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FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Contemporary management. Presented papers contain result of researches conducted by various universities from Poland. The number consists of 42 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: innovation management, project management, human resource management, financial management, sustainability, logistics, environmental management, public management, impact of COVID-19 on management, information management, economics, production management, management in healthcare, AI in management, Industry4.0, CSR, and business analytics.

Radosław Wolniak

COMPLAINT ANALYSIS AS A TOOL FOR PRODUCT IMPROVEMENT: A CASE STUDY OF BABY STROLLER MANUFACTURING

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Purpose: A significant source of information regarding product quality for a company is the complaints lodged by customers. The analysis of complaints can provide the company with valuable insights. Therefore, the objective of this study is to analyze complaints from a one-month period within a company manufacturing baby strollers. The analysis of complaints was conducted to identify areas within the studied company where discrepancies occur, enabling appropriate corrective actions to be implemented.

Design/methodology/approach: The Pareto chart was utilized to conduct the analysis of complaints, illustrating the group of most significant issues. To delve into the root cause of the problem, a task force team employed the 5 Whys method. In the article, based on conducted literature reviews, a theoretical description of quality management tools and methods such as the Pareto chart, the 5 Whys method, Kaizen philosophy, teamwork, and additionally, information regarding product quality and safety can be found.

Findings: During the course of our work, the source of failures within the company was identified. The major issue turned out to be haste, affecting both the production staff and an external company collaborating with the enterprise. As part of the corrective actions, a motivational system was implemented for employees, and piecework norms were established within the company. Additionally, an innovative solution was applied in the examined enterprise through the design and creation of pattern books for inter-process control within the company and final inspection at the crossbar flat supplier. The proposed problem-solving methods within the enterprise can be applicable for future endeavors.

Research limitations/implications: The study was conducted over a short period of time due to the urgent need to address existing issues within the company. It can be inferred that if a longer time frame were taken into account, it would be possible to identify additional causes of discrepancies.

Originality/value: The obtained results can serve as a valuable source of information for other companies manufacturing baby strollers, which are seeking solutions to their own issues.

Keywords: products quality, Kaizen, 5why, team work.

Category of the paper: Research paper.

1. Introduction

In Poland, the market for children's products is highly developed, ranking fourth in terms of the number of online stores offering children's products. There are many companies involved in the production of baby strollers, with the Częstochowa region being a leading area in this industry. Polish entrepreneurs have the opportunity to showcase their products at both domestic and international baby fairs. However, a significant threat to businesses in the childcare sector is demographics, with recent years witnessing a low birth rate. In the case of baby strollers, an additional challenge arises from the growing popularity of the secondary market, favored by parents.

Baby strollers, serving as indispensable tools in family life, must be designed and manufactured with the utmost care for quality and safety. There are several key reasons why these two aspects are incredibly important for this type of product. Firstly, the quality of a baby stroller directly impacts its durability and resilience. A stroller with a sturdy construction and made of high-quality materials will serve for many years, passing it down from generation to generation. Moreover, high quality also means less susceptibility to malfunctions and greater resistance to daily wear and tear, providing parents with peace of mind. Secondly, the safety of a baby stroller is invaluable. The child spends a significant portion of their day in it, making it crucial for it to be designed with maximum child safety in mind. Features such as a solid construction, stability, durable safety harnesses, and safeguards against accidental folding ensure parents that their child travels in safe conditions. It is worth noting that quality and safety are closely intertwined. High-quality craftsmanship of a baby stroller often goes hand in hand with ensuring the highest safety standards. Therefore, when choosing a stroller for your little one, it is important to consider both aspects to provide the child with the best travel conditions and give parents peace of mind.

Customer complaints are an important source of information regarding the quality of products, including baby strollers. This is a broad area that depends on the specifics of each company. Therefore, the topic has been discussed in general to emphasize the importance of conducting an analysis of customer complaints. It is worth noting that in many publications concerning service quality, this topic is often overlooked. Instead, they focus on typical methods used in such research, failing to appreciate the valuable insights that complaint analysis can provide.

