, the responses were mixed. A relatively small group fully agreed, while many respondents indicated neutrality or disagreement. This suggests that patients perceive teleconsultations as a convenient and acceptable form of care, but not fully equivalent to traditional visits.

4.4. Satisfaction with medical chat

Medical chat was used less frequently than teleconsultations, with half the respondents declaring that they had used this service between 2020 and 2023. Among users, satisfaction varied clearly across different aspects of the service.

The waiting time in the chat queue was assessed very negatively, with the most frequent rating being 1 and no respondent assigning the maximum rating. This indicates that queue lengths and response times represent a major procedural barrier. By contrast, satisfaction with prescriptions and referrals obtained via chat was relatively high, typically rated 4 or 5. The clarity of clinical advice and further treatment recommendations received via chat was rated around the middle of the scale, with most responses at 3 or 4, which suggests that while the channel is effective for documentation and administrative tasks, its usefulness for more complex clinical guidance may be limited.

Relational aspects of chat consultations were evaluated more positively. Most respondents rated physicians’ politeness, respect, and individual approach at 4 or 5, although ratings of engagement were slightly more moderate. Overall satisfaction with chat consultations was most commonly rated at 4, with 3 as the second most frequent rating. This pattern indicates that the interpersonal experience is generally acceptable but constrained by procedural weaknesses, especially waiting time.

4.5. Summary of satisfaction across the three dimensions

When viewed through the lens of the three-dimensional satisfaction model, the results reveal a differentiated picture. Substantive aspects of telemedicine services are evaluated relatively highly, procedural aspects show pronounced weaknesses in access and waiting times, and psychological aspects highlight challenges related to engagement, trust, and perceived equivalence with in-person care. A consolidated overview of the most important findings across these dimensions is presented in Table 3.

Table 3.

Summary of patient satisfaction with telemedicine services across the three dimensions

Dimension	Service element	Main findings from the survey	Interpretation
Procedural	Mobile application – usability	80% used the application; most ratings 4–5 for intuitiveness and ease of navigation.	App is generally intuitive and functional.
	Mobile application – visit availability	Stationary visits rated mainly 1–2; telephone visits mostly 3.	Accessibility and scheduling remain major pain points.
	Mobile application – prescription renewal	52% successfully renewed e-prescriptions; 8% failed; 40% did not use.	Feature valued but not fully reliable or broadly utilized.
	Mobile application – missing functions	Requests included: notifications about free slots, automatic follow-ups, booking from referrals, clearer payment information, biometric login for multiple accounts, greater stability.	Patients expect transparency, automation, and real-time updates.
	Medical chat – waiting time	Most ratings = 1; no maximum rating.	Very long queues significantly reduce satisfaction.
Substantive	Teleconsultations – technical quality	“Always/often” selected for clear sound and stable connection.	Technical performance supports effective remote care.
	Teleconsultations – clinical content	Clear explanations and necessary prescriptions often received; variability across physicians.	Substantive quality is generally good but inconsistent.
	Medical chat – clinical advice	Advice clarity rated mostly 3–4; prescriptions/referrals 4–5.	Chat effective for documentation tasks; mixed for clinical guidance.
Psychological	Teleconsultations – relational factors	Courtesy and respect consistently high; feeling heard, trust, and engagement more varied.	Emotional/relational quality weaker than substantive communication.
	Teleconsultations – comfort and preference	Strong agreement on time savings and lack of discomfort; mixed assessment of equivalence to in-person care.	Telemedicine perceived as convenient but not a full substitute.
	Medical chat – relational factors	Courtesy and politeness mostly 4–5; engagement and individual approach 3–4.	Interpersonal experience better than procedural, but not optimal.

Note. Table summarizes the main findings from the patient survey (N = 30) conducted between 2020–2023, structured according to the substantive, procedural, and psychological dimensions of satisfaction.

Source: Own elaboration.

5. Discussion

The findings of this study reflect patterns observed in previous research on telemedicine adoption in Poland. Similar to reports by Korneta et al. (2021), respondents valued teleconsultations primarily for their convenience and time efficiency. Substantive aspects of care i.e. clarity of explanations, receipt of necessary prescriptions and overall achievement of visit objectives, were generally rated positively, suggesting that remote consultations can meet clinical expectations when supported by functional digital infrastructure (Mahar et al., 2018). This aligns with wider international evidence showing that when telemedicine is perceived as clinically reliable and supported by well-defined follow-up pathways, patient evaluations are consistently favorable (Ramaswamy et al., 2020; Kruse et al., 2017). Similar conclusions were drawn by Bokolo (2020), who emphasizes that telemedicine proved effective during the pandemic particularly when technological systems ensured continuity and coordination of care.

However, procedural challenges emerged strongly in the results. Difficulties related to system functionality, waiting times and the availability of appointments mirror earlier findings that organizational barriers remain among the most significant limitations of telemedicine in Poland (Zygo et al., 2020; Zgliczyński et al., 2013). Recent international work similarly demonstrates that procedural shortcomings, especially unclear digital workflows, platform instability or delays, substantially reduce patient satisfaction and willingness to reuse telehealth services (Guntu et al., 2022). These issues highlight the dual nature of digital service quality: while technology can expand access, it can also create new bottlenecks when capacity, scheduling systems or application features do not keep pace with growing demand. The present findings therefore reinforce arguments that telemedicine's effectiveness depends not only on technological infrastructure but also on the organizational processes that support digital care pathways. Improving integration between scheduling systems, enhancing the stability of mobile applications and ensuring adequate staffing levels for online services appear crucial for strengthening the procedural dimension of patient satisfaction.

Psychological aspects constituted the weakest dimension of satisfaction. Respondents expressed concerns about physician engagement, the feeling of being fully heard and the relational quality of teleconsultations. Similar concerns have been identified in studies exploring patient experiences with remote care, which note that the absence of non-verbal communication and reduced personal contact may hinder rapport and trust (Maconko et al., 2016; Małecka, Marcinkowski, 2007). Wu and Brannon (2024) likewise demonstrate that communication quality and perceived attentiveness significantly shape future willingness to use telehealth, underscoring the centrality of relational factors even in technology-mediated encounters. The emotional and relational components of medical encounters, often embedded in subtle cues such as tone of voice, confirmation of understanding or empathetic statements, may be more difficult to convey through telephone calls or text-based interactions.

This highlights a critical tension in telemedicine: while digitalization improves efficiency, it may simultaneously constrain the relational depth that patients associate with high-quality care.

These findings resonate with broader research showing that healthcare improvement efforts are most effective when they explicitly incorporate patients' perspectives into service design and delivery (Poksinska et al., 2017). Applying similar principles to telemedicine could help providers ensure that digital processes and communication models are aligned with patient expectations rather than solely organizational priorities. Moore's (2014) triadic model illustrates how substantive, procedural and psychological factors interact in shaping overall satisfaction; even when substantive quality is adequate, deficits in procedural efficiency or psychological engagement can diminish the patient experience. Recent evidence further suggests that sustained telehealth use depends on addressing all three dimensions simultaneously (Wu, Brannon, 2024; Guntu et al., 2022). The present findings indicate that private healthcare organizations, whose patients often demonstrate higher expectations, greater ability to compare providers and lower tolerance for service failures, should prioritize not only technological improvement but also communication training and strategies to humanize digital encounters. Enhancing physicians' ability to express attentiveness and empathy in remote formats, as well as designing telemedicine interfaces that better support two-way communication, may help mitigate the relational constraints identified in this study.

6. Conclusions

This study explored patient satisfaction with telemedicine services in a private healthcare organization in Poland, focusing on the post-pandemic period when digital healthcare has become an established part of everyday medical practice. The results indicate that patients generally value telemedicine for its accessibility, time efficiency, and convenience. The high ratings in the substantive dimension suggest that remote care can maintain professional standards and provide medical advice perceived as competent and reliable. However, challenges remain in procedural and psychological aspects, particularly regarding waiting times, system usability, and the perceived empathy of physicians during online consultations.

These findings underline that technological performance alone is insufficient to ensure patient satisfaction. The human dimension, manifested in communication quality, attentiveness, and emotional support, remains essential for positive patient experiences in digital settings. The application of the three-dimensional satisfaction model has proven useful in identifying key determinants of satisfaction and in demonstrating that telemedicine quality depends on balancing technical, organizational, and interpersonal factors.

Although the research is exploratory and limited by its small sample size and single-case design, it provides valuable preliminary evidence on how patients perceive telemedicine within private healthcare. This study confirms that while digital platforms can successfully deliver substantive medical competence, they cannot automatically replicate the relational depth of in-person care. For private healthcare providers, sustainable competitive advantage will therefore depend on bridging this gap—transforming telemedicine from a purely functional transaction into a holistic, empathetic patient experience. Only by equally prioritizing procedural efficiency and psychological engagement can organizations fully realize the potential of patient-centered digital health. Future studies should extend this approach to larger and more diverse populations to validate the three-dimensional model across different medical specialties. Furthermore, combining quantitative and qualitative methods would allow researchers to build a more comprehensive understanding of patient-centered digital care and identify specific communication behaviors that bridge the gap between clinical competence and psychological satisfaction.

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BORN GLOBAL OUT OF NECESSITY: PUBLIC SUPPORT FOR THE INTERNATIONALIZATION OF START-UPS IN SINGAPORE

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Purpose: This paper aims to analyze the public policy instruments designed to support the internationalization of start-ups in Singapore. The country is renowned for supporting the development and internationalization of its enterprises, changing the dynamics of foreign expansion and leading to the establishment of numerous ‘born global’ companies.

Design/methodology/approach: The study adopts a qualitative case study approach, which is a common method in the field of firm internationalization. The most important theories explaining internationalization processes have been developed through case studies. However, the phenomenon of internationalization at a very early stage still requires a stronger theoretical foundation, and the Singaporean case study may shed light on some of the factors influencing this process.

Findings: According to the literature review, the internationalization of enterprises is time-consuming, primarily due to the need to acquire knowledge and resources, which is a gradual process. However, the Singaporean authorities have altered this dynamic by helping start-up founders to gain knowledge of foreign markets and by providing them with financial and non-financial resources.

Research limitations/implications: This study analyses the various instruments used by the Singaporean government to support the internationalization of businesses. However, achieving a comprehensive understanding of enterprise internationalization within the Singaporean start-up ecosystem requires further research, particularly in the form of a comparative analysis of enterprises that have undergone rapid internationalization, both with and without public support.

Practical implications: This paper presents research with practical applications for policymakers in the field of instruments that support the internationalization of enterprises. It outlines the wide variety of policy instruments that have been implemented in Singapore, and it categorizes all the instruments that could be considered during the policymaking process.

Originality/value: The study indicates that policy instruments can reduce, or even eliminate, some of the time-consuming stages of internationalization. In particular, they accelerate the acquisition of knowledge about foreign markets and provide the necessary resources. This is why policy can play a crucial role in creating ‘born global’ companies.

Keywords: Public support for internationalization, internationalization of start-ups, born global, start-up ecosystem, Singapore.

Category of the paper: Case study.

1. Introduction

The public support available to enterprises in Singapore constitutes an interesting case study, demonstrating the wide variety of policy instruments that can facilitate the internationalization of start-ups. Companies there are forced to internationalize due to the size of the market, and the government is dedicated to fostering their growth and expansion. Given that instruments supporting enterprise internationalization are crucial regardless of domestic market size, the Singaporean experience is of great importance. A small domestic market presents challenges and forces entrepreneurs to consider doing business internationally from the outset. In this respect, it acts as a stimulant. Nevertheless, a large domestic market should not lull policymakers into complacency. Many niche start-ups will not be able to grow based solely on the domestic market, so it is important to help such entrepreneurs expand overseas. State aid can give companies a competitive advantage and significantly reduce the time needed for foreign expansion. For this reason, Singapore should not be seen as an exceptional example of a very small country, but rather as an inspiration to others in terms of supporting internationalization.

2. Theoretical Background

Born globals (BGs) are defined as entrepreneurial start-ups that, from or near their foundation, seek to derive a substantial proportion of their revenue from selling products in international markets (Knight, Cavusgil, 2004). The term ‘born global’ was first used in a McKinsey & Company study of early internationalizing firms conducted in Australia (McKinsey & Company, 1993; Rennie, 1993). However, despite over three decades of research on BGs, the reasons why some start-ups internationalize early, others late and some never choose to go international remain a key area of interest for scholars (Cavusgil, Knight, 2015).

Scholars agree on various factors that seem to trigger early internationalization. These include the size of the firm’s home market, new market conditions in world markets (e.g. the emergence of global niche markets), technological developments in communications and production, the emergence of global networks and alliances, and organizational capabilities (Cavusgil, Knight, 2015; Rumyantseva, Catherine, 2023). Furthermore, early internationalization has been associated with a strong market orientation, international marketing capabilities and adaptability to changing conditions abroad (Aspelund, Madsen, Moen, 2007; Fan, Phan, 2007; Freeman, Cavusgil, 2007; Knight, Kim, 2009; Madsen, Servais, 1997; Mudambi, Zahra, 2007; Criado, Joseph, Knight, 2005; Zhou, 2007; Zhou, Barnes, Lu, 2010; Cavusgil, Knight, 2015).

Additionally, some literature on the internationalization of BGs also emphasizes the importance of institutional support, including the role of the state, in enabling rapid entry into foreign markets. Rumyantseva and Welch (2023) point out that many companies classified as BGs have benefited from the resources of pre-existing organizations, including state institutions. The case study of Australian company Cochlear shows how its internationalization was made possible by a national research and development project that brought together government, university and private sector activities. This also illustrates the importance of inter-institutional cooperation in line with the Triple Helix model, described by Etzkowitz (2008). Similarly, Oliva et al. (2022) emphasize the importance of programs such as Apex-Brasil and the Innovation Diplomacy Program in the context of the Brazilian start-up Asel-Tech. These programs supported foreign expansion and reduced the risks associated with entering new markets.

There are also studies that indicate the most efficient policy instruments for supporting BGs. In this regard, Bellone, Laffineur and Pommet (2023) point out that BGs in France were most successful in receiving public aid dedicated to supporting their innovation and internationalization projects. They also demonstrate that ‘the returns on aid dedicated to investment projects are especially high for born globals’ (Bellone, Laffineur, Pommet, 2023).

When it comes to the theories of the firm, Bouncken, Schuessler and Kraus (2015) indicate that three of such theories – Uppsala Internationalization Model, the Resource-Based Theory, and the Knowledge-Based Theory – ‘contain elements that connect them with each other and play an important role for BGs; already the Uppsala model describes incremental learning in the internationalization process of firms, which generates as a result new knowledge as a resource. Both the resource knowledge and the learning processes of individuals are taken up by the resource-based view and are developed further. The knowledge-based perspective contributes to a better understanding of the mechanism of absorptive capacity and dynamic capabilities that deal with the integration of knowledge in an organization’ (Bouncken, Schuessler, Kraus, 2015).

This article uses Singapore as a case study to demonstrate how public policy instruments can significantly impact start-ups’ internationalization processes by providing them with the necessary knowledge and resources. Singapore was chosen for this study because its support strategy for BGs is considered crucial for developing the Singaporean start-up ecosystem (Cheah, Ho, Lim, 2016). In other words, the policy has produced the expected results. The support strategy for BGs was fairly complex. As well as supporting companies in their internationalization at a very early stage, policies have also been implemented to attract foreign entrepreneurs to set up and run new businesses in Singapore (Cheah, Ho, Lim, 2016). This was based on the assumption that inward-flowing talent and ideas, as well as the presence of overseas entrepreneurs and start-ups, would enrich the networks within the local ecosystem and further influence the market dimension. Additionally, a more global outlook and interactions between local and foreign entrepreneurs would strengthen the culture dimension (Cheah, Ho,

Lim, 2016). However, to present the whole picture, it is necessary to mention that the country simultaneously implemented three strategies that have historically shaped the development of the Singaporean start-up ecosystem. Apart from supporting BGs, these strategies focused on: (1) promoting inter-institutional cooperation in line with the Triple Helix model, and (2) developing an ecosystem that meets the criteria of the agglomeration cluster model (Cheah, Ho, Lim, 2016).

3. Methodology

This study adopts a qualitative case study approach to examine how public institutions in Singapore support the internationalization of start-ups. The case study method has been successfully employed in various fields of international business research (Vissak, 2010) and has proven particularly useful in describing the process of business internationalization. The Uppsala model, i.e. the most cited and influential model of business internationalization, was originally developed through a multi-case study of Swedish firms (Johanson, Vahlne, 1977, 1990; Johanson, Wiedersheim-Paul, 1975), and it is a prime example of how case studies can contribute to the development of theory in international business. However, despite significant updates to the model over the years reflecting changes in the global business environment and advances in international business theory (Johanson, Vahlne, 2009; Schweizer, Vahlne, Johanson, 2010; Vahlne, Ivarsson, Johanson, 2011; Vahlne, Johanson, 2013, 2014; Vahlne, Johanson, 2017, 2020), the model does not account for all possible internationalization paths and is insufficient to explain the rapid internationalization of BGs. Rather, it only serves to distinguish the concept of BGs from existing internationalization models and highlight their unique characteristics (Bouncken, Schuessler, Kraus, 2015). This indicates the need for further case study analysis, and the Singaporean start-up ecosystem is a good example of how public policy can support start-ups in undergoing internationalization at a very early stage.

4. Research Results and Discussion

Singapore's start-up ecosystem has been successful due to the consistent implementation of a development strategy and strong government support (Audretsch, Fiedler, 2023). The range of instruments used by the state is extensive and includes both direct and indirect measures. Direct instruments support enterprises' internationalization efforts directly, while indirect instruments are designed to increase their chances of succeeding in this process by making enterprises, for example, more competitive. Indirect instruments can be aimed at improving

areas such as: (1) developing entrepreneurship; (2) developing research and development (and other innovative activities); (3) developing human capital; (4) developing traditional and digital infrastructure (important for e-commerce); (5) supporting the development of sectors or technologies (such as *fintech* and *deep tech* in the Singaporean case); and (6) reducing barriers to international trade, particularly in priority markets or within specific value chains (Pawęta, Stryjek, Tomaszewski, 2022).

In order to discuss the instruments used for enterprise internationalization in Singapore, it is helpful to classify them according to the support they provide to beneficiaries. At the most general level, this enables to distinguish between financial and non-financial instruments. Support for enterprise internationalization through financial instruments addresses one of the fundamental barriers identified by start-ups and other small and medium-sized enterprises (SMEs): the lack of working capital to finance export activities (Narayanan, 2015; OECD, 2009). Financial institutions generally perceive the export activities of SMEs as risky ventures and are reluctant to grant loans for this purpose. Even if they do grant a loan, they tend to offset the risk by charging high interest rates. This problem is particularly acute in the case of small start-ups, whose innovative activities are considered high-risk. Therefore, instruments that provide companies with access to capital for internationalization are a very important form of support. One example of good practice in this area is the Enterprise Financing Scheme, which was implemented by the Singaporean government agency Enterprise Singapore. The program provides loans to help companies enter foreign markets by financing the purchase of fixed assets (Enterprise Financing Scheme – SME..., 2025) as well as provides working capital for foreign operations (Enterprise Financing Scheme – Trade..., 2025).

In addition to organizing support in the form of loans, countries also stimulate the internationalization of enterprises through a number of other financial instruments, such as (Pawęta, Stryjek, Tomaszewski, 2022):

- refundable subsidies to cover operating and running costs during the initial period of foreign expansion,
- grants to support specific stages of an enterprise's internationalization process,
- financing the employment of staff for the purposes of the company's internationalization (e.g. consultants, researchers and accountants),
- financing a company's participation in international trade events,
- providing companies with the financial resources needed to enforce their trademarks, patents and copyrights in foreign markets,
- interest subsidies on export loans/credits,
- covering the costs of insuring loans/credits for foreign business activities,
- covering the costs of insuring trade receivables,
- covering the costs of insuring foreign assets (to reduce the risk of losing them if they are located in high-risk areas),

- granting foreign buyers credit for purchasing goods and services from domestic companies (which is an alternative to trade credit that SMEs often cannot afford),
- tax breaks (such as, for example, the ability to deduct marketing or investment expenses related to operating in foreign markets from tax).

Singapore has a lot to offer entrepreneurs when it comes to the wide range of financial instruments described above. Firstly, it offers the Double Tax Deduction for Internationalization program (Double Tax Deduction, 2025), which enables companies planning to expand abroad to deduct 200% of eligible expenses incurred when entering a given market or developing investments from their tax liability. The program supports companies in the following areas:

- Preparing for market entry, e.g. designing packaging for foreign markets, obtaining product/service certification and conducting market research/feasibility studies.

- Exploring the market, e.g. through market research trips, trade missions and participation in trade fairs.
- Promoting products and services in a given market (e.g. producing advertising materials and campaigns for foreign markets).
- Conducting business in a given market (e.g. sales office costs, licenses and franchising, secondment of employees abroad, investment study trips, investment feasibility studies and due diligence).

The next program to provide financial support for the internationalization of Singaporean companies is called the Local Enterprise and Association Development (LEAD) program (Local Enterprise and Association..., 2025). As part of this initiative, Trade Associations and Chambers (TACs) organize overseas missions and facilitate the participation of local enterprises in international trade fairs. TACs use the LEAD program budget to offset some of the costs that enterprises incur for these overseas missions and trade fairs. Eligible expenses include exhibition space rental, stand construction, advertising and consultancy costs relating to trade fairs or missions. Companies can receive funding to cover up to 70% of these costs.

Companies in Singapore can also apply for the Market Readiness Assistance Grant (Market Readiness Assistance..., 2025). This program aims to support SMEs in expanding into new foreign markets by covering business setup costs, as well as the costs of promoting and/or developing business in a given market. Companies can obtain a maximum of SGD 100,000 for operations in a specific market, with funding covering up to 50% of eligible costs.

Another program aimed at SMEs which supports business development and access to foreign markets is the Enterprise Development Grant (Enterprise Development Grant..., 2025). When it comes to foreign expansion, funds can be obtained for planning and evaluating potential merger and acquisition projects, as well as for post-merger and acquisition integration. Funding is also available for entering new geographical or product markets, including product testing in these markets and adapting the business to applicable market standards (e.g. assessment, training, initial certification and adoption of relevant standards for business

development). As a rule, SMEs can receive funding covering up to 50% of eligible costs. However, priority is given to projects that comply with the principles of sustainable development, which are eligible for support covering up to 70% of costs.

As part of the Global Innovation Alliance (GIA) initiative, Enterprise SG, a Singaporean government agency, has formed numerous partnerships with foreign organizations. These partnerships facilitate the implementation of co-innovation programs in collaboration with various countries around the world (Co-Innovation Programmes, 2025). The programs fund projects involving joint research and development activities with foreign partners, as well as the commercialization of innovations and business expansion. For instance, the Singapore-France Joint Innovation Call enables French and Singaporean companies to collaborate on joint innovation projects. This program is jointly managed by Enterprise SG and the French government agency Bpifrance and aims to provide public funding for projects selected by both parties. The initiative supports the development of technology-based solutions that are ready for the market and have significant potential in Singapore, France or internationally.

Another example of a co-innovation program is the Eureka Clusters initiative. This program involves cooperation with almost 40 countries, including EU Member States, as well as Canada, South Africa, and South Korea. It supports the implementation of software innovation projects in the following areas: (1) smart cities (supporting city management, including housing, energy, mobility and emergency services); (2) smart health (improving the efficiency of the healthcare system, from drug and therapy design to hospitals and home care); (3) smart industry (creating new opportunities for design, production, and maintenance, as well as improving supply chain efficiency); (4) smart communities (improving local community development, including personalization and building social trust); (5) smart mobility (supporting innovations in sustainable, efficient, autonomous, and energy-efficient transport systems and services); (6) smart energy (developing green energy sources and distribution networks, as well as improving energy efficiency); (7) smart engineering (enhancing complex system and software capabilities); and (8) security and protection (increasing critical system resilience and protection against cyber-attacks).

Singapore is also implementing an interesting co-innovation program called Eureka Eurostars. This program covers a similar group of countries to the Eureka Clusters program. It is open to companies in all sectors. To participate in Eureka Eurostars, a consortium must be created, comprising at least one entity from the program's covered countries, in addition to the Singaporean company seeking support. The objective of this collaboration is to develop and commercialize a new product, process or service. Any type of company or organization can be involved, including SMEs, large corporations, universities, and research institutes.

With regard to non-financial instruments that support the internationalization of enterprises, the following groups can be distinguished:

a) Information instruments:

- creation of internet portals containing economic information on individual markets and the companies operating within them, including information on applicable rules, legal regulations and procedures,
- information services provided by agencies located in foreign markets (e.g. information on local business contacts, market opportunities, and industry events).

b) Promotional instruments:

- promoting domestic industries and companies as potential suppliers to foreign customers through local media and online channels in foreign markets;
- organization of trips to trade fairs and exhibitions;
- organization of trade missions.

c) Advisory instruments, for example:

- advisory assistance in developing long-term strategies, business plans, marketing plans, etc.,
- advice on the use of support instruments offered by the target and home countries,
- technological advisory services to support technology transfer or adaptation to foreign market needs,
- advice on solving logistical problems related to shipping goods to foreign markets.

d) Training instruments, for example:

- training in conducting business abroad, taking into account the specific nature of the target market,
- training in protecting or using intellectual property rights,
- e-commerce training.

e) Networking instruments, for example:

- creation of networks of foreign agencies and commercial representations,
- supporting the exchange of knowledge between enterprises in the field of export experience,
- supporting partner searches and establishing cooperation between enterprises in the joint promotion of products or services,
- supporting the creation of international networks by organizing inbound missions,
- supporting the creation of networks by implementing bilateral soft-landing programs.

f) Sectoral instruments, for example:

- promoting sectors that are important for the national export development strategy on foreign markets,
- organizing economic missions and providing comprehensive services (e.g. information and advisory services) for selected sectors,
- creating sectoral export portals.

g) Matchmaking instruments, for example:

- providing services to identify partners, including assistance in establishing initial contact and advice on building lasting partnerships,
- creation of online platforms for matching partners from specific markets and industries.

As part of the Global Innovation Alliance initiative mentioned previously, Singapore provides domestic entrepreneurs with a variety of non-financial instruments. The initiative has established a network of overseas partners in major innovation hubs and key demand markets, with a particular focus on technology and innovation (GIA Acceleration Programmes, 2025). Enterprise SG runs acceleration programs in many locations in collaboration with local partners. These programs are offered in such destinations, as: Bangkok, Manila, Ho Chi Minh City, Jakarta, Bangalore, Beijing, Seoul, Melbourne, Mumbai, Shanghai, Shenzhen, Suzhou, Sydney, Tokyo, Amsterdam, Berlin, Eindhoven, London, Munich, Paris, Stockholm, Abu Dhabi, Austin, New York, San Francisco, Sao Paulo. While the specifics of each program vary, they all focus on helping companies expand into a given foreign market. This usually involves developing competencies, adapting the company's offering to the market in question, and searching for business partners. For example, the GIA Melbourne Acceleration Programme is organized by the start-up accelerator Haymarket HQ. It covers: (1) nine weeks of virtual acceleration, including networking sessions, one-to-one mentoring, business development support and virtual workshops led by leading Australian industry experts; at this stage, Haymarket HQ also starts to facilitate introductions to potential clients and partners; (2) one week of pre-market preparation, during which a professional Australian pitch coach helps to tailor the start-up's pitch for an Australian audience; (3) two weeks of in-market experience in Australia, taking place within the start-up ecosystems of Sydney and Melbourne; this stage includes networking opportunities, industry briefings and in-person meetings with potential clients, partners and investors; and (4) ten weeks of post-program support, where start-ups can work from the accelerator's co-working space, continue with one-to-one mentoring, and receive further customized support from Haymarket HQ.

Support for start-up internationalization is also offered by Singapore's universities. The National University of Singapore (NUS), for example, provides such support. Its entrepreneurial arm, NUS Enterprise, has collaborated with Singtel Innov8 and the Media Development Authority of Singapore to implement the BLOCK71 initiative, which supports start-ups in expanding internationally. BLOCK71 has 11 international hubs across Southeast

Asia, East Asia and the USA, including locations such as Silicon Valley, Jakarta, Saigon and Tokyo. These hubs serve as soft landing programs for start-ups looking to enter new markets by offering localized support, market insights, access to regional investors and corporate partners, co-working spaces, and community integration.

Another example of an academic initiative is the NUS Guangzhou Research, Translation and Innovation Institute (NUSGRTII), which is based in China. Established by NUS in partnership with the Guangzhou authorities, the institute specializes in areas such as sustainable cities, smart societies, information and communication technologies, and artificial intelligence. It offers an incubation program for start-ups, as well as educational programs to train personnel for the research and development sector.

Since 2001, NUS has also run an interesting program aimed at developing academic entrepreneurship. As part of this program, students learn about entrepreneurship at renowned universities around the world and gain insight into foreign start-up ecosystems by taking part in internship programs. The first edition of the program was carried out in cooperation with Stanford University in the United States, with participants being employed as interns in Stanford-affiliated technology start-ups. The program was then extended to other countries: China, Germany, Vietnam, Japan, Israel, Switzerland, Sweden and Canada.

Of the various policy instruments used in Singapore to promote internationalization, it was the generous grant system that came under scrutiny. It was suggested that this level of financing was higher than optimal in Singapore, hindering the market's ability to verify the existence of companies and delaying their rapid collapse in the event of negative feedback (Pangarkar, Vandenberg, 2022). Furthermore, high levels of public support may cause grant recipients to prioritize achieving the milestones set out in their grant applications over competing in the market, which is undesirable and calls into question the effective use of public funds. Such problems can be counteracted by requiring grant recipients to contribute to the investment themselves. Singapore is currently making a determined effort to follow this path, and all the public grant programs analyzed for this study require grant recipients to participate in financed investments.

During the global pandemic (2020-21), internationalization opportunities for Singaporean companies were limited. However, in 2022, the number of Singaporean firms expanding overseas with support from Enterprise Singapore increased significantly compared to the previous year. Around 2000 companies ventured abroad at that time, which was a 25 per cent increase on the pandemic years, but still below the pre-pandemic level of 2600 firms in 2019 (See, 2023). The following year, however, the number of enterprises entering new markets surpassed the pre-pandemic level. According to Enterprise Singapore, there was a 66% increase in local companies venturing into new overseas markets for the first time in 2023 compared to 2019 (*More Singapore firms...*, 2025). This includes firms that either went overseas for the first time or expanded into additional markets.

5. Conclusions

In Singapore, public policy instruments aim to address a variety of needs that companies have in relation to internationalization. These include equipping entrepreneurs with knowledge of foreign markets and providing them with the necessary financial and non-financial resources, as well as facilitating the search for business partners. By doing so, they alter the dynamics of the internationalization process, enabling companies to internationalize very early on and facilitating the emergence of 'born global' companies. This is because state support can replace (or considerably speed up) the incremental process based on experiential learning, indicated by the Uppsala model.

Born global companies are said to leverage global networks, advanced technologies, and the international experience of their founders in order to overcome knowledge barriers and resource constraints (Knight, Cavusgil, 2004). However, a similar effect can be achieved if founders are able to use global networks provided by public policy instruments, develop new technologies with overseas partners through international interinstitutional cooperation, gain experience through soft-landing programs and acquire the necessary additional knowledge and resources. Therefore, while the Uppsala model emphasizes risk reduction through gradual learning, using public policy internationalization instruments enables risk to be reduced in a shorter time, facilitating fast internationalization.

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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON WORK-LIFE BALANCE IN ORGANIZATIONS

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Purpose: The aim of this article is to examine how artificial intelligence (AI)-based solutions impact work - life balance (WLB) and the benefits and risks associated with their implementation in organizations. The study addresses the need to understand the role of AI in shaping working conditions and employee well-being.

Design/ methodology /approach: A narrative literature review and desk research approach were employed, including qualitative analysis of secondary data from reports by international institutions and consulting firms (OECD, WEF, Deloitte, EY, PwC, McKinsey, Microsoft & LinkedIn, CIPD). The analysis was framed within the theoretical frameworks of role conflict and enrichment, boundary control, conservation of resources theory, and self-determination theory.

Findings: The results indicate an ambivalent impact of AI on WLB. Under favorable organizational conditions, technology increases efficiency, reduces cognitive load, and enables greater work flexibility, which promotes role enrichment and resource accumulation. Otherwise, in the absence of clear rules and support, AI leads to increased technostress, a sense of surveillance, and a blurring of the boundaries between work and private life. A key moderator is the implementation context - strategy, governance, organizational culture, and employee competencies.

Research limitations/implications: The analysis is based on industry-specific and global reports, which focus primarily on large organizations and technology sectors. The data is cross-sectional and often declarative, limiting the ability to assess the long-term impact of implementations and their impact on different types of organizations.

Practical implications: Organizations should implement AI in a humanized manner, i.e., according to clear principles, with transparent governance, training, and a digital well-being policy. AI can become a tool supporting flexibility and reducing burden if implementations are linked to a culture of participation and monitoring the impact on well-being.

Social implications: Effective AI implementations can improve employee quality of life, reduce stress, and support work-life balance, which is important for labor market policies and sustainable development strategies. Otherwise, technology can exacerbate competency inequalities and job pressures.

Originality/value: This article integrates the findings of global reports with key WLB theories, proposing a conceptual model of AI's impact on work-life balance. It identifies the conditions under which AI acts as a resource and the risk factors leading to a loss of control over boundaries. It provides value to management HR researchers and public politicians, as well as practitioners implementing technologies in organizations.

Keywords: artificial intelligence, work-life balance, well-being, digital transformation, governance, public policies.

Category of the paper: Research paper.

1. Introduction

In an era of dynamic technological transformations and the evolving nature of work, work - life balance (WLB) is gaining importance in both scientific literature and in human resources management practice, as well as in public policies, especially those related to family and labor market issues. With the ongoing digitization and automation of organizational processes, we are observing the expansion of remote work options, the widespread adoption of flexible employment options, and the growing availability of technologies enabling the performance of professional duties regardless of time and place. These phenomena are part of broader transformations characteristic of the digital economy, in which the boundaries between the professional and private spheres are becoming increasingly fluid (Schor, 2020). At the same time, expectations regarding employees' constant readiness to respond to organizational needs, work intensity, and the constant availability of mobile technologies outside of traditional working hours are growing, which can lead to technostress overload and impaired well-being (Kumar, 2024; Ayyagari et al., 2011).

These trends raise questions about the extent to which AI-based tools can support work-life balance and the extent to which they can contribute to its disruption. Artificial intelligence is currently one of the most important directions of technological development in organizations, influencing the way work is organized, task design, performance monitoring, and decision-making processes are supported. In the context of WLB, AI can act as both a resource that increases autonomy, efficiency, and the ability to better match workloads to employee capabilities, as well as a factor that reinforces the pressure of constant availability and work intensification, especially in conditions of algorithmic management.

On the one hand, the development of artificial intelligence tools in the workplace opens up vast opportunities for process improvement and increased efficiency. AI allows for the automation of routine and administrative tasks, intelligent scheduling, and optimization of resource utilization. Through advanced data analysis, it supports decision-making, trend forecasting, and risk identification. It also enables the personalization of employee experiences, recommending development paths and training, while simultaneously monitoring workload and team well-being. In the areas of communication and collaboration, AI offers tools for real-time translation, content generation, and report and presentation creation, while in the area of security, it offers intelligent threat detection systems. All of this makes AI a key element of organizational transformation, impacting both operational efficiency and work quality. There is evidence in the literature that the use of such tools can reduce employee workload,

improve their sense of autonomy and competence, and consequently, improve the quality of professional and personal life (Huang, Zhao, 2025; García-Madurga et al., 2025; Brynjolfsson et al., 2025). On the other hand, the development of artificial intelligence in organizations is associated with significant threats, which are increasingly highlighted in the literature. These include growing digital surveillance, which enables detailed monitoring of employee activity, which can lead to a sense of permanent control. The “always-on” phenomenon, resulting from the easy availability of digital tools, promotes extended working hours and makes it difficult to disconnect from responsibilities, which in turn leads to the erosion of the boundaries between work and private life. Furthermore, research suggests that high levels of exposure to AI technologies, particularly in the context of automation and control, may result in decreased job satisfaction if implementations are not focused on supporting employees but on maximizing productivity (Acemoglu et al., 2023; Vitak, Zimmer, 2023; Hickok, Maslej, 2023; Zitek, Schlund, 2024).

Given the above, organizations face the challenge of designing and implementing AI solutions that truly support employee well-being and work-life balance, rather than merely serving as a tool for work intensification. In this context, it seems justified to deepen our understanding of the mechanisms through which AI can support WLB, as well as to identify the conditions under which these mechanisms operate effectively (Gualano et al., 2023).

In light of the above, the aim of this article is to examine how AI-based solutions can support work-life balance. To achieve this goal, a narrative literature review and secondary analysis of selected reports and data on the use of AI in the context of work-life balance were undertaken. The theoretical section discusses the concepts of roles and boundaries at work in the context of AI, highlighting their importance for the organization of work and private life. Next, the mechanisms of AI's impact on employee well-being are presented in light of the resource-overload theory (Conservation of Resources COR Theory) and the self-determination theory (Self-Determination Theory; SDT), considering both the potential benefits and risks of its implementation. The empirical study was based on secondary data analysis, including reports from international institutions and industry studies, including: PwC (2025), McKinsey & Company (2025), EY (2025), Microsoft & LinkedIn (2024), Deloitte (2024), CIPD (2025), EY (2025), WEF (2023), and OECD (2023). It should be emphasized that these sources, while valuable and current, may reflect specific institutional or business perspectives, which may influence the presentation of phenomena related to the use of artificial intelligence in the context of WLB. Furthermore, the dynamic development of AI technology means that some findings may be subject to rapid change, and the available data still do not cover all aspects of the impact of these solutions on the functioning of employees and organizations. Therefore, the conclusions presented in this article should be considered primarily as an indication of key directions for interpretation and possible trends, rather than as unequivocal, empirically determined results. At the same time, the presented analysis can serve as a starting point for further research on the role of AI in shaping working conditions, particularly in the context of

well-being and quality of professional life. This approach also allows us to grasp the complexity of the relationship between technology and human functioning in the work environment, preparing the ground for broader theoretical and practical reflection.

This article adds value by integrating a technological perspective with the concept of employee well-being, analyzing the dual impact of AI: first, as a tool supporting flexibility and reducing workload, but also as a potential source of technological stress and blurring the boundaries between work and life. This approach allows for the formulation of recommendations for management practice and public policies aimed at designing and implementing AI solutions in an ethical, transparent, and well-being-friendly manner. Based on the analysis of reports and reference to key theories (role conflict and enrichment, boundary control, resource theory, and self-determination), a conceptual model of AI's impact on WLB was developed, illustrating both positive mechanisms (automation, workload reduction, flexibility) and negative ones (technostress, surveillance, blurring the boundaries), as well as the role of organizational, cultural, and procedural moderators in shaping the ultimate effect on work-life balance.

2. Theoretical approaches to work-life balance and artificial intelligence

Over the past decade, the dynamic development of artificial intelligence (AI) and digital technologies has had a profound impact on organizational structures, work models, and employee experiences and well-being. The literature emphasizes that digital transformation is multidimensional, encompassing both technological and psychosocial changes. Therefore, analyzing its consequences for work - life balance (WLB) requires drawing on a broad spectrum of management theories, organizational psychology, labor sociology, and public policies (OECD, 2019; WEF, 2023).

The concept of work -life balance (WLB) refers to the degree to which an individual is able to harmoniously combine the demands of professional life with the needs and obligations of the private sphere. The scientific literature emphasizes that this balance does not mean a simple division of time between work and personal life, but rather a subjective sense of well-being resulting from an adequate match between the employee's resources and the expectations stemming from both areas of functioning (Greenhaus, Allen, 2011, p. 162). This concept combines a psychological perspective on satisfaction, stress, and cognitive load with an organizational perspective, encompassing, among other things, work flexibility, employment models, and practices supporting employee well-being. At the same time, WLB is rooted in theories of interaction between life roles, which describe both role conflicts (work - family conflict) and their possible synergy (work - family enrichment), constituting a potential source of resources for employees (Voydanoff, 2005, p. 825).

Contemporary approaches to WLB also emphasize the importance of the technological context, which redefines the boundaries between work and private life. Digitization, remote work, and mobile communication technologies have increased the flexibility of task performance, but at the same time, they have intensified the phenomena related to the penetration of professional duties into the home sphere. In this context, WLB becomes a dynamic state of balancing the tensions resulting from multiple roles, with an individual's ability to manage boundaries (boundary management) playing an increasingly important role. In relation to the above, it should be noted that in the literature on WLB, two classical groups of theories are of particular importance: boundary and border theories and role conflict and enrichment models. Boundary theories, developed by Ashforth, Kreiner, and Fugate (Ashforth, Kreiner, Fugate, 2000) and later supplemented by Clark (Clark, 2000), assume that work and private life operate in separate domains that may be more or less permeable. An individual regulates the boundaries between these areas through strategies of segmentation (maintaining a clear division) or integration (creating smooth transitions). The influence of digital technologies and artificial intelligence leads to the weakening of traditional work-private life boundaries, which is confirmed by empirical research results (Duan et al., 2023; Reinke et al., 2024). Communication tools, collaboration platforms, and remote work systems expand employee availability, which may lead to the erosion of temporal and psychological boundaries (Mazmanian et al., 2013).

The second group of theories comprises role conflict and enrichment models, derived from the concepts of Greenhaus and Beutell (Greenhaus, Beutell, 1985). Work-family conflict (WFC) occurs when the demands of one role prevent the fulfillment of the other, which may be temporal, energetic, or behavioral. Technology research has shown that intensive use of digital tools increases the likelihood of time and energy conflict through extended work hours and information overload (Boswell, Olson-Buchanan, 2007). In recent years, however, the concept of work-family enrichment has received increasing attention, according to which resources acquired in one role can support functioning in the other (Greenhaus, Powell, 2006). In this context, AI can act as an enriching factor, for example, by reducing routine tasks, providing time flexibility, and better work organization, which promotes greater harmony between life domains.

The concept of boundary control, introduced by Kossek, Ruderman, Hannum, and Braddy (Kossek et al., 2012), is an extension of boundary theory. It assumes that what is crucial for well-being is not the existence of segmentation or integration itself, but whether a person has the ability to choose their preferred boundary management style. Research indicates that work technologies, including AI, can both support the sense of control (e.g., through automation and personalization) and limit it (e.g., by generating forced accessibility), which makes this theory particularly useful in the context of analyses related to digitalization.

However, to explain not only how individuals negotiate boundaries but also why role conflict or role enrichment occurs under certain conditions, it is necessary to incorporate resource-based and motivational perspectives. Conservation of Resources (COR) theory (Hobfoll, 1989) and its extension, the Work - Home Resources Model (ten Brummelhuis, Bakker, 2012), indicate that work-life balance is largely a function of the availability, flow, and conservation of resources, both material and psychosocial. In this context, artificial intelligence can serve as an organizational resource that reduces cognitive load, automates routine tasks, and supports time management, which facilitates the creation of a “gain spiral” and role enrichment (García-Madurga et al., 2024). For example, intelligent work scheduling systems or task prioritization algorithms can increase the sense of control over one's schedule and thus improve the balance of personal resources. On the other hand, AI can act as a resource eroder when its implementation is associated with the pressure of constant availability, algorithmic surveillance or the need to quickly acquire new competences, which initiates “loss spirals” and intensifies role conflict (OECD, 2023; Yan, Gai, 2024).

This perspective is complemented by the Self-Determination Theory (SDT) (Deci, Ryan, 1985; Ryan, Deci, 2000), which emphasizes the importance of resource quality by fulfilling three basic psychological needs: autonomy, competence, and relationships. Implementing AI in organizations can support these needs, for example, by increasing autonomy through the personalization of work tools, developing competences through interactive learning systems, and strengthening relationships by reducing communication overload and better managing team time (Huang, Zhao, 2025). However, when AI technologies are used to intensify control, monitor activity, or force real-time responses, they can undermine autonomy and relationships, which negatively impacts well-being and work-life balance (Ryan, Deci, 2000; Kossek et al., 2012).

Integrating COR and SDT with boundary and role theories creates a multilevel analytical framework: structural (boundaries and roles), mechanistic (resource flows), and motivational (resource quality). This approach is particularly useful in the context of AI technologies, which can act both as a resource (e.g., reducing cognitive load, saving time, providing decision support) and as a source of new demands (e.g., pressure for constant availability, algorithmic surveillance, the need to adapt to new tools), thus influencing resource balance and the fulfillment of psychological needs (García-Madurga et al., 2024; Yan, Gai, 2024). In practice, this means that the impact of AI on WLB varies and depends on the implementation design. Technologies that support autonomy and boundary control may become a key resource in this balance, while solutions that violate privacy and intensify work pose a threat to it.

The ambivalence surrounding AI's impact on WLB is most clearly manifested in the area of technological surveillance and related phenomena, such as technostress. It is precisely the way organizations utilize algorithmic work monitoring and control systems that determines whether AI becomes a resource supporting well-being or a factor in its erosion. Algorithmic productivity monitoring systems, used in sectors based on remote work and the gig economy,

among others, are criticized as a source of additional stress and a sense of loss of privacy (Mateescu, Nguyen, 2019). Researchers emphasize that the level of acceptance for AI in the workplace is closely linked to the transparency of its operating principles, the extent of employee control over the system, and the degree to which technology is perceived as supporting, rather than replacing, humans. In this context, the importance of a human-centered AI approach is growing, which advocates co-creating technology in a manner consistent with human values, needs, and limitations (Shneiderman, 2020).

As noted above, the analysis of technological stress (technostress) remains an important research direction. Ragu-Nathan and co-authors (Ragu-Nathan et al., 2008) identify its main sources, among others, as excessive system complexity, frequent technological changes, unclear requirements for working with digital tools, and a sense of constant information overload. Some researchers indicate that the new generation of intelligent tools can reduce technostress through intuitiveness and automation, but it can also lead to new forms of burden resulting from the opacity of algorithms and difficulties in building trust in systems (Tarafdar et al., 2019).

In summary, the literature clearly indicates that the relationship between artificial intelligence and work-life balance is complex and multidimensional. It requires an approach that integrates various perspectives that consider both the resource potential of the technology and the risks arising from its inadequate implementation. Theories of COR and SDT are crucial here, emphasizing the role of resources, autonomy, and agency as the foundations of well-being. At the same time, a growing number of studies and reports emphasize the need to humanize AI, i.e. design and implement solutions in an ethical, transparent and human-centric manner. In light of these analyses, artificial intelligence appears not as a neutral tool of automation, but as a factor capable of co-creating new work models that can promote employee well-being, provided it is managed responsibly and with due regard for individual psychological resources. The ambiguous impact of artificial intelligence on work-life balance is also confirmed by empirical data, the conclusions of which are presented below.

3. Research methodology

This section of the article analyzes secondary data from reports by international institutions and industry studies, presenting global trends, research findings, and recommendations regarding AI implementation in the context of work and well-being. The analysis focuses on four main dimensions: (1) job satisfaction and quality when automating routine tasks, (2) the potential of AI to relieve employee workload and facilitate work organization, (3) risks, inequalities, and the importance of the implementation context, and (4) the importance of organizational, cultural, and procedural conditions for implementation effectiveness.

The selection of these areas stems from the need to capture both the positive potential of AI and the limitations that can impact WLB. The first dimension, concerning job satisfaction and quality, allows us to assess whether and to what extent the automation of routine tasks facilitates and accelerates work, reduces monotony, and increases employee competence, which is related to the resource and overload theory (COR). The second dimension, reducing employee workload and improving work time organization, examines how AI can enhance autonomy and control over work time, which aligns with the assumptions of self-determination theory (SDT) and role and boundary theory. The third dimension, concerning risk, inequality, and implementation context, allows us to assess the extent to which a lack of appropriate support, competencies, or implementation strategy limits potential benefits and may increase inequalities between employees. The fourth dimension, however, indicates that simply providing AI tools is not enough; organizational culture, leadership, implementation procedures, and training strategies are key factors in determining whether AI actually improves WLB.

The analysis is based on secondary data from industry reports and global studies, including: PwC (2025), McKinsey & Company (2025), EY (2025), Microsoft & LinkedIn (2024), Deloitte (2024), CIPD (2025), EY (2025), WEF (2023), and OECD (2023). The selection of these sources was dictated by their timeliness, reliability, and representativeness of data on AI implementations in various economic sectors. Methodologically, the analysis is conducted based on a desk-based approach. Research, which involves the selection, critical evaluation, and synthesis of secondary data. This approach involved a review of reports and studies published by institutions with high methodological credibility, focusing on the currency, representativeness, and quality of available information. Specifically, the selection of sources was based on explicit inclusion criteria: year of publication ≥ 2019 ; credibility (peer-reviewed reports or studies from institutions with an established reputation); direct relevance to the impact of AI solutions on working conditions and WLB; transparency of method and data. Items that did not meet at least one of the criteria, as well as comments, opinions without an empirical basis, were excluded. The results were interpreted within the context of role and boundary theory, resource and overload theory (COR), and self-determination theory (SDT), enabling an assessment of how AI implementations impact employee resources, a sense of autonomy and control, and the ability to maintain work-life balance.