We often have a negative perception of complaints due to their demanding nature. However, it is important to emphasize that they represent one of the most significant sources of information about product quality that a company can leverage. If a company treats complaints as routine issues that need to be resolved as quickly as possible, it may indicate a lack of understanding of the role of complaints in assessing quality. Furthermore, the way in which a company receives and handles complaints can negatively impact its reputation in the eyes of the customer.

A challenge lies in utilizing complaint data to make informed decisions. By leveraging this information in processes related to design, marketing, distribution, and after-sales service and maintenance, significant insights into customer preferences and market trends can be obtained. Moreover, complaints should not be solely viewed as a negative phenomenon. They serve as signals indicating product weaknesses and reasons for customer dissatisfaction, enabling effective responses from the company. A worse scenario is when a customer fails to report a complaint but instead shares their negative experiences with others and publishes them on various social media platforms, leading to poor publicity for the company and the inability to intervene to resolve the issue and satisfy the customer (Ingaldi, 2022).

The aim of this study is to analyze complaints from a selected period in a company manufacturing baby strollers. The study aims to utilize selected quality management methods and tools to identify areas of discrepancies and implement corrective actions accordingly. The Pareto chart was employed for analysis, illustrating a group of significant issues and identifying their underlying causes using the 5 Whys method. In the examined company, haste emerged as the major problem, affecting both production employees and an external company collaborating with the enterprise. As part of the corrective measures, a motivational system for employees was introduced, and piecework norms were established. Additionally, a pattern book was designed and created for a key component of the baby stroller, aimed at introducing inter-process control by employees and implementing final inspection at the suppliers.

2. Literature review

Running a business in today's times presents significant challenges for enterprises. This encompasses a range of interactions with the environment, which can generate both uncertainty and risk, as well as opportunities for rapid development and profit growth. The key to capitalizing on these potential opportunities is flexible business management, enabling quick responses to changing market conditions (Biadacz, 2024). Achieving success is a complex process that cannot be reduced to a single specific list of factors. Nonetheless, analyzing these factors allows for the identification of certain regularities that can be useful for businesses. There are many elements influencing success, the thorough analysis of which can aid in their prioritization. The appropriate combination of these factors can, in turn, lead to the development of a cohesive "success strategy" for the enterprise (Czerwińska, Pacana, 2023). Success in business increasingly depends on an approach to sustainable environmental development, working conditions, safety (Lazar et al., 2022) of work and products, and the quality of these products. The dynamic manufacturing market affects product quality and production process efficiency, significantly influencing the company's position in the market and its competitiveness (Pacana and Czerwińska, 2023).

Product quality meets the needs and expectations of customers. Products characterized by low quality lead to complaints, customer dissatisfaction, and loss of trust. For companies, product quality is a crucial factor in competitiveness. The market offers a vast array of products, some of which may pose risks to life and health. Therefore, entrepreneurs bear full responsibility for the quality and safety of their offered products. Companies that prioritize product quality can gain a competitive advantage and earn customer trust. Furthermore, product quality contributes to building the company's image as a producer of reliable, innovative, and sturdy products. Product quality is important for both customers and businesses in internal processes. Companies focusing on quality can succeed in the market by minimizing costs associated with complaints and repairs, increasing production efficiency, and fostering better relationships with suppliers. Product quality is a determinant factor of a company's success or failure in the market. The first person to define the term "quality" was Plato. The Greek philosopher described quality as a certain degree of excellence. This definition was expanded to include objective and subjective characteristics. Attributes such as weight and shape fall under measurable, objective characteristics, while color and scent belong to subjective traits. In the context of a product, quality attributes can include (Tamimi, Sebastianelli, 2022):

- functionality (determines the level of fulfillment of expected functions by the product),
- practicality (assesses whether the use of the product is intuitive, simple, and comfortable),
- reliability (determines the period of time during which the product will not require repairs),
- durability (determines the period of time during which the product maintains its functional characteristics),
- safety of use.