This approach allowed for a synthetic assessment of AI's potential in the context of WLB, identifying both the positive opportunities and limitations associated with implementing AI in organizations. While maintaining scientific rigor and basing conclusions on reliable empirical data, selecting these areas also enabled us to link the report findings to a theoretical framework and provide practical implications for managers and designers of AI workflows.

4. Analysis and research results

Satisfaction and work quality and the automation of routine tasks

Analysis of the latest reports and studies on the implementation of artificial intelligence in the workplace indicates that these technologies, often in a positive way, can significantly change the quality of work. According to data included in the PwC report “The fearless future: 2025 Global AI Jobs Barometer”, industries with high exposure to AI, i.e. those in which the majority of professions perform tasks susceptible to support or automation by artificial intelligence, record a three-fold increase in revenue generated by each employee. At the same time, employees with AI skills (including prompt - engineering, cooperation with AI agents) received on average a 56% higher salary premium (compared to 25% in 2024) than people in similar positions without these competences. Importantly, all surveyed industries saw an increase in the use of AI and a much faster change of skills in professions requiring artificial intelligence - 66%, and in 2024 - 25%. The data may indicate that adaptation and acquisition of new competences are becoming crucial, and AI contributes to increased productivity and increased work value. Consequently, even at the organizational level, work becomes more effective, which may translate into better task organization, reduced routine workload and increased ability to focus on tasks requiring creativity or decision-making. These results are consistent with the theoretical assumption that AI can serve as a resource, freeing up employee time and energy resources (COR), which in turn can contribute to improved well-being and work - life balance (PwC, 2025).

Additionally, an OECD report analyzing the impact of AI on work quality, titled "The Impact of AI on the Workplace", shows that employees engaging in AI work often report improved working conditions. Approximately 80% of respondents working with AI stated that AI had a positive impact on their productivity, and approximately 60% said it increased job satisfaction. According to the report's authors, AI is sometimes perceived as a tool for reducing monotony, eliminating boring, repetitive, or burdensome tasks (e.g., manual, dangerous, routine), which can improve work quality and increase acceptability. Importantly, where AI is used for management purposes, including monitoring, evaluation, and task allocation, so-called “algorithmic management” many people report increased work intensity.

Increased intensity, monitoring, and reduced autonomy in task performance are aspects that can negatively impact work-life balance if the pace and pressure are high (OECD, 2023). The report also indicates that there is a risk that employees who are not highly qualified or do not directly use AI may experience a decline in work quality, including: a greater burden of simple, monotonous tasks, which in turn may affect a possible decrease in autonomy or employment stability. The OECD report indicates that AI has the potential to improve work quality, reduce mechanical work, increase productivity, and provide decision-making support, which in turn can foster greater satisfaction, better engagement, and perhaps more flexible and

meaningful work. For employees with the right skills and in the right conditions, AI can indeed translate into a better work experience, but this potential is not automatic. A prerequisite is conscious, responsible implementation of AI, taking into account work organization, privacy protection, and the provision of appropriate support in the form of training and consultation. Without this, instead of reducing workload, AI can lead to the opposite effect: increased pressure, intensity, and worsening workload (OECD, 2023). Similar conclusions emerge from research by Brynjolfsson, Li, and Raymond, who show that in a group of over five thousand customer service agents, the introduction of a generative AI assistant increased productivity (the number of requests resolved per hour) by approximately 15% on average. For less experienced or lower-skilled employees, the gains were more pronounced, both in speed and quality of work. Moreover, some respondents indicated that AI helps them learn and develop competencies (e.g., language). This suggests that AI, if properly designed, can enhance employee resources, which promotes better work quality and perhaps better workload (less stress, greater satisfaction, less monotony) (Brynjolfsson et al., 2025).

The potential of AI to relieve employees and facilitate the organization of working time

Implementing artificial intelligence in organizations is increasingly seen as a tool that can significantly reduce employee workload and improve workflow. McKinsey & Company's "AI in the Workplace: A Report for 2025" indicates that, of the 3,613 employees surveyed, as many as 13% report using AI in at least 30% of their daily tasks - three times more than managers estimated. AI is therefore becoming a common support in operational work, enabling the delegation of routine and administrative tasks that previously consumed a significant portion of employees' time and energy. The study indicates that many employees and managers expect generative AI to become a key element of daily duties, and that implementing AI on a larger scale could free up a significant portion of time spent on administrative tasks, planning, and management, allowing for better use of time both at work and outside of it (McKinsey & Company, 2025).

Information from Microsoft & LinkedIn's 2024 Work Trend Index report indicates that 3 out of 4 people surveyed say they already use AI in their work, demonstrating the widespread adoption of tools supporting daily tasks. Among those who regularly use AI, strong claims of benefits emerge, with users saying that AI helps them save over 30 minutes a day. These same users indicate that AI allows them to focus on their most important tasks. They waste less time on routine, repetitive tasks, which improves efficiency and job satisfaction. The report also shows that in Poland, 61% of employees use generative AI in their daily tasks, and these tools have the potential to increase operational efficiency and reduce employee workload (Microsoft & LinkedIn, 2024).

Similar analyses can be found in the OECD report presented above, which shows that AI users report improved work efficiency and reduced time spent on monotonous activities, allowing them to focus on tasks requiring greater creativity and decision-making (OECD, 2023). It is worth emphasizing that the effectiveness of this support is strongly dependent on the implementation context, as employees who participated in the implementation process and received appropriate training reported greater autonomy at work and better control over their daily organization, which is consistent with the SDT theory of sense of competence and autonomy at work (Deci, Ryan, 2000). Report The World Economic Forum (WEF) also emphasizes that the development of AI leads to a shift in competences towards tasks requiring critical thinking and creativity, and the automation of simple, repeatable processes reduces the burden on employees (WEF, 2023). In turn, Chartered The Institute of Personnel and Development (CIPD) points out that the implementation of AI in HR and administration can improve the management of working time, schedules and task monitoring, which translates into less workload for employees and greater flexibility in performing duties (CIPD, 2025).

From a resource-based theory (COR) perspective, automating routine tasks and AI support for administrative tasks can be interpreted as increasing an employee's available resources, including time, energy, and attention, which can be used for recovery, professional development, or non-work-related responsibilities (Hobfoll, 1989). These same observations align with the concepts of work and role boundaries. AI allows for better management of work rhythm and work-life boundaries, provided that implementation is well-thought-out and organizationally supported.

Analysis of selected reports indicates that AI has the potential to significantly reduce employee workload and improve workflow. Implementation conditions are crucial to achieving these results, including organizational preparation, training, a work culture that supports autonomy, and active employee participation in the tool adaptation process. When these conditions are met, AI can contribute to increasing employees' time and cognitive resources, reducing the burden of routine tasks, and improving work-life balance.

Risks, inequalities and conditions affecting well-being – the importance of the implementation context

As AI-based technology implementations become more popular, so too does the number of signals pointing to potential threats, inequalities, and negative impacts on employee well-being. The impact of AI at work is strongly dependent on the implementation context and organizational conditions, as previously noted. A Deloitte report shows that organizations that invest in AI and, in parallel, in employee training experience increased productivity and reduced routine task burdens. However, companies without appropriate training strategies and process preparation risk that AI will increase pressure and a sense of overload among employees, especially in departments less prepared to use generative tools (Delloite, 2024). A study published by Microsoft & LinkedIn points to significant inequalities in employee access to AI.

Although a significant portion of employees use it in their daily tasks, significant variations still exist depending on the role, level of digital competence, and type of tasks performed. The potential for reducing workload and better organization of working time is not equally available, which may deepen inequalities and a sense of injustice among employees (Microsoft & LinkedIn, 2024). The increasing automation of routine tasks and a shift in competencies towards critical thinking, creativity, and the ability to collaborate with technology are a significant factor in the transformation of work. However, such a shift may exclude employees with lower qualifications or in roles less supported by AI, leading to increased job insecurity, a sense of lack of control over work schedules, and cognitive stress. From the perspective of WLB, this means potential inequalities in the benefits of automation and opportunities for better work time management (WEF, 2023). Additionally, the results of the EY report entitled "Work Reimagined 2025" indicate that although 88% of respondents declare support from AI in everyday tasks, currently only a small percentage, approximately 5%, uses AI in an advanced way that maximizes its benefits (EY, 2025). This discrepancy between declarations and actual use suggests that without a proper adaptation strategy and organizational support, the potential of AI remains largely untapped, which reduces the chance of real support for WLB. The OECD emphasizes that the effects of AI on employee well-being depend on organizational policies, work culture, and supervision over the use of tools. The report indicates that the lack of transparent rules for the use of AI, monitoring workload, and support for competence development can lead to inequalities in access to AI benefits, increase pressure and the risk of burnout, and limit the sense of control over one's own working time (OECD, 2023). The CIPD recommends creating policies and rules for the use of AI, including monitoring tasks and schedules, to counteract inequalities and excessive workload. The lack of such a policy can lead to a situation in which AI operates inconsistently across departments and roles, which negatively impacts well-being, satisfaction, and flexibility in work (CIPID, 2025). PwC points out that automating routine tasks promotes increased job satisfaction and quality, but only when implemented thoughtfully and with employee needs in mind. Lack of such preparation increases the risk of inequalities in the benefits of AI and may also worsen work-life balance if tasks are shifted or the workload is concentrated on less advantaged groups (PwC, 2025).

While AI, with the right approach, can indeed support work reorganization and reduce employee workload, there are many prerequisites that must be met, including an appropriate implementation strategy, training, fair management, sensitivity to inequalities, and a concern for privacy and autonomy. Without these, the risks associated with work intensification, loss of autonomy, inequality, and stress may outweigh the benefits.

The importance of organizational, cultural and procedural conditions for effective AI implementations in the context of work -life balance

An analysis of international reports shows that the impact of artificial intelligence on work-life balance depends primarily on the quality of an organization's preparedness, not just on the availability of technology. Deloitte points out that companies are still struggling with the gap between the rapid development of tools and the ability to implement them safely and effectively. Key barriers include a lack of trust in results, data-related risks, and insufficient employee competencies (Deloitte, 2024). McKinsey emphasizes that only 1% of leaders rate their organizations as mature in integrating AI into work processes, despite the majority of employees being ready to use these solutions (McKinsey, 2025).

EY highlights the discrepancy between high levels of AI adoption (88% of employees) and organizations' low preparedness to utilize its potential – only 28% of companies have implemented appropriate talent and training strategies. The lack of support and clear policies leads to increased workload and technological stress (EY, 2025). Similar conclusions emerge from a Microsoft & LinkedIn report, which shows that 78% of employees use bring-your-own-AI (BYOAI) tools, often beyond the organization's control. The lack of policies in this area increases the risk of security breaches and blurs the lines between work and personal life (Microsoft & LinkedIn, 2024).

At the same time, OECD research indicates that employee training and consultation are crucial for building trust and mitigating concerns about algorithmic surveillance. Organizations that involve employees in the implementation process achieve better results in terms of work quality and well-being (OECD, 2023). The CIPD recommends creating clear rules for the use of AI, covering ethics, privacy, and transparency, which reduces technostress and strengthens a sense of control (CIPD, 2025). PwC data shows that companies that treat AI as part of their growth strategy, rather than simply a cost-cutting tool, achieve higher productivity growth and develop employee competencies more quickly (PwC, 2025). A study by Brynjolfsson, Li, and Raymond shows that the use of generative AI can increase productivity by approximately 15%, especially among less experienced employees, improving service quality and reducing stress (Brynjolfsson, Li, Raymond, 2025).

As the above suggests, AI can support work -life balance if implementations are based on a clear strategy, consistent governance, a culture of participation, and investment in competencies. Otherwise, the risk of pressure, a sense of surveillance, and a blurring of work boundaries increases. Organizations that integrate AI into processes in a structured manner, monitor the impact on well-being, and communicate implementation goals achieve lasting benefits in both employee productivity and quality of life (Deloitte, 2024; EY, 2025; McKinsey, 2025; Microsoft & LinkedIn, 2024; OECD, 2023; PwC, 2025).

5. Research results and conclusions - a conceptual model of the impact of artificial intelligence (AI) on work-life balance (WLB)

The analysis, based on four dimensions: task automation, potential for relief, risk and inequality, and organizational conditions, allowed us to compare the data from the reports with key WLB theories. The results confirm the mechanisms described in the concept of role conflict and enrichment (Greenhaus, Beutell, 1985). AI can reduce cognitive load and shorten working hours, which promotes role enrichment, but in the absence of clear rules and support, it leads to blurred boundaries and role conflict (EY, 2025; Microsoft & LinkedIn, 2024). From the perspective of the conservation of resources theory (Hobfoll, 1989) and the work-home resources model (ten Brummelhuis, Bakker, 2012), AI acts as a factor of resource gain or loss, where training and governance enhance resources, while implementation chaos and technostress deplete them (OECD, 2023; Deloitte, 2024). In turn, the self-determination theory (Deci, Ryan, 1985) highlights the importance of autonomy and competences, which can be supported by AI if implementations are participatory and transparent (CIPD, 2025).

Combining these findings with empirical data allowed us to develop a conceptual model of AI's impact on WLB, which considers both positive mechanisms (automation, flexibility, and workload reduction) and negative ones (technostress, supervision, and boundary blurring), as well as the role of organizational, cultural, and procedural moderators. This model demonstrates that the effect of AI on work-life balance is not deterministic but depends on the quality of the implementation context (Figure 1).

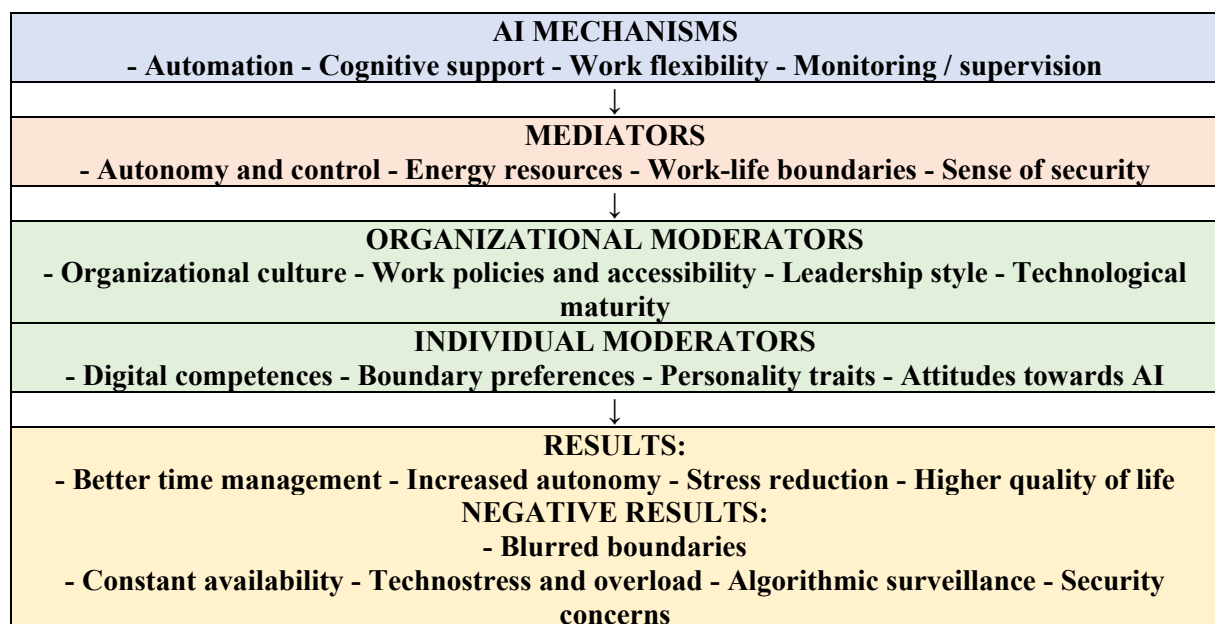


Figure 1. Conceptual model of the impact of artificial intelligence (AI) on work-life balance (WLB).

Source: own study.

The proposed conceptual model assumes that the impact of AI on WLB is not linear or one-dimensional, but rather represents a dynamic interaction between technological mechanisms, psychological processes, organizational context, and individual employee characteristics. The model demonstrates that AI technologies can be both a resource and a source of threats to well-being, and that the ultimate effect depends on a combination of factors operating at various levels.

In the first stage of its impact, AI operates through four main technological mechanisms: automation, cognitive support, work flexibility, and algorithmic monitoring. These mechanisms redefine workflows, influencing the structure of time, the scope of responsibilities, and the employee's relationship with technology. Automation reduces task burden and can shorten working hours, while cognitive support relieves mental strain, aiding decision-making and limiting information overload. Flexibility, in turn, fosters greater freedom in organizing work time and adapting it to personal needs, which is the foundation of the modern concept of work-life balance. Simultaneously, algorithmic monitoring can generate pressure, reduce autonomy, and increase technological stress, thus disrupting WLB.

These mechanisms then activate a complex set of mediating processes that explain how AI technologies impact individual employee experiences. Autonomy plays a central role here, being a key determinant of well-being according to self-determination theory (Deci, Ryan, 2000). AI can enhance this autonomy by offering greater flexibility and reducing the number of routine tasks, but it can also undermine it through surveillance and algorithmic control. The second key mediator is energy resources, understood in light of the Conservation of Resources Theory (Hobfoll, 1989). Reducing cognitive load and automating routine activities increase employee resources, while the need to constantly adapt to new tools and information overload may reduce them.

The third mediator is control over work-life boundaries, which determines the degree of role permeability and the ability to maintain balance between these spheres. AI can support boundary segmentation by reducing working time, but it can just as easily blur them through constant digital accessibility and synchronous contact functions. Another mediating process is a sense of technological and professional security, particularly in the context of automation and algorithmic assessment systems. Fears of job loss, lack of competence, or being assessed by the system can significantly reduce well-being and disrupt balance.

The effect of mediators is then modulated by a series of moderating factors, divided into organizational and individual levels. At the organizational level, organizational culture is crucial, as it can foster trust and sustainable use of technology or reinforce a culture of control and pressure. Equally important are work and digital accessibility policies, which regulate the boundaries of AI use and protect employees from excessive burden. The leadership style and technological maturity of an organization influence whether AI is perceived as a support tool or a control mechanism. At the individual level, digital competencies, preferences for role

segmentation or integration, personality traits, and attitudes toward technology are crucial. These elements determine susceptibility to technological stress and readiness to adapt.

Ultimately, the combination of these factors leads to specific WLB outcomes, which can be positive or negative. On the positive side, we see: more effective time management, greater autonomy, reduced cognitive load, and improved quality of private life. On the negative side, we see: blurring of the work-life boundary, increased technostress, a sense of surveillance, and job insecurity. The model thus highlights the fundamental ambivalence of AI technology and its dependence on the implementation context.

The entire model presents a logic in which technology is neither clearly beneficial nor clearly harmful, but becomes a contextual variable whose effects depend on the method of implementation, the quality of organizational support, the maturity of the work culture and the individual perception of the employee.

6. Discussion

Analysis of the results in light of work -life balance theory shows that the impact of AI is complex and depends on the organizational context. From the perspective of role conflict and enrichment (Greenhaus, Beutell, 1985), AI can work in two directions. On the one hand, the automation of routine tasks and the reduction of cognitive load promote role enrichment, freeing up time and energy for tasks requiring greater concentration. Field studies confirm an increase in productivity of approximately 15% after the implementation of generative tools, especially among less experienced employees (Brynjolfsson, Li, Raymond, 2025). On the other hand, the lack of clear rules for using AI and insufficient organizational preparation lead to role conflict - blurring work boundaries, pressure for constant availability, and increased technostress (EY, 2025; Microsoft & LinkedIn, 2024).

The perspective of boundary control emphasizes the importance of policies and governance. Reports show that the BYOAI phenomenon (78% of employees use their own tools) without regulation increases the risk of security breaches and hinders the separation of work and private life (Microsoft & LinkedIn, 2024). Organizations that implement clear policies, audit usage, and integrate AI into processes strengthen the sense of control and mitigate negative impacts (Deloitte, 2024; CIPD, 2025).

In light of the Conservation of Resources Theory (COR) (Hobfoll, 1989) and the Work -Home Resources Model (ten Brummelhuis, Bakker, 2012), AI can be a source of resource gains-time, energy, and competencies-if implementations are supported by training and work redesign. Otherwise, resource losses occur, including uncertainty, technological stress, and additional burdens (OECD, 2023; EY, 2025). PwC data shows that organizations that treat

AI as part of their growth strategy, not just cost reduction, achieve higher productivity growth and develop competencies more quickly, which promotes work rhythm stability (PwC, 2025).

From a Self-Determination Theory (SDT) perspective (Deci, Ryan, 1985; Ryan, Deci, 2000), AI can support the needs for autonomy and competence if employees have a say in how it is implemented and access to training. Participation and communication of “AI as support” enhance a sense of agency, while implementations perceived as a tool of control reduce well-being (OECD, 2023; CIPD, 2025).

In summary, AI can reduce role conflict and enhance resources if organizations provide clear rules, training, and a collaborative culture. Otherwise, the technology becomes a source of pressure and loss of control over boundaries. The results support the need to design implementations in the spirit of resource-based theory and self-determination, with well-being metrics alongside productivity.

7. Summary

The aim of this article was to examine how AI-based solutions can support work-life balance and the challenges associated with their implementation in organizational practice. Through a literature review and analysis of existing data, the research objective was achieved, identifying both the potential benefits and risks of implementing AI in the workplace. The results confirm that the impact of technology on work-life balance is complex, multidimensional, and largely dependent on the quality of the implementation context. Under favorable conditions, AI can relieve employees by automating repetitive tasks, reduce cognitive load, and increase work flexibility. This, according to the Conservation of Resources theory and the Work-Home Resources model, promotes role enrichment and the accumulation of personal resources. In organizations with high digital maturity, this technology supports well-being, enabling more effective time management, improved interaction quality, and reduced stress associated with excessive responsibilities.

At the same time, the analysis reveals that improper AI implementation can lead to counterproductive outcomes. A lack of clear rules of use, insufficient training, low competency awareness, and grassroots BYOAI (Bring Your Own AI) practices foster technostress, uncertainty, and a sense of over-supervision. These phenomena weaken control over role boundaries, exacerbate work-life conflict, and can lead to systematic resource depletion, which is supported by the mechanisms described in the concepts of role conflict and enrichment, boundary theory, COR resource theory, and self-determination theory. As a technology with dual potential, AI can therefore equally enhance autonomy and well-being, as well as limit them, depending on the organizational culture and principles under which it is utilized.

Therefore, a key requirement for the effective and responsible use of AI is its humanization. This includes ethical design, transparent implementation, linking it to a digital well-being policy, and building a mature governance environment. Organizations that treat AI not as a cost-cutting tool but as a component of their growth strategy are more likely to leverage its potential to create flexible, trusted, and sustainable work models. However, this requires consistent efforts to develop digital skills, educate users, and regularly monitor the technology's impact on employees, so that early signals of overload or declining well-being can be appropriately addressed.

Although the recommendations presented so far are general principles, their effectiveness depends on their translation into concrete actions. In the area of public policy, introducing the right to “disconnect” in an AI-supported work environment is crucial, as it helps protect the boundaries between work and private life. Regulations regarding algorithm transparency are equally important to reduce the risk of excessive control and stress associated with automated performance monitoring. Such solutions are cited in OECD and WEF reports as a foundation for sustainable technology implementation. At the organizational level, it's worth initially focusing on solutions that are relatively simple and support employee well-being without the risk of excessive control or pressure. An example would be allowing employees to customize settings in AI tools, such as notification times or task presentation preferences. Such features enhance a sense of autonomy and allow for better management of the boundaries between work and private life. Fostering a culture where AI is viewed as a support, not a control tool, is also crucial. This could include training demonstrating how technologies facilitate work organization and free time planning, rather than increasing workload. Such actions are easy to implement and consistent with the idea of role enrichment and border protection, which international reports indicate is crucial for well-being in the era of digital transformation.

Further research is warranted, particularly through longitudinal and experimental studies that will capture the dynamics of changes in work-life balance. Comparing different technology management strategies across diverse sectors and organizational types is also crucial to identify models that best promote well-being. The findings of this study point to directions and mechanisms worth exploring in the future, providing a starting point for in-depth reflection on the role of AI in shaping more inclusive, responsible, and sustainable work environments.

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THE IMPACT OF PENSION FUNDS ON THE FINANCIAL PERFORMANCE OF PORTFOLIO COMPANIES

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Purpose: The purpose of this study is to examine the impact of pension funds on the financial performance of portfolio companies. It is particularly important to determine whether an increase in pension fund participation at general shareholder meetings leads to a mitigation of agency conflicts and thus to an improvement in the financial performance of portfolio companies.

Design/methodology/approach: The study covered 72 non-financial companies included in the investment portfolio of the largest pension funds. These were companies listed on the Warsaw Stock Exchange for at least six years, i.e. from 2016 to 2021. The adjusted return on assets ratio was adopted as a measure of financial performance. Three models were estimated, each using a different set of control variables.

Findings: It was found that the total share of pension funds at general shareholders' meetings has a positive and statistically significant effect on the adjusted return on assets of the portfolio companies. By exercising their voting rights at general meetings, pension funds exert effective control over the portfolio companies. The findings provide evidence supporting the hypothesis of effective monitoring of portfolio companies by pension funds.

Research limitations/implications: The conducted research is of a pilot nature. Further research should incorporate a larger number of portfolio companies and a broader set of control variables. Moreover, it would be worthwhile to examine whether the relationships under study may be of a non-linear character.

Practical implications: The article provides arguments concerning the effectiveness of corporate governance exercised by pension funds. The findings are relevant for scholars working in this field, as well as for pension fund managers and both current and potential investors.

Originality/value: The added value of this paper lies in investigating the impact of pension funds on mitigating agency conflicts in portfolio companies. Important novel elements include the analysis of pension fund participation at general shareholders' meetings and the fundamental assessment of the financial performance of companies.

Keywords: pension funds, corporate governance, return on assets.

Category of the paper: Research paper.

Introduction

Pension funds constitute one of the most important groups of institutional investors in the Polish capital market. The significance of pension funds among institutional investors acquiring shares in listed companies increased markedly after another pension market reform in 2013 (Ustawa z dnia 6 grudnia 2013 r...., 2013).

Pension funds account for 20.6% of the market capitalisation of companies listed on the Warsaw Stock Exchange, and 41.8% of the *free float*. In contrast, the share of investment funds is respectively: 4.3% and 9% (NBP, 2022). Pension funds therefore have a substantially larger share in both market capitalisation and *free float* than investment funds.

Pension funds demonstrate a high level of engagement in corporate governance over the portfolio companies. This is evidenced by their significant participation at general shareholders' meetings and their active submission of resolution proposals at AGMs. The three largest pension funds (Sołdek, 2022a, 2022b, 2023; Szewc-Rogalska, Wąsacz, 2024) show a particularly strong involvement.

A distinctive feature of the institutionalisation of corporate ownership in Poland is the substantial share of pension funds in institutional ownership. Consequently, it is important to examine the implications of this process, especially to determine whether pension funds mitigate agency conflicts in listed companies. It is essential to assess whether, and to what extent, pension fund involvement in corporate governance contributes to improving the financial performance of portfolio companies.

Previous theoretical considerations and empirical studies on the Polish capital market have typically focused on assessing the role of institutional investors in corporate governance. Institutional investors were treated as a homogeneous group (Szewc-Rogalska, 2017; Bosek-Rak, 2019; Błoch et al., 2020; Kałdoński et al., 2020; Aluchna, Kuszewski, 2021a). In contrast, analyses of the importance of pension funds in corporate governance are relatively rare (Słomka-Gołębiowska, 2014; Sołdek, 2022a, 2022b, 2023; Szewc-Rogalska, Wąsacz, 2024). Existing research on the impact of pension funds on the financial performance of portfolio companies in Poland is limited. Furthermore, they only cover the years 2011-2016 and therefore do not reflect current conditions (Kałdoński, Jewartowski, 2024), or focus exclusively on market-based measures of financial performance (Szewc-Rogalska, 2024). This paper therefore attempts to fill this research gap.

The main objective of this study is to attempt to examine the influence of pension funds on the financial performance of portfolio companies. It is particularly important to determine whether an increase in pension fund participation at general shareholder meetings leads to a mitigation of agency conflicts and thus to an improvement in the financial performance of portfolio companies.

The added value of this work lies in analysing the impact of pension funds on mitigating agency conflicts in portfolio companies. Most previous studies adopt a market-based approach and use Tobin's Q as a measure of the market value of companies. An important innovative element of this study, however, is the focus on a fundamental approach and the examination of portfolio companies' return on assets (ROA).

The structure of the subsequent sections of the work is as follows. The second part of the paper presents a literature review and an analysis of existing research findings. The third part outlines the research methodology. The fourth section presents the empirical research results followed by a discussion in section five. The final part of the study provides a summary, research limitations, and directions for further studies.

Literature review

Pension funds are classified as institutional (financial) investors. The literature offers various definitions and approaches to institutional investors. However, the most common approach includes pension funds, investment funds, insurance companies, and banks within this group (Ferreira, Matos, 2008; Sahut, Gharbi, 2010; Elyasiani, Jia, 2010). The main task of pension funds is to provide a special category of services, including the financing of pensions, medical treatment, and compensation for accidents (Sopoćko, 2005). The assets accumulated by pension funds are frequently allocated to long-term investments. The structure of the investment portfolio of pension funds also contains shares of listed companies, with their share depending, among other factors, on the legal regulations of the pension system. The fiduciary nature of pension funds' activities gives them the grounds and the capacity to exercise effective corporate governance over the portfolio companies.

The theoretical foundations for analysing the impact of pension funds and other institutional investors on the financial performance of portfolio companies derive from agency theory (Jensen, Meckling, 1976; Shleifer, Vishny, 1997). According to the agency theory, two types of agency conflicts may arise. In the case of dispersed ownership, the conflict occurs between the principal and the agent, that is, between shareholders (investors) and the corporate managers. In contrast, in the case of concentrated ownership, the conflict arises between principals themselves, i.e. the conflict between majority and minority shareholders.

In both dispersed and concentrated ownership structures, there is a significant risk of the expropriation of minority shareholders. Managers and majority shareholders may extract private benefits of control (Leuz et al., 2003; Gopalan, Jayaraman, 2012). The occurrence of agency conflicts leads to various types of agency costs. Actual and alternative costs of agency lead to a reduction in the welfare of minority shareholders. Therefore, mitigating these agency conflicts is of key importance. A major role in this process is attributed to institutional investors,

particularly pension funds and investment funds. In research on the role of institutional investors in corporate governance, three hypotheses are formulated. The literature mentions the efficient-monitoring hypothesis, the conflict-of-interest hypothesis and the strategic-alignment hypothesis (Pound, 1988; Aluchna, Kuszewski, 2021a; Kulkarni, Hyderabad, 2023).

The efficient-monitoring hypothesis assumes that pension funds and other financial investors exercise effective corporate governance over portfolio companies. They invest substantial capital resources in these companies and possess extensive experience, professionalism, and access to information, enabling them to monitor portfolio company managers effectively. They have considerable expertise in investment management and frequently participate in making informed voting decisions at general meetings of shareholders. They are more competent in monitoring the performance of portfolio companies than dispersed shareholders. As a result, pension funds and other institutional investors can mitigate agency problems, which may lead to improved performance and higher value of portfolio companies (Kulkarni, Hyderabad, 2023).

The efficient-monitoring hypothesis therefore predicts a positive relationship between institutional investors' ownership and the performance of portfolio companies (Kulkarni, Hyderabad, 2023; Aluchna, Kuszewski, 2021a; Nagel et al., 2015; Mehrani et al., 2017). Effective corporate governance results in better operational performance and higher value of the companies, as well as a reduction in managerial tendencies towards overinvestment (Ferreira and Matos, 2008). Numerous studies support the efficient-monitoring hypothesis. These studies show a positive impact on financial investors, on the performance and value of portfolio companies (Thomsen, Pederson, 2000; Elyasiani, Jia, 2010; Yuan et al., 2008; Lin, Fu, 2017).

The conflict-of-interest hypothesis assumes that institutional investors such as banks and insurance companies are involved in portfolio companies as lenders, insurers and providers of financial service. This generates conflicts of interest and disrupts the monitoring role of these investors. As a result of the conflict of interest, in many cases they may side with the board. Business relationships between institutional investors and the managers of portfolio companies may lead to passivity and opportunism on the part of these investors. The strategic-alignment hypothesis assumes that institutional investors and company management will cooperate for mutual benefits, which may cause negative consequences for the performance of portfolio companies (Kulkarni, Hyderabad, 2023). According to the conflict-of-interest hypothesis and the strategic-alignment hypothesis, institutional investors do not have a positive impact on the management and performance of portfolio companies. Negative effects on the value of portfolio companies may be observed (Shin-Ping, Tsung-Hsien, 2008).

When testing these hypotheses, attention is drawn to the heterogeneity of institutional investors. Investment funds and pension funds are classified as institutional, independent investors, insensitive to pressure from the business environment. Business ties are primarily characteristic for such groups of institutional investors as banks and insurance companies.

They are treated as pressure-sensitive institutional investors (Ferreira, Matos, 2008; Sahut, Gharbi, 2010; Elyasiani, Jia, 2010).

The research shows that ownership by independent institutions has a positive and statistically significant effect on ROA and net profit margin. In contrast, the ownership by financial institutions such as banks and insurance companies has no significant impact on the increase in the value of companies (Ferreira, Matos, 2008). Also Firth et al. (2016) found that pressure-insensitive institutional ownership exerts a positive influence on the performance of these companies. Whereas pressure-sensitive institutional ownership has no positive effect on the performance of the companies examined.

Elyasiani and Jia (2010), on the other hand, concluded that so-called pressure-insensitive institutional investors have a stronger positive impact on investment return rate than pressure-sensitive institutional investors. Lin and Fu (2017) found that pressure-insensitive, foreign and large-shareholding institutional investors have a greater positive impact on company performance than pressure-sensitive, domestic and small-shareholding investors. Sahut and Gharbi (2010) identified a negative relationship between the share of pressure-sensitive institutional investors and Tobin's Q index.

The mechanisms through which pension funds and other institutional investors influence the performance of portfolio companies are highly complex. In addition to the aspects discussed so far, other factors must also be considered, such as the ownership structure of pension funds, the degree of involvement in corporate governance, the monitoring strategies employed, and the size of shareholdings. Woidtke (2002), for example, takes into account the ownership diversity of pension funds and distinguishes between private and public pension funds. The author verifies both the efficient-monitoring hypothesis and the political-influence hypothesis. The author finds that private pension funds positively impact the value of portfolio companies, whereas public pension funds have a negative effect. In the case of public pension funds, the mechanisms described by the political-influence hypothesis play a significant role.

Pension funds and other institutional investors may use different strategies to monitor portfolio companies, thus distinguishing between active and passive investors. Active investors are interested in exercising control and – through active participation in general shareholder meetings – can apply a voting strategy. Passive investors, on the other hand, often limit themselves to employing an exit strategy from portfolio companies (Adamska, Urbanek, 2014). Aluchna and Kuszewski (2021a) distinguish between control-oriented financial investors (shareholdings of 10% or more) and portfolio-oriented financial investors (shareholdings below 10%). They found that ownership by control-oriented financial investors has a positive effect on the value of companies. Whereas ownership by portfolio-oriented financial investors has no significant impact on the value of companies.

The role of pension funds in corporate governance may depend significantly on the size of their shareholdings. It is assumed that minority shareholders generally adopt a short investment horizon and tend to focus on short-term gains. They adopt a passive attitude and are not

interested in exercising direct corporate governance. In contrast, majority shareholders tend to have a longer investment horizon, adopt a proactive attitude and are interested in monitoring portfolio companies. The high concentration of ownership enables them to internalise most of the benefits achieved by monitoring the portfolio company managers (Sundaramurthy et al., 2005; Cornett et al., 2008).

Accordingly, depending on the size of their shareholdings, the shareholders may display different attitudes and strategies. For example, Sahut and Gharbi (2010) found that in the French market, the impact of total institutional ownership on Tobin's Q is non-linear. For smaller shareholdings, a negative relationship was observed, whereas – after a certain threshold had been exceeded – a positive relationship emerged. The findings indicate that, in the case of large institutional shareholdings, an efficient-monitoring strategy is pursued.

However, excessive ownership concentration may be detrimental. Once a certain threshold is exceeded, an entrenchment effect becomes apparent (Claessens et al., 2002). This is confirmed, among others, by Jiao and Ye (2013), who found that the relationship between the share of public pension funds in the equity of portfolio companies and company performance was positive when these funds had moderate shareholdings. In contrast, when pension funds had very large shareholdings, different effects were observed.

Previous empirical research has not produced conclusive results concerning the impact of institutional investors, particularly pension funds, on the financial performance of portfolio companies. This is attributable to the complexity of corporate governance mechanisms and the diversity of institutional investors. Moreover, studies adopt various measures of the financial performance of portfolio companies. The most common is the Tobin's Q ratio, which reflects financial performance from a market perspective. In contrast, fewer studies consider measures of financial performance from a fundamental perspective (e.g. return on assets). Therefore, this paper examines pension funds as a specific group of institutional investors and focuses on one corporate governance mechanism – active participation at general meetings of shareholders. Additionally, it investigates the influence of pension funds on the financial performance of portfolio companies from a fundamental perspective.

Research methods

The research sample consisted of non-financial companies included in the investment portfolios of the two largest pension funds (as at 2021). In 2021, the largest pension funds in Poland were: Nationale-Nederlanden OFE and Aviva OFE Aviva Santander. Their total share of the pension fund market amounted to almost 48%. Nationale-Nederlanden OFE held shares in 38.8% of the companies listed on the Warsaw Stock Exchange, while Aviva OFE Aviva Santander held shares in 27.2% of listed companies (Szewc-Rogalska, Wąsacz, 2024).

The research covered non-financial companies over which the above pension funds exercised corporate governance, among other things through participation at general meetings of shareholders (as at 2021). The analysis included companies listed on the Warsaw Stock Exchange for at least six years, i.e. between 2016 and 2021. A total of 72 companies met these criteria. It should be emphasised that the selected companies represented 33.3% of all listed companies in which open pension funds operating in Poland held shares. Cases with incomplete or unavailable data were excluded. In addition, extreme outliers were removed, i.e. where return on assets was below -100% or above 100%, and where the return on sales exceeded 300%. The final number of panel data (company / year) was 360 observations.

It should be clarified that the study period 2016-2021 was selected due to the construction of the sample based on the composition of pension fund portfolios in 2021. Including six consecutive years retrospectively allows the long-term nature of corporate governance exercised by pension funds to be captured. Moreover, the adopted time horizon covers a period of significant institutional and macroeconomic changes, which makes it possible to assess the robustness of the obtained results.

The financial statements of the companies examined were obtained from the Emerging Markets Information Service Poland (EMIS Poland) database. Information on the shareholder structure at general shareholders' meetings was collected on the basis of the announcements of the general shareholders' meetings. This required extensive work and the construction of a database of announcements published on financial portals such as *bankier.pl* and *money.pl*.

Table 1 presents the variables used in the analysis. The following categories of variables were distinguished: firm performance variable, ownership structure variable, firm-level control variables and robustness test variables.

Table 1.
Variables used in the analysis

Variables	Variable description
Firm Performance Variable	
ROAadj	Sector-adjusted and time-adjusted return of assets ratio (w %)
Ownership Structure Variable	
TOTAL PF	Total share of pension funds in the total number of votes at the general meeting of shareholders (%)
Firm-level Control Variables	
Ln(Assets)	The natural logarithm of total assets (total assets in thousands of PLN)
SALES GROWTH	Growth rate in net sales (w %)
CASH/Total Assets	Cash and short-term investments divided by total assets (w %)
CAPEX/Total Assets	Capital expenditures divided by total assets (w %)
Robustness Test Variables	
Ln(DEBT)	The natural logarithm of total debt (total debt in thousands of PLN)
LEVERAGE	Total debt divided by total assets (w %)

Source: Author's own creation.

Return on assets (ROA) was adopted as a measure of financial performance (Homanen, Liang, 2018). An adjustment procedure was applied to the ROA ratio based on the median value (Vintila et al. 2014; Aluchna, Kuszewski, 2021b). For ROA, the procedure is as follows:

$$ROAadj_{it} = ROA_{it} - medianROA_{SE,t}, \quad (1)$$

where:

$i = 1, 2, \dots, 72$,

$t = 1, 2, \dots, 6$,

SE – the sector to which the company belongs.

The adjusted ROA value was calculated as the difference between the original ROA of a company and the median ROA in a sector for a given year. The research took into account how the companies are grouped according to the classification used by the Warsaw Stock Exchange (GPW, 2022). Seven sectors were distinguished:

- fuels and energy,
- chemicals and raw materials,
- industrial and construction production,
- consumer goods,
- trade and services,
- health care,
- technology (software, information systems).

The variable describing ownership structure was defined as the share held by all pension funds participating at general meetings of shareholders. Their percentage share in the total number of votes in the analysed companies was calculated. This approach to assessing shareholder involvement is particularly justified for the Polish capital market (Szewc-Rogalska, 2012), which is characterised by greater concentration of control than of ownership (Adamska, 2013).

Firm-level control variables were also used, i.e. asset size (Sahut, Gharbi, 2010; Mishra, Modi, 2013; Lin, Fu, 2017; Aluchna, Kuszewski, 2021a), SALES GROWTH, CASH/Total Assets, CAPEX/Total Assets (Homanen, Liang, 2018). The variable $\ln(\text{Assets})$ is often regarded as one that may give rise to endogeneity problems (Aluchna, Kuszewski, 2021a, 2021b). Therefore, in the estimation of one of the models, this variable was omitted to see whether its exclusion would affect the results obtained. In addition, a robustness check was carried out to determine the extent to which the findings are resilient to alternative measures. Robustness tests were carried out with respect to different control variables, specifically $\ln(\text{DEBT})$ and LEVERAGE level (Aluchna, Kuszewski, 2021a; Huang et al., 2007; Elyasiani, Jia, 2010; Kałdoński et al., 2020).

For each variable, basic statistics were calculated, including mean, median, standard deviation, minimum value, maximum value and skewness. Panel A reports descriptive statistics prior to the winsorisation of the variables, while Panel B presents the statistics after winsorisation. All variables were winsorised at the 1st and 99th percentiles. This method is widely applied in the corporate finance literature (Homanen, Liang, 2018; Leone et al., 2019;

Carline et al., 2024). The use of winsorisation improves the stability of parameter estimates in regression models. The models were first estimated using the data from Panel A, followed by additional estimations based on the data from Panel B. This procedure allowed for an assessment of the robustness of the estimation results to outliers observations.

Subsequently, the appropriate form of the panel model was selected. The following models were considered (Kufel, 2013; Verbeek, 2017):

- a panel model (without distinguishing individual effects), estimated using the classical least squares method,
- the fixed effects model (FEM),
- the random effects model (REM).

In order to select the appropriate panel model form, the following statistical tests were applied: the Chow F-test, the Breusch-Pagan test, and the Hausman test (Maddala, 2006; Kufel, 2013). In addition, the Wald test for heteroscedasticity was performed (Maddala, 2006). Based on this, it was determined that the heteroscedasticity of the model random component was present in the models, what was corrected by introducing robust standard errors (robust HAC). The statistical calculations were carried out using the GRETTL programme.

Results

Table 2 presents the basic statistics for all variables. The total participation of the pension funds at the general meetings of shareholders in the companies under study ranged from 2.2% to approximately 66.4% of the overall number of votes (Panel A). It should be noted that listed companies publish information on their shareholders holding at least 5% of the votes represented by investors at the general meeting of shareholders. At the same time, there may be isolated cases in which a shareholder holds at least 5% of the votes at the annual general meeting but their share in the total number of votes is below 5%.

The total share of pension funds in the overall number of votes at general meetings of shareholders was approximately 16.7%. The median was around 14.3%. The distribution of pension fund holdings was right-skewed, meaning that for most companies examined, the total share of pension funds was lower than the average.

The mean values of the variables included in the analysis were higher than the medians. Only the LEVERAGE variable was an exception. The variables considered in the analysis exhibited right-skewness (except for LEVERAGE). Right-skewness was particularly pronounced for two variables, namely ROAadj and CASH/Total Assets.

Panel B presents descriptive statistics for the winsorised variables. Winsorisation reduced the influence of outliers and led to a decrease in the skewness of most of the analysed variables, especially ROAadj, CASH/Total Assets, and SALES GROWTH.

Table 2.*Variables used in the analysis*

Variables	Average	Median	Minimum value	Maximum value	Standard deviation	Skewness
Panel A: Data prior to winsorisation						
ROAadj	0.371	0.000	-54.475	86.600	11.599	3.215
TOTAL PF	16.741	14.255	2.210	66.350	10.977	1.675
Ln(Assets)	13.748	13.644	10.237	18.486	1.522	0.742
SALES GROWTH	9.197	7.473	-89.528	194.490	27.579	1.558
CASH/Total Assets	10.104	5.885	0.000	73.107	10.862	2.290
CAPEX/Total Assets	4.475	3.596	-12.797	20.583	4.809	0.351
Ln(DEBT)	12.913	12.857	7.794	17.808	1.786	0.101
LEVERAGE	48.080	49.004	2.650	91.045	18.418	-0.077
Panel B: Winsorised data at the 1 st and 99 th percentiles						
ROAadj	0.159	0.000	-28.938	49.169	8.667	1.509
TOTAL PF	16.728	14.255	3.834	59.610	10.887	1.626
Ln(Assets)	13.748	13.644	10.688	17.944	1.509	0.737
SALES GROWTH	8.914	7.473	-58.043	104.170	24.711	0.803
CASH/Total Assets	9.983	5.885	0.000	48.472	10.317	1.946
CAPEX/Total Assets	4.479	3.596	-8.313	17.598	4.709	0.400
Ln(DEBT)	12.912	12.857	8.307	17.116	1.769	0.098
LEVERAGE	48.092	49.004	7.704	86.745	18.265	-0.068

Source: original studies.

Following the methodology outlined in the previous section of this paper, it was established that a fixed-effects panel model should be selected. For both Panel A and Panel B, the models were estimated using different sets of control variables (Table 3).

Table 3.*Fixed-effects panel models for ROAadj in companies with pension funds, among the shareholders (robust HAC)*

ROAadj	Panel A			Panel B		
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
TOTAL PF	0.135** (0.055)	0.137** (0.056)	0.123** (0.060)	0.126** (0.055)	0.122** (0.055)	0.119* (0.060)
Ln(Assets)	0.165 (2.006)	X	X	-0.392 (1.569)	X	X
SALES GROWTH	0.056** (0.023)	0.056** (0.022)	X	0.063*** (0.021)	0.063*** (0.021)	X
CASH/Total Assets	0.120 (0.097)	0.119 (0.093)	X	0.132 (0.079)	0.133* (0.079)	X
CAPEX/Total Assets	-0.007 (0.149)	-0.008 (0.152)	X	0.002 (0.136)	0.005 (0.141)	X
Ln(DEBT)	X	X	3.177** (1.521)	X	X	2.664** (1.327)
LEVERAGE	X	X	-0.325*** (0.096)	X	X	-0.283*** (0.076)
Const	-5.852 (27.923)	-3.596** (1.664)	-27.093* (15.895)	1.561 (21.326)	-3.801** (1.455)	-22.603 (14.490)
Number of observations	360	360	360	360	360	360
LSDV R-square	0.768	0.768	0.774	0.707	0.707	0.707
Within R-square	0.080	0.080	0.103	0.107	0.106	0.107

Notes: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Source: original studies.

Based on the data from Panel A, models (1)–(3) were estimated. In estimating Model (1), four control variables were included: Ln(Assets), SALES GROWTH, CASH/Total Assets and CAPEX/Total Assets. Model (1) indicates that an increase in the total share of pension funds in the overall number of votes at the general meeting of shareholders exerts a positive and statistically significant effect on return on assets (ROAadj). Moreover, the sales growth rate (SALES GROWTH variable) significantly affects the increase in asset profitability in the companies examined.

In the estimation of model (2), the variable Ln(Assets) was omitted, as it is often considered as a variable causing endogeneity problems (cf. Aluchna, Kuszewski, 2021a, 2021b). The results obtained by using Model (2) were highly consistent with those obtained from Model (1). It was found that an increase in the total share of pension funds in the overall number of votes at the general meeting of shareholders exerts a positive and statistically significant effect on return on assets (ROAadj).

For model (3), a different set of control variables was applied, i.e. the variables Ln(DEBT) and LEVERAGE. The use of alternative control variables also confirmed the previous key results obtained from models (1) and (2). For Model (3), it was also established that the participation of pension funds at general meetings has a positive and statistically significant impact on the adjusted return on assets (ROAadj).

Based on the data from Panel B, models (4)–(6) were estimated. The results obtained from these models confirm that an increase in the aggregate share of pension funds in the total voting rights at the general meeting of shareholders exerts a positive and statistically significant effect on return on assets (ROAadj).

The coefficient for the variable TOTAL PF remains positive and statistically significant across all models. Its value is very similar between the models, indicating a high stability of the estimates. After applying a more restrictive treatment of outliers observations, the estimates remain stable in terms of sign and exhibit lower variability. A comparison of models (1)–(3) with models (4)–(6) indicates a high robustness of the estimation results. The coefficient values in the second set of models are slightly lower, but remain very similar across specifications. Moreover, the sign and economic interpretation of the effect do not change. The coefficients in models (4)–(6) show lower variability, which indicates greater robustness of the estimates after winsorising the variables.

Discussions

The conducted research shows that the aggregate participation of pension funds at general meetings of shareholders exerts a positive and statistically significant impact on the financial performance of portfolio companies. The estimation results of the six panel models – using

different datasets and sets of control variables – are consistent in terms of the direction and statistical significance of the relationships examined.

These findings suggest that pension funds participating at general meetings of shareholders are oriented towards exercising corporate governance in portfolio companies. By using their voting rights at general meetings, they perform effective control over the portfolio companies. The findings provide evidence supporting the hypothesis of effective monitoring of portfolio companies by pension funds.

The positive impact of institutional investors (including pension funds) on the financial performance of listed companies is also confirmed by the results of other studies (Ferreira, Matos, 2008; Elyasiani, Jia, 2010; Firth et al., 2016, Aluchna, Kuszewski, 2021a; Kulkarni, Hyderabad, 2023). It should be noted, however, that the cited studies analyse the aggregate share of institutional investors, whereas the present research focuses on pension funds. Moreover, different measures of the financial performance of portfolio companies were typically used.

The findings of the present study show that the relationship between the share of pension funds and the financial performance of portfolio companies can be described by a linear function. It was established that the positive impact of pension funds on the return on assets of portfolio companies occurs throughout the entire range of aggregate pension fund shareholdings at general meetings. In contrast, some other studies (Jiao, Ye, 2013; Szewc-Rogalska, 2024) have found that the relationship between the pension fund participation and financial performance may be non-linear. In the case of a non-linear relationship, the positive influence of pension funds is observed only within a certain range.

When comparing the results of this study with those of other authors, certain limitations must be taken into account. In this study, the adjusted return on assets was adopted as a measure of financial performance, whereas other studies included, i.a., return on stock (Jiao, Ye, 2013), Tobin's Q ratio (Szewc-Rogalska, 2024). This implies that different aspects of financial performance were taken into account. The present study considered financial performance from a fundamental perspective, while the cited studies approached it from a market perspective. It should be noted that in the latter approach, the financial performance of portfolio companies may depend to a greater extent – compared with the former approach – on the expectations and reactions of investors in the capital market. This may influence the varied nature of the relationships studied.

Conclusions

This paper attempts to examine the impact of pension funds on the financial performance of portfolio companies in Poland between 2016 and 2021. In this period, the key role was played primarily by the two largest pension funds, Nationale-Nederlanden OFE and Aviva OFE Aviva Santander. The research focused on active pension funds that exercised corporate governance over portfolio companies, including through their participation at general meetings of shareholders. It was found that the total share of pension funds at the general meetings of the companies under study amounted, on average, to 16.7%, while the maximum level reached 66.4%.

The conducted research indicates a linear relationship between the share of pension funds and the level of the adjusted return on assets in the companies examined. The estimation results of six models, conducted using different datasets and sets of control variables, demonstrate a positive and statistically significant impact of the aggregate share of pension funds on the financial performance of the companies analysed.

The findings show that the engagement of pension funds in corporate governance and their participation at general meetings of shareholders has positive effects. This implies that pension funds may play an important role in mitigating agency conflicts within portfolio companies. The findings provide evidence supporting the hypothesis of effective monitoring of portfolio companies by pension funds.

It is essential to continue research into the impact of pension funds on the financial condition of portfolio companies. The present study is a pilot study; therefore, future research should incorporate a larger number of listed companies and a different set of control variables. Moreover, it would be worth considering a more detailed analyses to verify whether the examined relationships may exhibit a non-linear character.

The findings have important implications for both theory and practice. The article is part of the discussion on corporate governance mechanisms in emerging markets. It provides evidence concerning the effectiveness of monitoring exercised by pension funds. It highlights the positive influence of pension fund activism on the return on assets of portfolio companies. The use of voting rights by pension funds at general meetings of shareholders leads to the mitigation of agency conflicts in listed companies. The article provides recommendations for policymakers regarding the support and improvement of the institutional environment.

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SUBVERSIVE REPERCUSSIONS OF THE *NEPO-BABY* PHENOMENON IN ORGANIZATIONAL MANAGEMENT: JOB SATISFACTION, EMPLOYEE WELL-BEING

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Purpose: The purpose of the study was to identify the negative consequences of the *nepo-baby* phenomenon in management by verifying the level of job satisfaction and the level of employee well-being among employees of SME companies in Poland.

Design/methodology/approach: The article is based on an empirical study using questionnaires to measure job satisfaction (MSQ) and to measure well-being (PWBS) among a study and a control group and their detailed statistical analysis. The topic area includes human resource management and work psychology.

Findings: The article presents the context of the negative effects of the *nepo-baby* phenomenon and shows that job satisfaction and well-being of employees are significantly lower in companies where respondents declared the phenomenon of *nepo-baby* than in those where it was not declared. The results are a starting point for further analysis of the effects of nepo-baby in organizational management.

Research limitations/implications: The study focused on the Polish SME sector in the Świętokrzyskie Voivodeship, so the results may be specific to this sector, and the sample was relatively small, which is the kind of limitation that makes the research conducted exploratory and preliminary. In the future, it is necessary to conduct a longitudinal study on a larger sample.

Practical implications: The results show that employees working in a *nepo-baby* environment have low job satisfaction and their wellbeing is also low. This shows that this phenomenon is not conducive to the development of the company and that it can be crucial. This research may lead to specific solutions to counteract the negative effects of the phenomenon. It is important to start by raising awareness that the company should be managed by qualified people and not by people with family connections, as this is detrimental to the company.

Originality/value: This is the first article to present the *nepo-baby* phenomenon directly and a study that examines employee job satisfaction and well-being in organizations where this phenomenon occurs.

Keywords: *nepo-baby*, management, negative consequences, job satisfaction, employee well-being.

Category of the paper: empirical and scientific research.

1. Introduction

Nepotism is a ubiquitous phenomenon, and while there have been many publications on it and it is generally a phenomenon eagerly addressed by various fields of study, the *nepo-baby* phenomenon itself is a relatively new concept in science. It is most often encountered in the literature as a term for the children of celebrities who, either through fame or their parents' achievements, become famous and wealthy themselves (Jones, 2023). Special attention was paid to the children of music celebrities, where it was investigated whether *nepo-babys* entered the music industry out of passion or rather out of a desire to take advantage of an easy money-making opportunity (Maziriri et al., 2024). And a recent article addressing the phenomenon juxtaposes it with meritocracy and asks respondents how they perceive the success and causes of *nepo-babys* in Hollywood (Foster, Maroto, 2025).

And while the focus on this phenomenon in the influencer, film, music or just celebrity-related industries in general is high (Becsek, 2025) it is in the context of organizational management that little is yet known about it and there are very few publications in this area (Foster, Maroto, 2025). And since nepotism in itself is a mechanism significantly affecting the fate of the enterprise, it can be assumed that the phenomenon of *nepo-baby* in management, which is, as it were, a detailed distinction of it, also significantly affects the dynamics and organizational culture of the enterprise. Including already on the basis of existing literature, it can be surmised that job satisfaction of employees who are managed by *nepo-babys* may be inadequate (Rasheed et al., 2025) and that employee well-being company where nepotism is present may be significantly worse than those where it is not (Lasisi et al., 2022). Given these statements, it seems reasonable to specifically examine the *nepo-baby* phenomenon's impact on these two factors among workers.

2. Importance of the *Nepo-baby* phenomenon in management

The *nepo-baby* phenomenon originates from the discourse treating celebrities and when it comes to presenting a definition of this phenomenon this must be the starting point. In the simplest terms, they are defined beginning with *nepo-babys* as the children of celebrities who are famous for the sake of their also famous parents. An example of such a person is *Hailey Bieber*, who is the daughter of *Stephen Baldwin*, a well-known American actor who starred in, among other things, *The Flintstones* (Jones, 2023). And while the definition of nepotism per se is even intuitively clear to everyone, it needs to be demarcated in some way from *nepo-babys* (Maziriri et al., 2024). *Nepo-baby* refers exclusively to people born into influential families and

can refer to a variety of industries who, by virtue of their origin, have better opportunities and are treated professionally in a favourable manner (Maziriri et al., 2024; cf. Crump, 2022).

However, this phenomenon does not only occur in relation to the world of celebrity, but also in politics and, above all what interests us from the point of view of this article, in management. And despite the fact that there are few publications specifically on the topic of *nepo-baby* in management, the phenomenon of nepotism itself is widespread in small and medium-sized enterprises. On this basis, it can also be surmised that the *nepo-baby* construct itself is also widespread and thus of considerable importance in the context of the course of the company's processes (Schilpzand et al.; cf. Perez-Alvarez, Strulik, 2021).

In the most general terms, it can be said that a *nepo-baby* is a person whose career path develops due to family connections usually in the same industry as the parent or parents, with particular consequences in terms of inequality in access to managerial positions (Foster, Maroto, 2025). This also includes people who start their careers in companies owned by their parents (Staiger, 2023) and heirs of these companies (Maziriri et al., 2024). This is because there, without qualifications and the necessary experience, they can hold high positions such as board member, president, director or manager just for the sake of being the son or daughter of influential people. According to another distinction, *nepo-babies* are those who, by virtue of their influential parents, have easier access to resources (Staiger, 2023) as well as persons benefiting from family ties (Padgett et al., 2015). In other words, such people have much higher opportunities than those who do not have such family connections and often, despite a lot of ability, effort, toil or qualifications, will never have the chance to match the *nepo-babys*. Furthermore, *nepo-babys* often do not seek to develop their skills or qualifications because they do not need them and their background alone guarantees them career success. One can also encounter opinions that if it were not for a certain kind of personal charm or effort on the part of the *nepo-babys*, they would not have had professional success, however, such an opinion appears mainly among themselves (Foster, Maroto, 2025). It should be noted that this distinction is very preliminary for this phenomenon, as the concept of *nepo-baby* is new in management and it should be assumed that it will expand over time. It is extremely important to be aware that in this case there is a clear conceptual immersion, i.e. *nepo-baby* itself can be treated as a substructure of nepotism, but at the same time it can be considered separately. Due to this fact, it is impossible to completely separate this concept from nepotism, as it derives from it.

In addition, it is also recognised that *nepo-babys* are also people who, despite the fact that they are apparently trying to shape their career, it is controlled by their parents, or they are more easily accepted in other companies for the sake of their influential parents. This means that even if people who are children of influential parents want to develop their careers on their own, their parents often extend an invisible protection over them that makes everything come more easily, or other people facilitate this path for them because they want to buy into their parents' favour. *Nepo-baby* refers exclusively to people born into influential families and can refer to

a variety of industries who, by virtue of their origin, have better opportunities and are treated professionally in a favourable manner (Staiger, 2023). One can also encounter the term *nepo-baby* for people who are not the children of influential parents but, for example, their relatives (Foster, Maroto, 2025). Due to the multiplicity of meanings, a complex distinction of this phenomenon in management has been developed on the basis of literature (Figure 1), which is presented below.

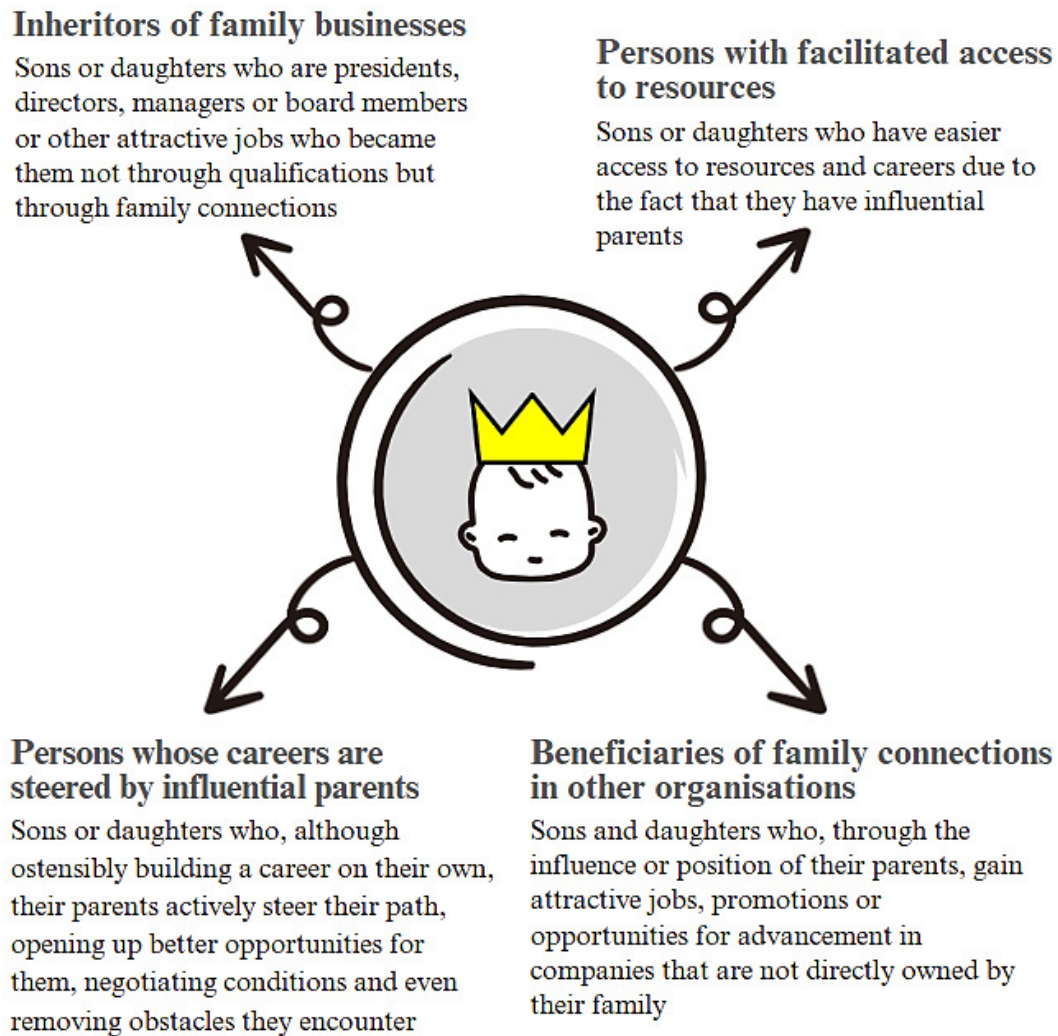


Figure 1. Complex distinction of *nepo-baby* in management.

Source: own elaboration

This distinction between types of *nepo-babies* is important because the phenomenon functions differently depending on the context in which it occurs and how it is initiated. For this reason, such an outline will allow for a better understanding of the forms this phenomenon can take.

3. Subversive repercussions of the *nepo-baby* phenomenon

The *nepo-baby* phenomenon, like nepotism, has a number of negative consequences for the company. Wypych-Dobkowska in the context of nepotism distinguishes three areas that encompass its negative consequences. The first level she distinguishes is the individual level. Wypych-Dobkowska in the context of nepotism distinguishes three areas that encompass its negative consequences. The first level she distinguishes is the individual level. The second area that stands out is that of team consequences, where nepotism leads to exacerbated conflicts and communication problems among the workforce. And the last dimension affected by nepotism is the organizational consequences. This leads to increased absenteeism and employee turnover. The quality of work and productivity decreases, which also leads to a worsening of the company's financial situation and image problems (Wypych-Dobkowska, 2010).

Given that *nepo-baby* is semantically embedded in nepotism itself, based on the literature available on the general phenomenon of nepotism, it can be assumed that the phenomenon of *nepo-baby* has similar effects. One of these is a decline in trust in institutions or superiors. (Becsek, 2025). Another issue is the fact that the phenomenon of nepotism carries the risk of interpersonal conflicts within the team, which significantly reduces not only morale but also employee efficiency (Akar, 2020). This undermines employees' belief in their own agency and in the fact that they can achieve something through hard work. In addition, it leads to employees resorting to dirty tricks, intrigue and manipulation in order to get promoted, or engaging in personal relationships with their superiors in order to achieve promotion or benefits. This has consequences for the organizational culture (Schilpzand, 2025).

In addition, the literature shows that the *nepo-baby* can disrupt organisational effectiveness and lead to a decrease in productivity and motivation among employees (Şeker, Karadayı, 2024). This phenomenon also leads to a lowering of ethical values and results in low employee morale. Because they feel that they have no chance of real promotion in such a structure and that there is no justice in this type of arrangement. In such a company, the rules of appraisal and promotion are diluted as a result of which employees learn that incompetence and close relationships and family connections are more important than real performance (Akar, 2020). In addition, this phenomenon exacerbates workplace inequalities and perpetuates elite structures (Foster, Maroto, 2025). It also results in talented employees being demotivated and more likely to leave the organisation due to impeded access to real promotion (Staiger, 2023). Unfortunately, most of the implications of this in the literature appear to be negative as shown below (Figure 2) on a six-arm model.

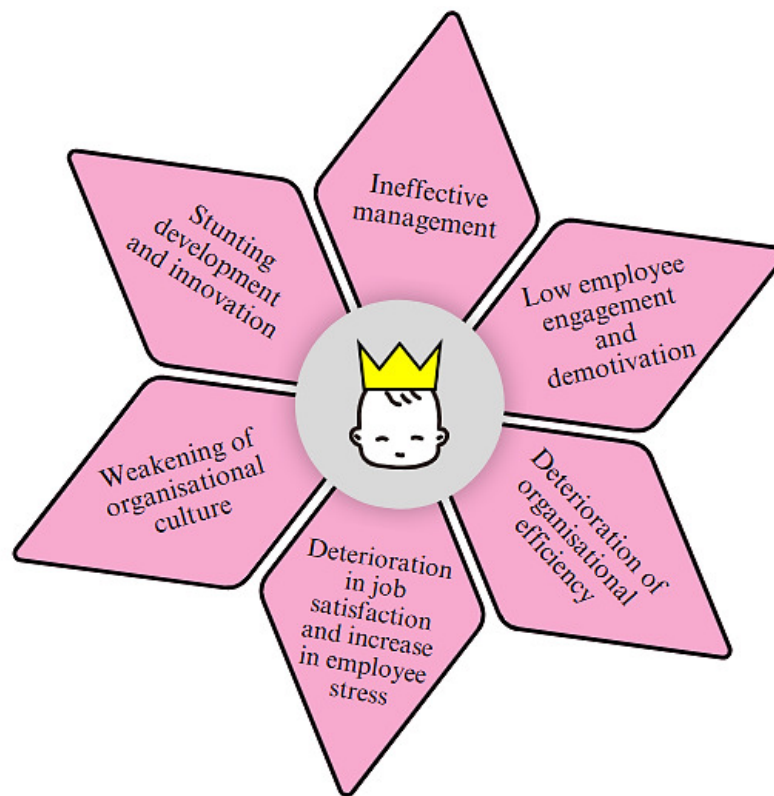


Figure 2. Six-arm model of negative *nepo-baby* effects in management.

Source: own elaboration.

In addition to this, the literature mentions that nepotism negatively affects employees' job satisfaction (Rasheed et al., 2025) and the very assumption that *nepo-baby* may lead to precisely this reduced job satisfaction of his subordinates (Lasisi et al, 2022). It is also a not insignificant phenomenon in terms of employee wellbeing. Indeed, research has already been carried out on the negative impact of nepotism on employee well-being hence it is highly likely that management specifically by *nepo-babies* also creates specific working conditions for employees (Lasisi et al., 2022). And this leads directly to the following hypotheses:

1. *In organizations where nepo-babies manage, job satisfaction of subordinates is low.*
2. *In organizations where nepo-babies manage the wellbeing of subordinates is at a low level.*

The conclusion is the literature provides premises leading to such assumptions. And their empirical testing may prove relevant to the definition of corporate management strategies and may lead to a broader discourse in this area. Particularly as the *nepo-baby* phenomenon in management is not yet widely exposed, it certainly has some impact on organizations and the human resources present.

4. Methodology

Two specialised questionnaires measuring well-being and measuring employee satisfaction were used for the study. It was an abridged version of MSQ (*Minnesota Satisfaction Questionnaire*) and an abridged version PWBS (*Psychological Well-Being Scales*) and were used in a research group comprising companies where the *nepo-baby* phenomenon occurred and in a control group where this phenomenon was not declared by respondents. The MSQ measures job satisfaction, with a Cronbach's α ranging from 0.84 to 0.92, indicating very good reliability. It consists of 20 questions where respondents answer using a five-point scale (Kukla et al, 2024). The PWBS, on the other hand, measures wellbeing and has a Cronbach's α coefficient of 0.79 - 0.93, which also indicates very good reliability (Karaś, Ciecuch, 2019). Both questionnaires have been adapted to Polish conditions and meet norms and standardization (Kukla et al, 2024; Karaś, Ciecuch, 2019). They can be used to measure individual subscales of these dimensions such as wellbeing or employee satisfaction however, the focus of this study is on the overall score i.e. the overall wellbeing score and the overall score and their juxtaposition and statistical analysis of both groups.

The survey procedures were preceded by the fact that groups were differentiated by filling in an initial metric declaring group membership based on observations of the occurrence of the *nepo-baby* phenomenon. The *nepo-baby* variable itself is a *quasi-independent* variable because it was a study with naturally occurring groups. The dependent variables in this study were wellbeing and job satisfaction. Prior to completing the questionnaires, the definition of *nepo-baby* was carefully explained to the study participants so that they could indicate which study group they belonged to. A total of 50 people took part in the study (half of the study group and the control group respectively) who were both male and female representatives of different jobs with different material status; however, these parameters were not controlled and were not taken into account. It is also worth noting that the companies came from the SME sector and were located in the Świętokrzyskie voivodeship.

5. Research results

The collected data from the empirical study were statistically analysed using the program *Jamovi*. A summary of the results of the job satisfaction variable (*MSQ*) and the employee wellbeing variable (*PWBS*) is presented below (figure 3-6).

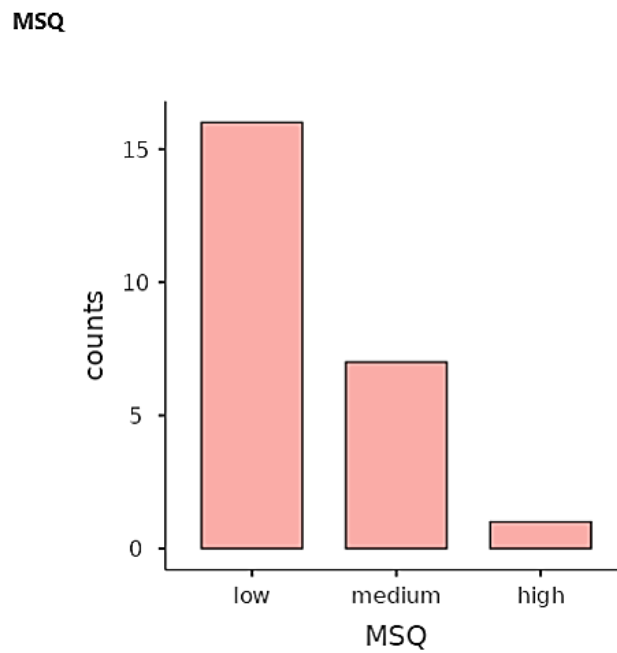


Figure 3. Summary of MSQ results for the study group.

Source: own elaboration based on *Jamovi*.

As can be seen in the figure 3 among the people in the research group, i.e. those in which the *nepo-baby* phenomenon occurred in the organisation, the level of job satisfaction was predominantly low.

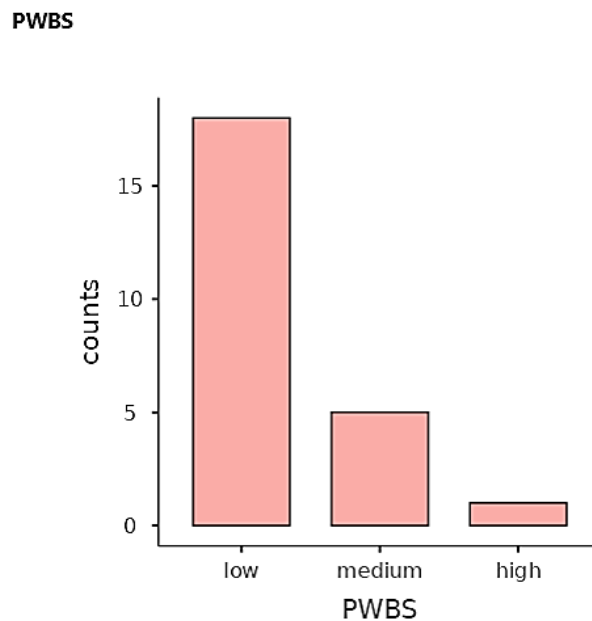


Figure 4. Summary of PWBS results for the study group.

Source: own elaboration based on *Jamovi*.

The same was true for the level of well-being (figure 4), which was also predominantly low in the study group.

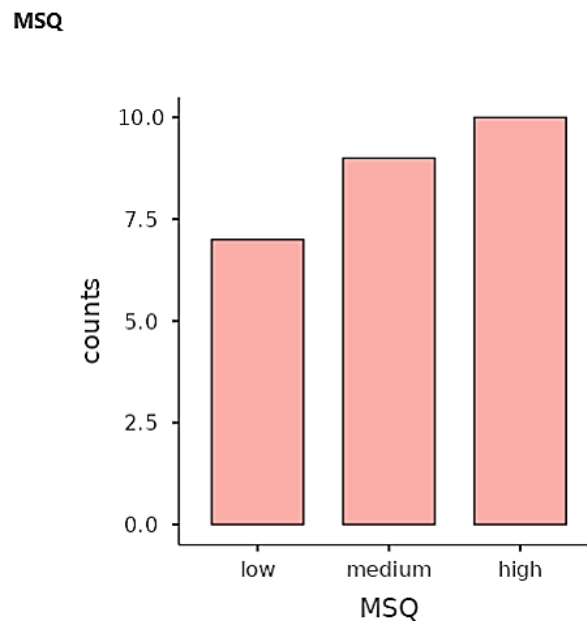


Figure 5. Summary of MSQ results for the control group.

Source: own elaboration based on *Jamovi*.

In the control group, i.e. the group in which respondents did not declare the occurrence of the *nepo-baby* phenomenon, the tendency in the case of job satisfaction was the opposite (figure 5) there were more people who manifested an average or high level and the differences between respondents were not so pronounced.

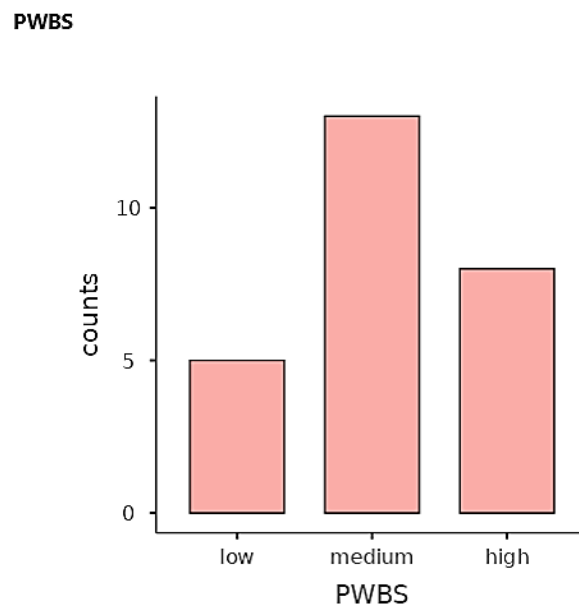


Figure 6. Summary of PWBS results for the control group.

Source: own elaboration based on *Jamovi*.

In contrast, for well-being in the control group, most scores were at the medium level (figure 6) and there was more of an upward trend. From these charts alone, it can be assumed that the hypotheses formulated were quite correct. However, to be sure whether these results supported the hypotheses and provide a valid rationale for further analysis, they need to be

analysed in more detail. For this purpose, with the help of the statistical programme z, the results obtained were analysed using the χ^2 test of independence including contingency and frequency. This was necessary not only to better visualise the data but also to verify the statistical significance of the results obtained. The purpose of using the chi-square test is to test whether the distribution of responses in terms of MSQ and PWBS levels is statistically significantly different between the study group and the control group. Frequencies have been used below to organise and summarise the data (Table 1).

Table 1.
Cumulative frequency

MSQ frequencies for the study group				MSQ frequencies for the control group			
MSQ	Frequency	% total	% cumulative	MSQ	Frequency	% total	% cumulative
low	16	66.7%	66.7%	low	7	26.9%	26.9%
medium	7	29.2%	95.8%	medium	9	34.6%	61.5%
high	1	4.2%	100.0%	high	10	38.5%	100.0%
PWBS frequencies for the study group				PWBS frequencies for the control group			
PWBS	Frequency	% total	% cumulative	PWBS	Frequency	% total	% cumulative
low	18	75.0%	75%	low	5	19.2%	19.2%
medium	5	20.8%	95.8%	medium	13	50%	69.2%
high	1	4.2%	100%	high	8	30.8%	100.0%

Source: own elaboration based on *Jamovi*.

Based on the frequency, it can be concluded that as many as 66.7% of the people in the study group declared a low level of job satisfaction and only 4.2% a high level of satisfaction. When it comes to the control group, the distribution is quite different, namely only 27.3% of people had a low level of job satisfaction and 40% a high one. Preliminarily, based on this table, it can be concluded that the research group has a low level of job satisfaction. Another key observation is that one can already see differences in job satisfaction between the research group and the control group in terms of job satisfaction at this stage. With regard to the second variable concerning the level of wellbeing, up to 75.0 % of people in the study group manifested a low level of wellbeing, which shows a clear trend in this group. In the control group, on the other hand, the distribution of wellbeing levels varies, with most people displaying average levels of wellbeing. For this variable, differences can also be observed between the study group and the control group already at this stage of the analyses. It is apparent that for both the MSQ and PWBS variable that the study group tends to have lower levels of both job satisfaction and wellbeing compared to the control group. This provides an important basis on which to analyse the data more closely using cross-tabulation (Table 2) and to finally apply a chi-square analysis (Table 3) to confirm statistical significance.

Table 2.*Cross tabulations for MSQ and PWBS variables in both groups*

group		MSQ			
		low	medium	high	totality
Research group	observed	16	7	1	24
	expected	10.8	7.84	5.39	24.0
	% in the line	66.7%	29.2%	4.2%	100%
	% in the column	72.7%	43.8%	9.1%	49.0%
Control group	observed	6	9	10	25
	expected	11.2	8.16	5.61	25.0
	% in the line	24.0%	36.0%	40.0%	100.0%
	% in the column	27.3%	56.3%	90.9%	51.0%
totality	observed	22	16	11	49
	expected	22	16	11	49
	% in the line	44.9%	32.7%	22.4%	100.0%
	% in the column	100.0%	100.0%	100.0%	100.0%
group		PWBS			
		low	medium	high	totality
Research group	observed	18	5	1	24
	expected	11.0	8.64	4.32	24.0
	% in the line	75.0%	20.8%	4.2%	100.0%
	% in the column	78.3%	27.8%	11.1%	48.0%
Control group	observed	5	13	8	26
	expected	12.0	9.36	4.68	26.0
	% in the line	19.2%	50.0%	30.8%	100.0%
	% in the column	21.7%	72.2%	88.9%	52.0%
totality	observed	23	18	9	50
	expected	23	18	9	50
	% in the line	46.0%	36.0%	18.0%	100.0%
	% in the column	100.0%	100.0%	100.0%	100.0%

Source: own elaboration based on *Jamovi*.

The cross-tabulation in the case of the *MSQ* Descriptive leads to the following conclusion: the research group has a clearly different structure of job satisfaction than the control group. The control group showed a higher level of satisfaction much more often than the research group. For the second *PWBS* variable, the descriptive conclusion is analogous. In this case, the research group has a clearly lower level of well-being than the control group. Looking a little more closely at the cross-tabulation, it is also possible to see some disparity between the frequently observed and expected bones in the individual cells, which indicates the existence of a relationship. For example, in the study group, 16 people were observed with a low level from work while the expected number was only 10.8. in the control group, on the other hand, only 6 people were observed with a low *MSQ* while 11.2 were expected. The difference between 16 and 6 observed with the expected 10.8 vs. 11.2 respectively is a strong indicator that low levels of satisfaction at work may be statistically significant. The over-representation of those with low levels of job satisfaction and under-representation of those with high levels compared to what would be expected in the study group is reinforced by the opposite trend seen in the control group. Interesting observations can also be made in the case of the second *PWBS* variable, where as many as 18 people with low wellbeing were observed, while only 12.0 were expected, i.e. six more people than theoretically expected. In the control group for wellbeing,

only 5 people were observed with this result with an expected value of 12.0. There is a huge disparity here (18 vs 5 with an expectation of 12.0 vs 12.0). The study group is characterised by an excessively high number of people with low well-being. If the variables were not dependent to some extent on each other such results would be impossible. However, a chi-square test verification is also required to be certain (Table 3, figure 6, figure 7), which is detailed below.

Table 3.

Results of the chi-square test of independence for MSQ and PWBS levels in the study and control groups

Tests χ^2 MSQ				Nominal MSQ	
	value	df	p		value
χ^2	12.1	2	0.002	Phi	NaN
N	49			V Cramera	0.498
Tests χ^2 PWBS				Nominal PWBS	
	value	df	p		value
χ^2	16.3	2	< .001	Phi	NaN
N	50			V Cramera	0.571

Source: own elaboration based on *Jamovi*.

The results of the chi-square test showed a statistically significant relationship between group membership and job satisfaction (MSQ), as indicated by the value obtained: $\chi^2 = 12.1$ with 2 degrees of freedom (df). What is important is the observed value of $p < 0.05$, which means that the differences in job satisfaction between the study group and the control group are so large that they cannot be random. In addition, Cramér's V clearly indicates a moderately strong relationship. This shows that the research group, i.e. the one in which the participants declared the occurrence of *nepo-baby* in management in their organisation, has a much lower level of job satisfaction than those in which this phenomenon does not occur. As regards the results for the second variable concerning the level of well-being (PWBS), the *chi-square* test showed an even higher statistical correlation with group membership. With two degrees of freedom (df), the value $\chi^2 = 16.3$, and $p < 0.001$, which shows that there is a very low probability of obtaining such results by chance. Cramér's V indicates a strong connection between them. Based on this, it can be seen that belonging to a group is linked to the level of well-being. And considering both variables, both job satisfaction and well-being depend on whether or not the phenomenon of organisation occurs. Thus, the hypotheses were confirmed. Additionally, bar charts are provided below to visualise the observed distributions and differences between the groups (figure 7, figure 8).

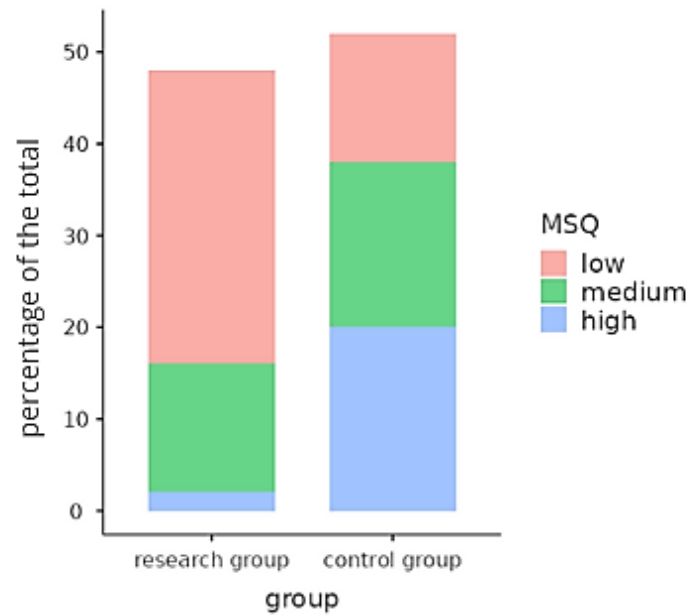


Figure 7. Summary of the results of the *Chi-square* test for MSQ.

Source: own elaboration based on *Jamovi*.

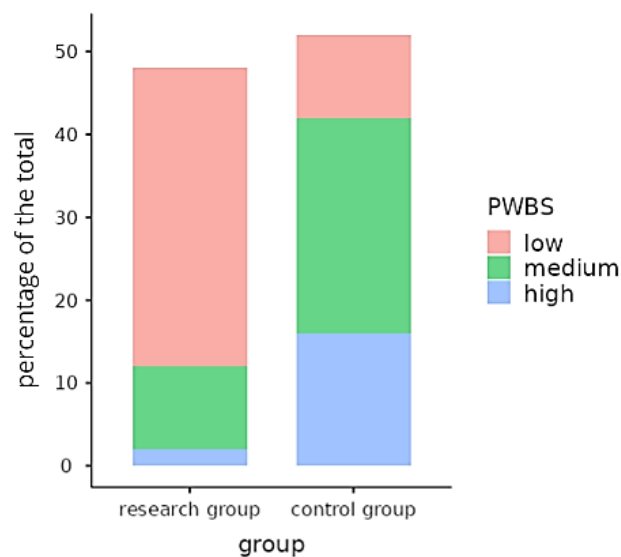


Figure 8. Summary of the results of the Chi-square independence test for the PWBS.

Source: own elaboration based on *Jamovi*.

Figures 7 and 8 show that the distribution in the statistical sense depends on the group, as was also demonstrated in detail earlier.

6. Discussion

As a result of the research conducted in this article on job satisfaction and employee well-being, firms where the *nepo-baby* phenomenon occurs reveal some specific observations on this topic. Both the level of well-being and the level of job satisfaction in organizations where this phenomenon occurs show a downward trend. In organizations where respondents did not report this phenomenon, job satisfaction and well-being levels among employees were significantly higher than in those where it did occur. This means that based on this study it can be assumed that the *nepo-baby* phenomenon has a negative impact on employees. The literature on the subject provides evidence suggesting that *nepo-baby* leads to negative consequences for organizations at both the individual and overall levels. Despite the small sample size, the results of the study were statistically significant, and on this basis it can be assumed with a high degree of probability that such a trend exists in management.

According to the literature on the subject, the *nepo-baby* phenomenon tends to have negative effects in organizations regardless of the industry (Foster, Maroto, 2025). Also, when we read about the general mechanism of nepotism, there are many publications on this subject which mention that it has a negative impact not only on management itself, but also holistically on the entire company (Akar, 2020). Importantly, in the context of this research, there are references in the literature not only to the fact that nepotism can have a negative impact on employee well-being (Lasisi et al., 2022) but also a reference to the fact that *nepo-babies* themselves have lower well-being due to their awareness of their lack of competence (Calvard, 2012). A manager who is unsure of himself and his decisions will also manage the company poorly, which in turn will affect all processes within the company and the well-being of his subordinates (Qian, 2020). It can also be noted on the basis of research from this article and other literature on the subject that well-being in companies where *nepo-baby* occurs is disrupted at various levels. Another issue is that, at a general level, nepotism has a negative impact on organizational culture and hinders processes within the company (Akar, 2020).

Considering that employee wellbeing and job satisfaction are crucial for a company's development (Calvard, 2012), it is important to counteract the phenomenon of *nepo-baby* in company management structures. For this to happen, it is necessary to raise awareness of the problem and its negative consequences for the company. Without realizing how adversely it affects organizations and employee morale, it will not be possible to achieve transparency and strive for continuous development of the company. Practical strategies to counteract the phenomenon of *nepo-baby* may include the introduction of external performance appraisal systems, performance- and competency-based succession monitoring, and training in ethics and diversity in the workplace (Marcíanová et al., 2025).

7. Summary

In summary, the occurrence of the *nepo-baby* phenomenon in managerial positions in organizations is associated with low levels of well-being and low levels of job satisfaction. The findings of this article are alarming and indicate a trend showing that the occurrence of *nepo-baby* significantly affects the company. There is little discussion of this phenomenon in management, which is why further exploration in this area is necessary. What is certain, however, is that the results of these studies show that *nepo-baby* in management is a topic worth researching, as it can be safely assumed that, apart from employee well-being and job satisfaction, it also affects other components, both at the individual and organizational level.

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FORMULATING A STRATEGY FOR A PROCESS-PROJECT ORGANIZATION

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Purpose: Although scientific research in the field of process and project management is becoming increasingly common, it is still fragmentary in nature. In particular, it does not address the issue of formulating a strategy that combines reactive and proactive orientations, focused on the exploitation and exploration of processes and projects. The authors of this publication wish to contribute to filling this knowledge gap and describe selected research results aimed at determining how to formulate a strategy in a process and project organization.

Design/methodology/approach: The formulated main objective was achieved in two stages. Stage 1 was based on a case study applied to an entity that is a business environment institution with the highest level of process and project maturity. In this stage, the organization's documents were first analyzed. Next, semi-structured interviews and participant observations were conducted. In the second stage, as part of the discussion, the results of the case study were compared with the solutions indicated in the literature on strategy formulation.

Findings: The research conducted allowed us to map out the process of formulating a process-project organization strategy, which uses a number of methods, such as PESTEL, Porter's 5 forces analysis, SWOT, BSC, and strategy mapping. This method includes specific and new solutions dedicated to process-project organizations in the assumptions for strategy formulation, external and internal analysis, objective setting, strategy selection, and implementation plan development.

Research limitations: The main limitation of the study is the individual nature of the case study, which limits the possibility of generalizing its findings in order to recommend them to other organizations. The study was largely based on observations and interviews, which may reflect the subjective perspective of those involved in formulating strategies within the organization.

Practical implications: The results of the study can serve as guidelines for managers of process- -project organizations on how to formulate proactive and reactive strategies.

Originality/value: To date, no approach has been described for integrating strategic objectives with operational and exploratory processes and projects, while simultaneously determining what incremental or radical changes they should involve. Also noteworthy is the integration of KPIs that combine the perspectives of objectives, processes, and projects.

Keywords: process-project organization, strategy formulation.

Category of the paper: Research paper.

1. Introduction

Contemporary organizations operate in an environment characterized by dynamism, market globalization, and fierce competition, as well as rapidly changing and increasingly high customer expectations. In such conditions, classic strategic management models, which focus on long-term planning, often prove insufficient (Mintzberg et al., 2005) because they are too rigid and unable to respond to dynamic changes (Grant, 2019). It is believed that in order to function properly and achieve success, organizations must operate effectively on a daily basis, continuously improve the quality and efficiency of their work, demonstrate adaptive flexibility, and quickly adapt to customer needs by introducing changes and innovations (Sudoł, 2006; Johnson et al., 2008). This has led to growing interest among management practitioners and theorists in the concept of process-project organization, which focuses simultaneously on processes that ensure the stability and effectiveness of current activities, as well as on projects that enable flexible responses to change and the introduction of innovation (Szpitter, 2020; Sliž, 2021). Two approaches to management are dedicated to this concept of organization in relation to processes and projects: exploitative and exploratory (Raisch et al., 2009), which involves the simultaneous implementation of two strategic orientations (Hu, Chen, 2016; Zhang et al., 2016). The first of these orientations – reactive – refers to exploitation and is focused on productivity, efficiency, updates, modifications, and improvement of current activities to adapt to market needs (Kohtamäki et al., 2010). The second orientation, proactive, refers to exploration and is focused on change, searching for and researching new opportunities, and introducing innovations (Raisch et al., 2009). It is worth noting that the simultaneous use of these orientations, focused on exploitation and exploration, has been one of the most discussed paradoxes in strategic management in recent years (Zakrzewska-Bielawska, 2016). It has been discussed, among others, in the context of technological innovation (Jansen et al., 2006; Andriopoulos, Lewis, 2009; Martini et al., 2013), organizational design (O'Reilly, Tushman 2004; Selcer, Decker, 2012; Chen, Kannan-Narasimhan, 2015), organizational adaptability (Huy 2002; O'Reilly et al., 2009), and strategic management. From the latter perspective, exploration and exploitation were most often considered orthogonal activities, as both are necessary for an organization to survive and grow. The ability to manage activities focused on exploration and exploitation and to seek the ideal balance between them has been termed ambidexterity (Czakoń, 2012), which requires outstanding leadership (Skubis, Bijańska, 2024), strategic sophistication, significant resources, thorough knowledge, conflicting structures, and adaptive systems (Gilbert et al., 2015). It should be emphasized that ambidexterity was also the subject of research in the context of strategy formulation (Burgelman, 2002), strategy implementation (O'Cass et al., 2014), and strategic flexibility (Wei et al., 2014), but it was analyzed in terms of the results achieved exclusively in the course of processes. Therefore, no indication was given as to how to formulate a strategy focused on exploitation and

exploration in process-project organization. Such considerations are also absent from the literature on process-project management. And although scientific research in this area is being conducted more and more often, it is still fragmentary in nature (Nowosielski, 2017, 2018; Lichtarski, Osbert-Pociecha, 2019; Strojny, 2019), and has been presented most extensively in only two books (Szpitter, 2020; Sliż, 2021), which do not address the issue of formulating a strategy that combines reactive and proactive orientations, focused on the exploitation and exploration of processes and projects. The authors of this publication wish to contribute to filling this gap and describe selected research results in the field of strategy formulation in a process-project organization with a reactive and proactive orientation. The presented solutions are part of broader research on the problems of managing process-project organization.

2. Basis for research, its purpose, subject, course, and methods used

For the purposes of research on the problems of managing process-project organizations, a model of a ambidextrous process-project organization was adopted (Fig. 1).

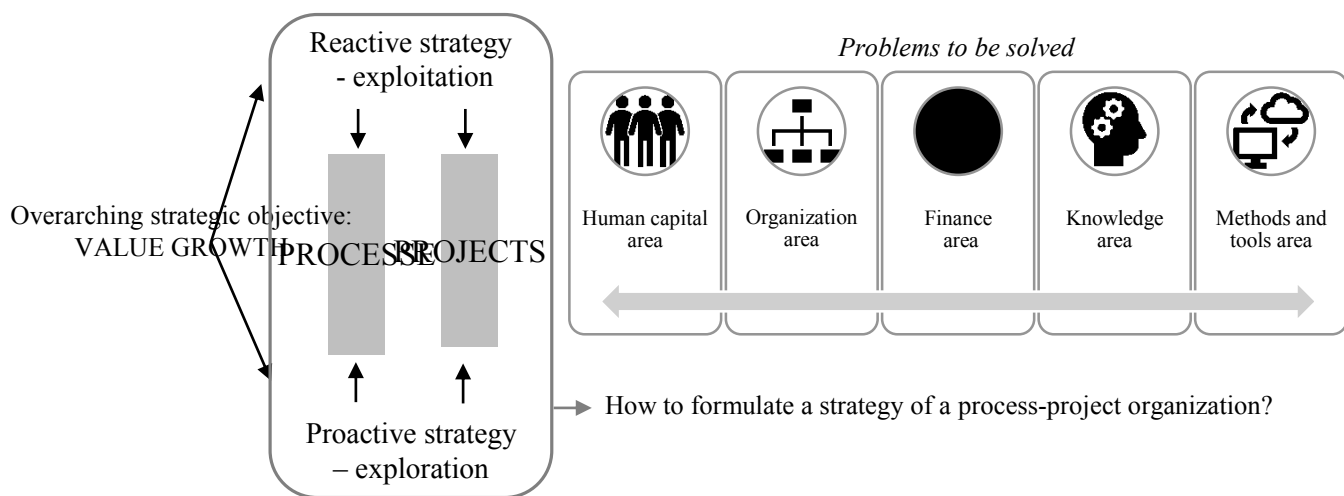


Figure 1. Generalized model of a ambidextrous process-project organization, taking into account the main problem in the area of strategy.

Source: own study.

The model assumes that the overarching strategic objective of such an organization is to increase value, which can be achieved through proper functioning and development, as well as obtaining a sustainable competitive advantage that allows for generating high financial results. This requires the development and implementation of a strategy focused on:

- 1) reactivity, referring to operations, including the ability to implement incremental changes – improvements for the effective implementation of existing processes and projects,

- 2) proactivity, referring to exploration, including the ability to implement radical changes – new, adaptive, innovative solutions in existing processes or new processes, as well as in existing and new projects.

The research was conducted in several interrelated areas, i.e., human capital, organizational capital, financial capital, knowledge, methods, and tools. Within these areas, many problems were identified, the solution of which supports the achievement of the overarching strategic objective. The results of the considerations regarding these problems are the subject of other publications.

This publication presents part of the research¹, which aimed to determine how strategies are formulated in process-project organizations. In particular, it presents the results obtained in the course of a case study, which was exploratory in nature, because, as mentioned in the introduction, the issue of strategy formulation in organizations integrating process and project management is a relatively new and less recognized issue in the literature.

To achieve the research objective, the focus was on answering three questions:

1. How does a process-project organization formulate its strategy?
2. What tools and methods are used for this purpose?
3. What barriers and difficulties may arise during the implementation of the strategy?

The case study method was chosen because of its focus on in-depth understanding of complex phenomena in their natural organizational context (Yin, 2018). This method was applied in an entity that is a business environment institution, operating for 26 years for the benefit of enterprises, local government, and scientific institutions, in which many processes and projects are carried out. The criteria for selecting this organization for the study were its highest (5) level of process and project maturity, assessed on the basis of an appropriate model (Sliż, 2021, pp. 201-211), as well as its many years of experience in creating process and project strategies and the willingness of its top management to participate in the study.

The research was conducted in two stages, which followed initial contact with senior management, discussion of the purpose of the research, and signing of consent forms for access to documentation and for conducting interviews and observations.

In stage 1 document analysis was used (Bowen, 2009), including specific assumptions for formulating the organization's strategy, its current strategy, process documentation, project documentation, reports on the implementation of processes and projects, and internal presentations. The document analysis allowed for the identification of formal assumptions and preliminary understanding of the mechanisms of strategy formulation.

Following that, semi-structured interviews and participant observations were conducted. Semi-structured interviews (Kvale, Brinkmann, 2015), which combine elements of structure and flexibility, allowed for further exploration of the problem of strategy formulation in both

¹ Research in the area of strategy formulation, which is not presented in this publication, also included interviews and discussions within the expert panel.

an orderly and free manner. The interviews were attended by senior management representatives, process owners, and project managers who were involved in strategy formulation. The interviews provided insight into their subjective assessments, experiences, and opinions. Participatory observation (Dźwigoł, 2018) was also used at this stage. In particular, the authors of the 2025 publication were allowed to interactively observe how the new strategy was formulated in the organization under study, which meant that they could ask questions, participate in discussions, and propose improvements. This observation provided a deeper understanding of the practices used in strategy formulation.

In stage 2 as part of the discussion, the results of the case study were compared with the solutions indicated in the literature on strategy formulation.

3. Research results

3.1. The method of strategy formulation and the methods and tools used in it

Based on the results obtained in stage 1 of the research, i.e., analysis of source documentation, interviews, and participant observation, the method of strategy formulation in the studied organization was mapped (Fig. 2). It proceeded in phases, using several methods and tools. The result was a document of over 100 pages.

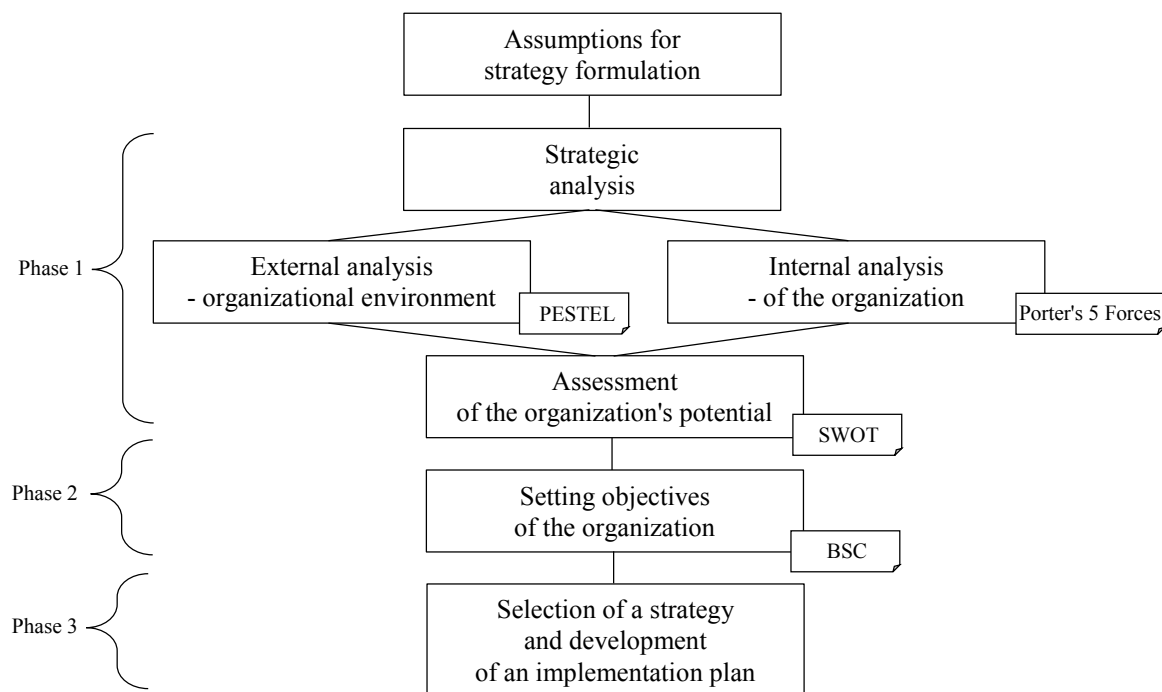


Figure 2. Generalized model for formulating a ambidextrous strategy for a process-project organization, taking into account the methods and tools used.

Source: own study.

The basis for strategy formulation in the examined process-project organization are specific assumptions, in particular its mission, vision, overarching objective, and strategic orientations. Specifically:

- its mission is to provide modern services promoting innovative solutions and involvement in major infrastructure investments,
- its vision is to strive to become a leading center for infrastructure investments in the areas made available, supporting the dynamic development of a competitive economy by creating favorable conditions for new investors and existing enterprises, as well as promoting and supporting innovative technologies and cooperation between science, business, and local government,
- its overriding objective is to increase value by generating high financial results,
- its strategic orientations relate equally to reactivity and proactivity through the exploitation and exploration of processes and projects, thanks to which the organization plays a dual role: a stable partner supporting entrepreneurs in their day-to-day operations and an innovative catalyst for change in the region.

Phase 1. Strategic analysis

Strategy formulation begins with a comprehensive strategic analysis that provides an understanding of both the external and internal conditions of the organization.

The environmental analysis focuses on identifying external factors affecting the organization's operations and the opportunities and threats that arise from them. This analysis is the basis for later adapting the strategy to changing market conditions, as it allows for a better understanding of the organization's competitive position, taking into account anticipated trends in the environment.

In the organization under study, the environmental analysis was conducted by answering questions such as:

- what are the current conditions for the organization's functioning (e.g., economic and social)?
- what are the directions and trends of change in these conditions?
- what solutions are necessary to achieve success in the given conditions, taking into account the anticipated directions of change?

For example, in terms of economic conditions, the level of economic development of the city and region in which the organization operates, the situation of companies in the environment, their financial condition, access to capital, investments, and the level of innovation and technology were discussed. In terms of social conditions, the demographic structure of the city and region, the level of education of the inhabitants, their expectations, and their level of activity were analyzed. This made it possible to identify trends in economic and social changes in the city and region, taking into account, among other things, energy transition, digitization, and the development of the SME sector. A growing need for support for innovative startups and industrial technologies was identified.

In turn, the internal analysis in the examined organization referred to its organizational, financial, material, human, and intangible resources. As before, the analysis was conducted by answering questions such as:

- with regard to organizational resources: which of the organization's processes and projects are most important for creating its value, and which of them require change?
- with regard to financial resources: what is the level of cash available and committed to projects? What is the capital structure?
- with regard to tangible resources: what is the condition of the infrastructure? What needs to be improved?
- in terms of human resources: are the competencies of process owners, project managers, and process and project team members sufficient? Is their number adequate?
- in terms of intangible resources: what is the organization's reputation in local or industry circles?, what are the relationships with customers/stakeholders?

For example, in response to questions relating to organizational resources, it was indicated that:

- 1) the most important factors for creating value for the organization include²:
 - the process of leasing offices, production halls, warehouses, industrial or service areas in several industrial parks, business centers, and other properties owned, as well as the incubation process – support for the development of new enterprises and startups,
 - projects related to the preparation of new land for investors from the aviation industry and for SMEs, as well as those related to the acquisition and preparation of new land for technology investors and the construction of modern laboratories for companies from the medical industry,
- 2) changes are required, among others, in:
 - the process of servicing customers renting facilities in industrial parks, business centers, and other owned properties, as well as the incubation process,
 - projects related to the acquisition and preparation of new land for investors, as well as the construction of modern laboratories.

It should be emphasized that in this phase of strategy formulation, the organization under study used three methods. These were PESTEL and Porter's 5 forces analyses, as well as SWOT. In particular:

1. The PESTEL analysis, covering macro-environmental factors P – Political, E – Economic, S – Social, T – Technological, E – Environmental, L – Legal, was aimed at identifying external opportunities and threats in the context of their impact on the

² The names of these projects have been deliberately omitted due to signed agreements regarding the disclosure of detailed information about the organization under study.

functioning of the organization, as well as enabling better adaptation of its activities to changing environmental conditions.

2. Porter's 5 forces analysis focused on assessing the attractiveness of the industry and identifying sources of threats and ways to minimize them. It covered the power of suppliers, the power of customers, the threat from new players, substitutes, and competition within the sector.
3. The SWOT analysis covered S – Strengths, W – Weaknesses, O – Opportunities, and T – Threats. It was focused on synthesizing the results of previous analyses and assessing the organization's potential in the context of external conditions. It identified how the organization could more effectively leverage its strengths, eliminate weaknesses, respond to threats, and take advantage of emerging development opportunities.

Phase 2. Setting objectives in the organization

When setting objectives, senior management first emphasized what the organization should achieve in the future (in the short and long term). This was the basis for defining several objectives in the following areas: finance, customers, learning and growth. A map of these objectives was developed. It can be seen that this approach is based on the Balanced Scorecard (BSC) method, in which the objectives identified for achieving the organization's overarching objectives are assigned to four perspectives, which means that the internal business processes perspective is missing (Kaplan, Norton, 2001). Next, the defined objectives were directly linked to the relevant reactive and proactive processes and projects, assuming that their achievement is determined by the effectiveness and efficiency of process and project management. For example, the objective defined in the financial perspective as increasing the financial efficiency of the organization by 3% over the year compared to the previous year, measured by net cash flow (NCF)³, was linked, among other things, to:

- with the processes of servicing customers renting facilities and incubation,
- projects related to the acquisition and preparation of new land for investors, as well as the construction of modern laboratories.

In the organization under study, objectives were defined in accordance with the SMART principle (S – Specific, M – Measurable, A – Achievable, R – Relevant, T – Time-bound), which facilitated their correct formulation and supported their subsequent translation into specific processes and projects. Particular attention was paid to defining the target measurement indicator, its target value, and the time frame for achieving it. The authors of the publication found that there was a lack of common measurement indicators for a specific objective and the related process(es) and project(s). They therefore proposed their adoption, including those with a financial dimension (expenditures/revenues), which would facilitate the assessment of

³ Monetary values have been deliberately omitted due to signed agreements regarding the disclosure of detailed information about the organization under study.

a specific objective from the point of view of its impact on the achievement of the overarching objective. In addition, they noted that it is worth prioritizing individual objectives. Such ideas are consistent with the Management by Objectives method (Bijańska, Wodarski, 2020). The authors of the publication also noted that an alternative way of setting objectives would be to adopt the missing (from the BSC) perspective of internal processes and to create an additional fifth perspective – projects, which would include objectives directly related to them. An example would be the objective: 80% of projects should be completed according to the agreed schedule this year. The proposed solutions met with interest from those involved in formulating the strategy in the organization under study, and the first of them were applied during the formulation of the current strategy.

Phase 3. Selection of a strategy and development of an implementation plan

The assumptions for the strategy, the results of the strategic analysis, and the specific objectives were the basis for considering two strategy options: growth or stabilization. First, a discussion was held on these options. Among other things, the consistency and feasibility of the objectives were analyzed and assessed in relation to the available resources and the possibility of influencing the risk factors that determine the success of the strategy. After discussion and presentation of arguments, a growth strategy was chosen, i.e., the development of the organization through the skillful use of an integrated combination of its resources, with an emphasis on the importance of processes and projects whose implementation is to contribute to the achievement of related objectives. It was agreed that the implementation of this strategy would take into account its two orientations – reactive and proactive – which would simultaneously refer to the exploitation and exploration of processes and projects for proper day-to-day functioning, ensuring adaptive flexibility and adaptation to the needs of customers or stakeholders.

Next, as part of the reactive strategic orientation for each objective, incremental changes were identified that should be introduced in the processes and projects related to that objective. It should be emphasized that these changes were characterized by a gradual, systematic streamlining and improvement of existing processes and projects, without the need to spend significant financial resources.

For example, for the previously indicated objective from a financial perspective, defined as increasing the financial efficiency of the organization by 3% ..., which was linked, among other things, to the processes of servicing customers renting facilities and incubation, as well as to projects related to the acquisition and preparation of new land for investors or the construction of modern laboratories, the strategy adopted:

1. Improving the customer service process by simplifying the internal customer service procedure, which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - a reduction in the unit cost of customer service, as fewer steps in the procedure will shorten service time and allow more customers to be served at the same time,
 - reducing labor and operating costs by reducing the number of errors and misunderstandings – saving time on necessary corrections, which can be used for other activities,
 - increased revenue, which should result from:
 - additional revenue from new customers acquired through recommendations from existing customers who are satisfied with faster and better service,
 - faster receipt of funds as a result of shorter service times and, therefore, faster invoicing.
2. Improvement of the incubation process through regular updates of advisory programs and workshops based on participant feedback and market needs analysis, which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - reducing the costs of implementing ineffective programs and workshops with little interest by reducing or eliminating them,
 - reducing the costs of promoting new, current programs and workshops, as satisfied participants will recommend them to others,
 - increase revenue, which should result from:
 - higher revenues from fees paid by a larger number of program and workshop participants,
 - additional revenue from new customers acquired through recommendations from satisfied participants in new programs and workshops.
3. Shortening the time needed to complete projects related to acquiring and preparing new land for investors by simplifying and standardizing internal procedures and implementing appropriate document circulation, which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - a reduction in labor costs thanks to less bureaucracy,
 - limiting negative financial effects through better control of the budget and financial flows, implying a faster response to deviations,

- increase revenue, which should result from:
 - earlier revenues from transactions or lease fees and faster recovery of invested funds (faster acquisition and preparation of land enables its faster sale or release to investors,
 - additional revenue from new investors attracted by the efficiency of the organization.
- 4. Implementation of the project to build modern laboratories in stages that can be used independently (each stage, e.g., one laboratory, should be completed and ready for use before the next one begins), which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - reducing financial costs (interest, commissions), thanks to the possibility of financing the next stage from the revenue obtained from the completion of the previous stage,
 - reducing costs not provided for in the project budget, thanks to a reduction in the risk of errors achieved by eliminating unsuccessful solutions, e.g., technical or organizational, which were in the previous stage,
 - increase revenue, which should result from:
 - earlier revenue inflow, which will shorten the payback period of the invested funds, thanks to the possibility of renting or making available the completed result of the stage, which can be used commercially,
 - the generation of future contracts, thanks to the possibility of conducting promotional activities in the completed stage result, which will increase interest in the offer.

After identifying incremental changes, as part of a proactive strategic orientation for each objective, radical changes were identified that should be introduced in existing or new processes and projects related to that objective. It should be emphasized that these changes, often bearing the hallmarks of innovation, had a significant impact on improving the functioning of the organization, expanded its existing scope of activity, responded to future market needs and the region's development policy, and required significant financial expenditure.

For example, for the previously indicated objective from a financial perspective, defined as increasing the financial efficiency of the organization by 3% ..., which was linked, among other things, to the processes of servicing customers renting facilities and incubation, as well as to projects related to the acquisition and preparation of new land for investors or the construction of modern laboratories, the strategy adopted:

1. Improvement of customer service through digitization – implementation of a CRM (Customer Relationship Management) system, which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - reducing labor costs through the automation of many activities (e.g., registering contacts, sending messages, reminders, or reports), eliminating document loss, searching for documents, errors, the need for corrections, and additional communication,
 - reducing excess costs, e.g., for campaigns, meetings, reports, thanks to more accurate forecasting of demand for labor, materials, and services, as a result of the system providing up-to-date data on customers, sales, etc.,
 - reducing the costs of paper, printers, binders, and archive maintenance by replacing paper document circulation and manual statements with an electronic system,
 - lower marketing and sales costs, thanks to the ability to monitor customer satisfaction and personalize contact, which will increase the loyalty of regular customers, and retaining them is cheaper than acquiring new ones,
 - increase revenue, which should result from:
 - the ability to respond more quickly and accurately to customer needs, which will increase their loyalty and recommendations to other organizations,
 - collecting data on customer preferences, which will enable better tailoring of offers and promotional activities and allow you to focus on the most promising customers, increasing the effectiveness of promotional campaigns,
 - automatic recording of customer inquiries or reminders about contacts, which will help retain customers and offer them additional services or contracts,
 - providing detailed reports on sales results, customer behavior, and market trends, which will support business decision-making and allow the offer to be directed where it will be most profitable.
2. Improving the incubation process by using AI (artificial intelligence) based on a model dedicated to the organization, which will be integrated with current processes and projects and will analyze submitted business ideas, compare them with a database of successful and unsuccessful ideas, assess their innovativeness, scalability, and compliance with market trends, rank ideas according to their development potential, and select appropriate experts, mentors, analysts, and support programs for specific originators. The use of AI should contribute to increased financial efficiency by:
 - reducing costs, which should result from:
 - reducing labor costs, thanks to the rapid initial evaluation of even hundreds of business ideas by AI algorithms, leaving only the most promising ones to the experts,

- limiting inefficiently spent costs on the work of experts, mentors, and analysts, as AI will predict the likelihood of success of ideas by analyzing market data, trends, and business models,
 - lowering the costs of legal consultations and reducing the risk of subsequent disputes, thanks to the use of AI to analyze the compliance of ideas with regulations, patents, and legal risks,
 - reducing the costs of marketing campaigns by using AI to analyze the market and identify niches,
 - increase revenue, which should result from:
 - using AI to support the selection of the best ideas, and a larger number of start-ups achieving mass scale, generating greater revenue for the organization from shares or licensing fees,
 - using AI to analyze large amounts of data and detect early signs of trends, enabling the organization to invest in future areas that will soon become profitable and increase revenues,
 - the possibility of selling or licensing AI tools for evaluating ideas to other incubators, funds, or corporations, which can be a source of new revenue,
 - the possibility of selling or using generated data on trends, customer preferences, and the effectiveness of business models (e.g., start-ups) to formulate a more profitable strategy.
3. Shortening the time needed to complete projects related to acquiring and preparing new land for investors by integrating GIS (Geographic Information System) with AI, i.e., combining spatial data with intelligent algorithms that can independently analyze, forecast, and recommend the best decisions, which should contribute to increased financial efficiency through:
- reducing costs, which should result from:
 - lowering labor costs by automating the analysis of hundreds of plots and development scenarios (AI) and eliminating the need to manually check maps, plans, and documents (GIS), which will reduce the working time of analytical and urban planning experts,
 - avoiding costly investment mistakes that can generate significant losses, thanks to the ability to quickly detect risks (e.g., flooding, problematic land),
 - lower site preparation costs thanks to better spatial planning – the ability to optimize the layout of roads, water and sewage networks, and functional zones,
 - reducing documentation handling costs thanks to automatic updating of spatial data and investment documentation,

- increase revenue, which should result from:
 - the ability to quickly identify the most profitable locations that are well-suited to the market, which will attract greater interest from investors and increase the value of their sale or lease,
 - opportunities to optimize the use of space and infrastructure – e.g., minimizing the occurrence of vacant lots or unused facilities, thereby increasing revenue from the same area without increasing expenditure,
 - opportunities to sell or share spatial data in the form of services (e.g., "investment potential maps," "risk analyses"),
 - gaining the status of an innovative and reliable partner, which will attract new business partners and customers.
- 4. Implementation of a project to build modern laboratories using Smart Building systems integrated with BMS (Building Management System), which should contribute to increased financial efficiency through:
 - reducing costs, which should result from:
 - reducing the operating costs of laboratories through automatic control of lighting, air conditioning, ventilation, and heating (depending on the presence of people, outside temperature, time of day), as well as real-time data analysis to avoid waste in media consumption,
 - lowering the technical maintenance costs of laboratories by analyzing data from sensors and detecting irregularities (e.g., pressure drops, excessive power consumption), as well as sending information about potential failures before they occur or planning service when needed,
 - reduce labor costs, as automation will reduce the number of laboratory staff,
 - lower infrastructure development costs, as modern Smart Building systems are modular and flexible – new features (e.g., sensors, AI integrations, automation modules) can be added without major upgrades,
 - increase revenue, which should result from:
 - perception of the organization as an innovative and technological leader, which should increase the number of visiting customers, partners, and business, thereby increasing the chances of contracts and investments, as well as revenue from rentals or demonstration services,
 - the possibility of making modern laboratories available to external partners or startups outside working hours, which should generate revenue from infrastructure rental in a pay-per-use model and attract a larger number of customers,

- shortening the time needed to conduct research in scientific laboratories with BMS, which will enable a greater number of projects to be carried out or laboratory services to be provided at the same time,
- the possibility of selling data and knowledge-based services obtained from BMS and Smart Building, which may generate new sources of revenue.

All of the identified operational and exploratory processes and projects were mapped onto the previously developed strategy map. It visualized the integration of processes and projects from a strategic perspective. In addition, at this stage, KPIs consistent with the objectives were established jointly with the process owners and project managers, which enables monitoring of the degree of strategy implementation – assessment of strategic objectives within a specified time frame. The management team emphasized to the authors of the study that in this phase of strategy formulation, setting KPIs is a key element of the strategic management process, used to track subsequent progress, identify deviations from assumptions, and make corrective decisions. Thanks to KPIs, the organization gains the ability to measure the effectiveness and efficiency of processes and projects related to objectives in all perspectives – financial, customer, learning, and growth. This also promotes transparency, accountability, and employee engagement in the implementation of the adopted objectives.

In the case of exploratory processes and projects, an assessment of the financial effectiveness of significant investment expenditures was carried out, based on the NPV (Net Present Value) indicator. The authors proposed that they also be assessed in terms of the risk of not recovering the invested funds, in the manner proposed for the assessment of the project portfolio (Jamroz, Wodarski, 2023), which met with interest. Process owners were required to design them taking into account the indicated changes by developing models of their course, while project managers, especially those of new projects, were required to prepare their plans.

3.2. Barriers and difficulties that may arise during the implementation of the strategy

During the interviews, the organization's top management was asked about barriers and difficulties that may arise in the implementation of the strategy, which would increase the risk of not achieving its overall objective. The idea was that the organization's experience would help others overcome the problems they may encounter. The management identified several problems in three areas.

The first area was the formulation of the strategy itself. It was emphasized that initially, it was very difficult to develop a method of integrating processes and projects with a strategic perspective, taking into account the reactive and proactive orientations that should be implemented in parallel. The method presented to the authors of the study was the result of many months of discussions and analyses conducted at the management board level, with the executive staff and with employees distinguished in terms of their competence. This method was refined over several years. It was very difficult to combine the KPIs of processes, projects,

and objectives in the perspectives. It was helpful to adopt the solutions proposed, among others, in the BSC, as well as to hold joint discussions and accept compromises, and sometimes consensus.

Of course, financial resources, and especially their synchronization, are a certain difficulty in implementing the strategy. The organization carries out many projects, which it tries to finance from the cheapest sources, including EU, national, and local government funds. Differences in procedures, schedules, and reporting requirements pose a significant challenge, and the need to meet different formal criteria sometimes prolongs decision-making processes and limits the flexibility of strategy implementation. Another barrier is the limited financial resources, which sometimes force the postponement of capital-intensive investments in processes or projects or the implementation of new, innovative processes and projects. This problem is discussed in more detail in the publication on finance.

The area related to employees was also highlighted. It was noted that initially, a significant barrier was the resistance of some employees to the need to introduce changes that required their involvement. In the case of the organization, some employees were negative about the need to systematically make changes to processes and projects or to introduce new processes and projects. This problem was solved through effective communication focused on highlighting the benefits of these changes and offering help in solving emerging problems, as well as the introduction of an incentive system linked to KPIs. A gradual introduction of changes, adapted to the pace of employee learning, was also declared. An organizational culture was also introduced, whose elements include cooperation, assistance, consulting, and acceptance of mistakes during the implementation of changes.

In addition, there was a problem related to the lack of appropriate employee competencies, mainly in the area of process management and project management. The organization solved this problem through internal training and the hiring of experts within the framework of EU projects. At present, there are no longer any problems in this area, but it was noted that in many institutions this is still a serious barrier.

Finally, it was added that the biggest barrier in this area is the lack of involvement of top management in the process of formulating and implementing strategies, as well as the lack of support, motivation, and appreciation for employees who play important roles in the implementation of reactive and proactive processes and projects, thereby contributing to the success of the organization.

According to management, these barriers should be taken into account when formulating a strategy in a process-project organization, especially when this is done for the first time.

3.3. Discussion of results

The case study and the very good situation of the organization under study allow us to conclude that the integration of the process and project approaches is an effective way to achieve success by responding flexibly to the needs of a dynamically changing market.

As part of the discussion, it is worth asking the following questions:

- are the presented solutions for formulating strategies in a process- and project-based organization novel?,
- can they be generalized in the manner presented in order to recommend them to other organizations?

The authors of the study believe that the presented method of strategy formulation is largely based on solutions, methods, and tools that are well known and described in numerous publications on strategic management, process management, and project management. However, it also includes solutions dedicated to process- project organizations that are novel and have not yet been presented in the literature.

Thus, starting with the general structure of the strategy formulation process, it can be said that it is based on well-known and widely described solutions in this area (e.g., Demecki, Żukowski, 2010; Kaleta, 2011; Niemczyk, Trzaska). The same applies to phases 1 and 2, i.e., external and internal strategic analysis, as well as objective setting. The course of these phases and the methods and tools used are well known and described in the literature (e.g., Johnson et al., 2008, Porter, 2010; Paluch, 2016; Dźwigoł, 2018). However, it should be noted that although the approach used is consistent with the known ones, it takes into account the simultaneous use of proactive and reactive strategic options, for example, in the adopted assumptions or in the manner of achieving objectives, by linking objectives with the implementation of exploitative and exploratory processes and projects. In fact, it can be said that in the presented solution used in the studied organization, the defined objectives are decomposed in parallel into operational and exploratory processes and projects, and the degree to which these objectives are achieved depends on the ability to manage processes and projects effectively and efficiently.

The most novel features can be seen in phase 3 – selection of a strategy and development of an implementation plan. To date, no approach has been described for integrating strategic objectives with operational and exploratory processes and projects, while simultaneously determining what incremental or radical changes they should involve. Also noteworthy is the integration of KPIs that combine the perspectives of objectives, processes, and projects, enabling the monitoring of the degree of strategy implementation – the assessment of the achievement of strategic objectives within a specified time frame.

Taking into account the observations of management regarding the barriers and difficulties that may arise in the implementation of the strategy, it can be concluded that, although they are important, they are part of the scientific considerations relating to the introduction of changes that are described in the literature, with regard to the integration of processes and projects with the strategic perspective (Dinsmore, Cooke-Davies, 2010), challenges related to synchronizing the financing of processes and projects (Yin, 2018), or employee resistance to change, lack of competence, and the need for top management involvement (e.g., Hammer, Champy, 2006; Kerzner, 2017; Bijańska, Wodarski, 2020).

According to the authors, the proposed solutions for strategy formulation and insights into the difficulties and barriers that may arise in its implementation are worth presenting. However, their main limitation is the individual nature of the case study, which limits the possibility of generalizing them to recommend them to other organizations (Yin, 2018). Furthermore, the research was largely based on observation and interviews, which may reflect the subjective perspective of those involved in formulating the strategy within the organization.

Summary

The article presents the results of research aimed at determining how strategy is formulated in a process- project organization. No considerations in this area have been presented to date, although scientific research in the field of process and project management is being conducted more and more frequently.

Case studies were used to achieve the research objective. The research, which included document analysis, semi-structured interviews, and participant observation, was conducted in an organization characterized by the highest level of process and project maturity and several years of experience in formulating a strategy oriented reactively and proactively toward the simultaneous implementation of operational and exploratory processes and projects. The research focused on answering three questions:

1. How does a process-project organization formulate its strategy?
2. What tools and methods are used for this purpose?
3. What barriers and difficulties may arise during the implementation of the strategy?

The research allowed us to map out the strategy formulation process, which is largely based on an approach that is well known and described in the literature on strategic management, process management, and project management. This also applies to the methods and tools used, such as PESTEL, Porter's 5 forces analysis, SWOT, BSC, or strategy map. However, this approach includes solutions dedicated to process- project organizations in the assumptions for strategy formulation, external and internal analysis, and objective setting, referring to the simultaneous use of proactive and reactive strategic options by linking objectives to the implementation of operational and exploratory processes and projects. The most novel features can be seen in the strategy selection and implementation plan development phase. They relate to the integration of strategic objectives with operational and exploratory processes and projects, while simultaneously determining what incremental or radical changes they should involve. Also noteworthy is the integration of KPIs that combine the perspectives of strategic objectives and processes and projects, enabling the monitoring of the degree of strategy implementation. According to the authors, the indicated solutions may contribute to the existing knowledge gap related to strategy formulation in a process-project organization.

The experience of the management staff of the organization under study shows that the greatest difficulties and barriers to strategy implementation relate to the integration of processes and projects with the strategic perspective, the challenges of synchronizing the financing of processes and projects, as well as employee resistance to change, lack of competence, and the need for top management involvement. And although this is consistent with the considerations presented in the literature, it is worth taking these barriers into account when formulating a strategy in a process-project organization, especially when doing so for the first time.

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PEOPLE ANALYTICS AND ARTIFICIAL INTELLIGENCE IN THE ANALYSIS OF ORGANIZATIONAL BEHAVIOR

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Purpose: The purpose of this publication is to analyse the potential of AI implementation in people analytics.

Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases connecting with researched topic.

Findings: The main findings of the study indicate that the integration of artificial intelligence into People Analytics significantly extends the analytical capacity of organizational behavior research by enabling dynamic, multi-level, and behaviorally grounded analysis of employee activity, interaction, and decision-making. The paper demonstrates that AI-driven People Analytics shifts the focus from static, descriptive HR indicators toward predictive and pattern-oriented explanations rooted in real-time, multi-source data, allowing classical organizational behavior theories to be operationalized at unprecedented scale and temporal resolution. Empirical applications reviewed in the study show that AI supports more accurate identification of engagement dynamics, turnover risk configurations, team interaction structures, leadership behaviors, well-being trajectories, and skill development processes, while also revealing latent patterns that remain invisible to traditional methods. At the same time, the findings emphasize that the scientific and practical value of AI-based analytics depends on strong theoretical framing, contextual interpretation, and ethical governance, without which algorithmic insights risk reductionism and loss of explanatory depth in organizational research.

Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage analysed scientific problem.

Keywords: People Analytics; Artificial Intelligence; organizational behavior; human resource analytics; machine learning; employee engagement; workforce decision-making; predictive analytics; data-driven management.

Category of the paper: literature review.

1. Conceptual Foundations of People Analytics and Artificial Intelligence in Organizational Research

People Analytics has emerged as a distinctive analytical paradigm within organizational research, positioned at the intersection of human resource management, organizational behavior, data science, and decision theory. Its conceptual core lies in the systematic use of data related to employees, work processes, and organizational contexts to explain, predict, and influence individual and collective behavior in organizations. Unlike traditional HR analytics, which has largely focused on descriptive indicators and retrospective reporting, People Analytics emphasizes explanatory and predictive reasoning, often supported by advanced statistical modeling and artificial intelligence techniques. This shift reflects a broader transformation in management sciences toward evidence-based decision-making under conditions of complexity and uncertainty.

The purpose of this publication is to analyse the potential of AI implementation in people analytics.

From a theoretical perspective, People Analytics can be understood as an extension of organizational behavior research grounded in empirical positivism, but augmented by computational approaches. Classical theories of organizational behavior—such as motivation theories, social exchange theory, job design models, and leadership frameworks—provide the conceptual scaffolding for interpreting behavioral data. AI-driven analytics does not replace these theories; rather, it operationalizes them in new ways. Behavioral constructs that were previously measured through limited survey instruments are now increasingly inferred from multi-source, high-frequency data, including digital traces of work activities, communication patterns, and performance dynamics. This transformation alters not only the scale of analysis, but also the epistemological assumptions about how organizational knowledge is generated (Antczak et al., Bottesch et al., 2025; Lim, Jang, 2025; Kaur et al., 2025; Zheng, Sikora, 2025).

Artificial intelligence plays an important role in this evolution by enabling the processing and interpretation of complex, high-dimensional datasets that exceed the capacity of conventional analytical methods. In organizational research, AI is primarily associated with machine learning, natural language processing, and network analysis. These approaches are designed to identify latent patterns, non-linear relationships, and interaction effects within behavioral data. Conceptually, this introduces a shift from variable-centered explanations toward pattern-centered reasoning. Rather than testing isolated hypotheses about single predictors, AI-based People Analytics often explores configurations of factors that jointly shape organizational behavior (Zhu et al., 2025; Parter et al., 2025; Rafi et al., 2025).

At the same time, this computational orientation raises important conceptual distinctions. Traditional organizational research typically prioritizes theory-driven model specification, where variables and relationships are defined *ex ante* based on established frameworks. In contrast, AI-driven analytics often relies on data-driven discovery, where patterns emerge inductively from the data. This does not imply a rejection of theory, but it does require

a rethinking of the role of theory in the research process. Theory increasingly functions as an interpretative lens used to make sense of algorithmic outputs, rather than as a strict blueprint for model construction. This creates a hybrid epistemology, combining inductive learning with deductive interpretation (Gokhale et al., 2025; Mahar, 2025; Pareek, 2025; Jonek-Kowalska, Wolniak, 2021, 2023).

People Analytics also draws conceptually on decision science and management control theory. The fundamental promise of the approach is not merely improved description of organizational phenomena, but enhanced decision quality. AI-supported People Analytics aims to reduce cognitive biases, information asymmetries, and bounded rationality in managerial decision-making. From this perspective, organizational behavior is treated as a dynamic system in which individual actions, social interactions, and structural constraints co-evolve over time. AI models, particularly predictive and simulation-based ones, allow researchers and practitioners to explore counterfactual scenarios, assess intervention effects, and anticipate unintended consequences of managerial actions (Han et al., 2024; Handa et al., 2025; Aggarwal, Kaur, 2024).

An important conceptual foundation of People Analytics lies in its treatment of employees as both agents and data subjects. Organizational behavior research has long emphasized human agency, meaning-making, and contextual embeddedness. AI-driven analytics, however, risks reducing behavior to measurable signals if not theoretically grounded. Conceptually robust People Analytics frameworks therefore stress the need to contextualize data within organizational culture, institutional norms, and power relations. Behavioral patterns identified by algorithms acquire meaning only when interpreted in relation to these broader social structures. This interpretive layer is essential to avoid technological determinism and to preserve the explanatory richness of organizational research (Atakan, 2024; Frumento et al., 2025; Di Lauro et al., 2025; Rosak-Szyrocka, Wolniak, 2025a, 2025b).

Another issue concerns the level of analysis. Organizational behavior traditionally distinguishes between individual, group, and organizational levels. People Analytics, supported by AI, enables simultaneous multi-level analysis, linking micro-level behavioral data with meso-level team dynamics and macro-level organizational outcomes. Conceptually, this supports more integrated models of organizational behavior, where cross-level interactions can be examined empirically rather than assumed theoretically. However, it also requires careful attention to aggregation logic, temporal alignment, and causal inference, as correlations across levels do not automatically imply meaningful behavioral mechanisms (Sasitekha et al., 2024; Skotnicka-Zasadzień, Wolniak, 2026; Bandyopadhyay, Banerjee, 2025; Freeda et al., 2024).

Ethical and normative considerations form an integral part of the conceptual foundations of People Analytics. The use of AI in analyzing organizational behavior raises questions about privacy, autonomy, transparency, and fairness. From a theoretical standpoint, these issues intersect with stakeholder theory and theories of organizational justice. Conceptually sound People Analytics frameworks recognize that data-driven insights are not value-neutral. Choices

regarding what data are collected, how models are trained, and how results are used reflect implicit assumptions about control, trust, and the role of employees in the organization. Embedding ethical reasoning into the conceptual design of People Analytics is therefore not an external constraint, but a core theoretical requirement (Banerjee et al., 2015; Davanzo, 2025; Kaur et al., 2025; Kapil, Rawat, 2025).

The conceptual foundations of People Analytics and artificial intelligence in organizational research rest on a synthesis of classical organizational behavior theory, computational analytics, and decision science (table 1). AI extends the analytical reach of organizational research by enabling the exploration of complex behavioral patterns, yet it simultaneously challenges established epistemological and ethical assumptions. A theoretically informed approach to People Analytics treats AI not as a substitute for organizational theory, but as an analytical instrument whose value depends on rigorous conceptual framing. Such an approach allows organizational research to remain analytically robust while adapting to the data-rich realities of contemporary work environments (Md et al., 2025; Bhati, 2024; Corrigan et al., 2025).

Table 1.

Conceptual foundations of People Analytics and AI in organizational research

Conceptual dimension	Core assumptions	Implications for organizational behavior research
People Analytics as an analytical paradigm	Organizational behavior can be systematically explained and predicted using multi-source employee and process data rather than isolated HR indicators	Shifts research focus from descriptive HR metrics toward explanatory and predictive models of individual and collective behavior
Role of artificial intelligence	AI enables identification of non-linear, latent, and high-dimensional behavioral patterns beyond the limits of classical statistical methods	Encourages pattern-centered and configuration-based explanations instead of single-variable causal testing
Theory–data relationship	Theory provides interpretative and contextual grounding, while AI supports inductive pattern discovery	Requires hybrid epistemology combining data-driven learning with theory-based interpretation
Decision-oriented perspective	Behavioral insights should improve managerial decision quality under complexity and bounded rationality	Positions organizational behavior research closer to decision science and management control
Level of analysis integration	Individual, team, and organizational behaviors are interdependent and dynamically linked	Enables empirical investigation of cross-level interactions rather than purely conceptual models
Contextual embeddedness of behavior	Behavioral data acquire meaning only within organizational culture, norms, and power structures	Prevents reduction of human behavior to purely technical or algorithmic representations
Ethical and normative foundations	Data-driven analysis of employees is not value-neutral and affects trust, fairness, and autonomy	Integrates organizational justice and stakeholder theory into People Analytics design
Temporal and dynamic perspective	Organizational behavior evolves over time rather than remaining static	Supports longitudinal, predictive, and scenario-based behavioral modeling

Source: Author's own work.

2. Applications of AI-Driven People Analytics in Understanding Organizational Behavior

AI-driven People Analytics has become an increasingly important instrument for empirical research on organizational behavior, primarily because it enables the observation and analysis of behavioral phenomena at a scale, granularity, and temporal resolution that were previously inaccessible. Its applications extend well beyond operational HR reporting, contributing to theory-informed explanations of how individuals and groups behave in complex organizational systems. From an analytical standpoint, artificial intelligence allows behavioral constructs to be examined as dynamic, multi-dimensional processes rather than static attributes measured at single points in time (table 2).

AI-driven People Analytics concerns the analysis of employee engagement and motivation. Traditional engagement research relies heavily on self-reported survey data, often collected annually or biannually. AI methods make it possible to complement these measures with behavioral proxies derived from digital work traces, communication frequency, task completion rhythms, and collaboration patterns. Machine learning models can identify combinations of behavioral signals that correspond to sustained engagement, disengagement, or transitional states between them. Conceptually, this enables engagement to be treated as a fluctuating behavioral condition rather than a stable psychological trait, offering a more realistic representation of everyday organizational life (Das, Samal, 2025; Takascova, Petrínek, 2025).

Another important area of application is the analysis of employee turnover and retention. Predictive models based on AI are increasingly used to identify early warning signals of voluntary exit, drawing on heterogeneous data such as career trajectories, internal mobility, performance evaluations, workload indicators, and social network position. From the perspective of organizational behavior, the value of these applications lies not in prediction alone, but in the ability to uncover structural patterns associated with withdrawal behaviors. AI-driven clustering and classification techniques can reveal distinct profiles of turnover risk, indicating that exit decisions are often embedded in broader configurations of work conditions, social relations, and developmental opportunities.

AI-supported People Analytics also contributes significantly to the understanding of team dynamics and collaboration. Organizational behavior research has long emphasized the importance of informal interaction patterns, trust, and coordination for team effectiveness. Advances in network analysis and natural language processing allow researchers to reconstruct interaction networks from communication data and to examine how information flows, influence structures, and collaboration intensity evolve over time. These applications enable the empirical study of emergent team behaviors, such as the formation of informal leadership, sub-grouping, or coordination breakdowns, which are difficult to capture through conventional research designs.

Leadership analysis represents another domain where AI-driven People Analytics offers new insights. Rather than conceptualizing leadership solely through formal roles or self-assessments, AI models can analyze behavioral manifestations of leadership, including communication style, responsiveness, decision patterns, and relational positioning within networks. Natural language processing techniques applied to written or spoken communication can identify linguistic markers associated with supportive, directive, or participative leadership behaviors. This approach aligns leadership research more closely with observed behavior, reducing reliance on perceptual measures and enabling longitudinal analysis of leadership development and effectiveness (Jones et al., 2025; Mahar, 2025; Rafi et al., 2025; Zhen, Sikora, 2025).

Well-being and workload management constitute a further application area with strong implications for organizational behavior theory. AI-based People Analytics can detect patterns indicative of cognitive overload, work intensification, or work–life boundary erosion by analyzing temporal work patterns, task switching frequency, and communication outside standard working hours. These insights support a behavioral understanding of stress and burnout as cumulative processes shaped by organizational design and digital work practices. Importantly, such analyses shift attention from individual resilience toward structural conditions that systematically influence employee well-being (Wolniak, Stecuła, 2024; Wolniak et al., 2025).

Diversity, inclusion, and equity analyses have also been increasingly supported by AI-driven People Analytics. Machine learning techniques can be used to identify disparities in career progression, performance evaluation, or access to developmental opportunities across demographic and organizational groups. From an organizational behavior perspective, these applications help uncover subtle, systemic patterns of bias that may not be visible through aggregate statistics. When theoretically grounded, AI-supported analyses contribute to a more nuanced understanding of how organizational practices reproduce or mitigate inequality through everyday behavioral processes.

AI-driven People Analytics further enables the study of learning and skill development within organizations. By analyzing patterns of task performance, training participation, and knowledge sharing, AI models can identify learning trajectories and skill acquisition pathways. This supports a behavioral view of learning as an ongoing, socially embedded process rather than a discrete outcome of formal training interventions. Such applications are particularly relevant in knowledge-intensive and digitally mediated work environments, where informal learning plays a central role in organizational adaptation (Aggarwal, Kaur, 2024; Corrigan et al., 2025; Frumento et al., 2025; Lim, Jang, 2025; Pareek, 2025).

Table 2.

Implementation of artificial intelligence in People Analytics for organizational behavior analysis

Application area	AI-based analytical approaches	Contribution to understanding organizational behavior
Employee engagement and motivation	Machine learning models using behavioral proxies from digital work traces and communication patterns	Conceptualizes engagement as a dynamic behavioral state rather than a static attitudinal construct
Employee turnover and retention	Predictive modeling, classification, and clustering based on career, performance, and social network data	Reveals structural configurations of withdrawal behavior embedded in work conditions and social relations
Team dynamics and collaboration	Social network analysis, temporal interaction modeling, and communication analytics	Enables empirical analysis of emergent team behaviors, coordination patterns, and informal structures
Leadership behavior	Natural language processing and network-based role analysis	Shifts leadership research toward observed behavioral manifestations rather than perceptual measures
Employee well-being and workload	Temporal pattern analysis, anomaly detection, and workload modeling	Frames stress and burnout as cumulative, system-level behavioral processes
Diversity, equity, and inclusion	Bias detection models and comparative outcome analysis across groups	Identifies systemic and often invisible behavioral mechanisms reproducing inequality
Learning and skill development	Pattern recognition in task performance and training participation data	Supports a behavioral view of learning as a continuous, socially embedded process
Organizational change and adaptation	Predictive and scenario-based AI models	Improves understanding of behavioral responses to structural and technological change

Source: Author's own work.

The table 3 presenting existing AI-driven People Analytics applications illustrates both the functional diversity of contemporary analytical tools and their shared epistemological assumption that organizational behavior can be empirically reconstructed from multi-source digital data. Platforms such as Visier People Analytics, SAP SuccessFactors People Analytics, and Workday People Analytics represent an integrated workforce analytics approach in which transactional HR data are combined with predictive and scenario-based models. From the perspective of organizational behavior research, their primary contribution lies in shifting attention away from static workforce descriptions toward the analysis of behavioral processes, including turnover dynamics, internal mobility, and performance trajectories.

A distinct category is formed by applications embedded directly in digital work infrastructures, exemplified by Microsoft Viva Insights. By relying on collaboration metadata rather than self-reported information, these tools enable continuous observation of communication intensity, coordination patterns, and temporal work structures. This allows organizational behavior to be analyzed as an observable, ongoing process situated in everyday work practices, rather than as a set of attitudes captured at discrete moments. As a result, phenomena such as collaboration overload, fragmentation of attention, and boundary management become empirically accessible.

Another important group of applications focuses on social interaction and informal relational structures, as illustrated by Humanyze. By combining sensor-based data with communication analytics, such tools make it possible to empirically map social networks and interaction frequencies within organizations. This has substantial implications for organizational behavior theory, as constructs such as social capital, cohesion, and informal leadership can be operationalized using behavioral data rather than inferred indirectly through surveys or managerial assessments.

Applications such as Peakon and Culture Amp represent a hybrid approach that integrates traditional attitudinal measurement with AI-supported sentiment analysis and trend detection. Their analytical value lies in treating engagement, organizational climate, and employee voice as dynamic phenomena that evolve over time. For organizational behavior research, this supports a process-oriented understanding of collective attitudes, emphasizing short-term fluctuations and feedback loops rather than stable, long-term states.

The table also highlights platforms oriented toward skills, learning, and internal labor markets, including Eightfold AI and Gloat. By inferring competencies from work histories, project participation, and learning activities, these tools enable a behavioral analysis of career development, job crafting, and self-directed mobility. This perspective reframes learning and development as adaptive behavioral processes embedded in organizational contexts, rather than as outcomes of formal training interventions alone.

Taken together, the applications summarized in the table demonstrate that AI-driven People Analytics does not constitute a single technological solution but rather an ecosystem of tools addressing different dimensions of organizational behavior. Their common contribution is the ability to move organizational behavior research toward more processual, multi-level, and behaviorally grounded analyses. At the same time, the table implicitly underscores the need for strong theoretical framing, as the interpretive value of algorithmic outputs depends on their integration with established organizational behavior theories and contextual understanding.

Table 3.

Existing AI-driven People Analytics applications used in organizational behavior analysis

Application name	Core functionality	Relevance for understanding organizational behavior
Visier People Analytics	Advanced workforce analytics platform integrating HRIS data, predictive models, and scenario simulations	Enables analysis of behavioral drivers of turnover, engagement, and internal mobility at individual and group levels
Workday People Analytics	Embedded AI analytics using machine learning on performance, skills, and career data	Supports behavioral interpretation of career trajectories, performance dynamics, and skill development patterns
Microsoft Viva Insights	Behavioral analytics based on Microsoft 365 collaboration metadata	Reveals patterns of collaboration, workload distribution, boundary management, and team interaction rhythms
Humanyze	Wearable- and sensor-based analytics combined with communication data	Empirically captures face-to-face interaction, social connectivity, and informal collaboration behaviors

Cont. table 3.

Peakon (Workday Peakon Employee Voice)	AI-supported continuous listening platform integrating surveys and sentiment analysis	Models engagement and voice behavior as dynamic organizational processes
Eightfold AI	Talent intelligence platform using deep learning for skill inference and career matching	Supports behavioral understanding of learning, capability development, and talent mobility
Culture Amp	Engagement and performance platform using predictive analytics and NLP	Links organizational culture indicators with observable behavioral responses and performance outcomes
SAP Success Factors People Analytics	Workforce analytics combining HR data with predictive and comparative benchmarks	Enables behavioral analysis of workforce stability, performance variation, and succession risks
Gloat	AI-based internal talent marketplace	Provides insight into self-directed career behavior, project-based collaboration, and motivation patterns
IBM Watson Talent Insights	AI-driven labor market and workforce analytics platform	Contextualizes organizational behavior within external skill demand and workforce dynamics

Source: Author's own work.

3. Conclusion

This paper concludes that Artificial Intelligence–driven People Analytics constitutes a substantive methodological and conceptual advancement in organizational behavior research rather than a purely technological enhancement. By integrating computational analytics with established organizational behavior theories, AI enables the systematic analysis of employee behavior as a dynamic, multi-level, and context-dependent process, extending beyond the limitations of traditional, survey-based and descriptive HR approaches. The reviewed evidence demonstrates that AI-supported People Analytics allows for more precise identification of behavioral patterns related to engagement, turnover, collaboration, leadership, well-being, learning, and inclusion, while simultaneously improving the explanatory and predictive power of organizational research.

At the same time, the analysis clearly indicates that the effectiveness of AI in People Analytics is contingent upon rigorous theoretical grounding and careful epistemological positioning. AI methods do not replace organizational theory; rather, they transform its role from *ex ante* model specification toward interpretative sense-making of algorithmically detected patterns. This hybrid logic—combining inductive data-driven discovery with deductive theoretical interpretation—emerges as a defining characteristic of contemporary People Analytics. Without such integration, there is a risk of reducing complex human behavior to technical signals devoid of organizational meaning.

The paper also highlights that ethical and normative considerations are inseparable from the analytical design of AI-driven People Analytics. Issues of privacy, transparency, fairness, and employee autonomy are not peripheral constraints but central theoretical dimensions that shape trust and legitimacy within organizations. Consequently, future development of People Analytics should embed ethical reasoning directly into analytical frameworks, governance structures, and managerial decision processes.

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