Product quality is closely linked to user safety. A high-quality product is made from suitable materials, complies with safety standards and regulations, and undergoes thorough testing. To minimize the risk of accidents and damage, manufacturers place significant emphasis on product quality during the design phase. Additionally, to prevent defects and enhance product safety, quality control is necessary at every stage of production, from raw materials to the finished product on store shelves. Quality control in the production process enables the creation of safe products that meet customer needs and provide a safe working environment. Safe and high-quality products benefit manufacturers by allowing them to build a positive company image and gain customer trust. For consumers, the benefit lies in increased safety and reduced risk of accidents or injuries. Three indicators are used to assess product quality (Tang, 2008):

- complaint rate (indicates the number of complaints relative to the number of products sold),
- customer satisfaction index (information about the level of customer satisfaction with the purchased product obtained through surveys or satisfaction studies),

- product quality index (overall assessment of product quality. evaluation of durability, reliability, performance, safety of use, compliance with standards. ability to compare the product with competing products).

In every enterprise, both product quality and safety are equally important. Standards such as ISO 9001, ISO 45001, or other quality and safety management systems place great emphasis on achieving both objectives. As a result, companies establish an overall organizational culture of quality and safety. This has many benefits for the enterprise, including conducting a greater number of studies, access to data, employee training, and greater focus of management personnel.

In today's dynamic business environment, the occurrence of discrepancies in manufactured products becomes a key challenge for enterprises. As research indicates (Potkány et al., 2021), such discrepancies not only lead to customer dissatisfaction by failing to meet their expectations but also generate excessive production costs. Faced with this reality, anticipating the number of discrepancy incidents becomes an essential tool for management, enabling better preparation for the future by identifying the most probable scenario. As aptly noted by Knop and Ziora (2022), it is better to know the future with a certain degree of certainty than to be limited to analyzing the past with 100% certainty. Predicting the number and types of discrepancies is therefore a crucial element of risk analysis, allowing for effective preventive action.

By utilizing Kaizen, it is possible to improve a selected product, which should have an impact on its quality and customer satisfaction. The essence of Kaizen lies in engaging all employees at various organizational levels in identifying problems, seeking solutions, and implementing small improvements on a daily basis. Kaizen promotes a culture of continuous improvement based on trust, collaboration, and the pursuit of excellence. Kaizen is a particular management approach aimed at achieving competitive advantage through continuous learning (Samadhiya et al., 2023) and incremental improvement of processes in every organization (Khan et al., 2019; Sordan et al., 2022; Goni et al., 2018).

In every customer-centric enterprise, all customer complaints are thoroughly and meticulously investigated. As research shows (Skotnicka-Zasadzień, 2010), the majority of discrepancies and errors in products arise during the production process. Therefore, it is crucial to carefully analyze all stages of this process to avoid complaints regarding the finished product, which in turn leads to increased costs for the company.

According to research conducted by Stauss and Scholer (2004), only an average of 24% of dissatisfied customers decide to directly lodge a complaint with the company, with only about half of them receiving satisfactory resolution of their complaint, as noted by Estelami (2000). This is a well-documented phenomenon, where many businesses struggle to effectively handle customer complaints. Andreassen (2001) found that 40% of customers who complained about services were dissatisfied with the complaint resolution process by the service-providing companies. Therefore, it is evident that companies must significantly enhance their efforts in handling complaints to ensure customer satisfaction.

It is important to emphasize that properly conducted complaint analysis can bring greater benefits to a company than any other quality-related research. Organizations should realize that handling complaints and analyzing them, despite the incurred costs, allows for the implementation of corrective actions aimed at eliminating the sources of defects. In the short term, such actions can lead to delivering high-quality products to customers that do not require complaints. This, in turn, contributes to increased customer satisfaction and sales growth. Therefore, continuous monitoring of complaint causes is essential in every enterprise (Balon, 2016; 2017).

In the complexity of customer complaints lie numerous valuable insights for a company, encompassing customer expectations towards the product, unmet requirements, and perceived product quality. Through complaints, enterprises gain insights into how to improve products or services to better meet customer needs (Barlow, Moller, 2001; Balon, 2016). From this, it can be inferred that customer analysis plays a crucial role in shaping and improving product quality.

The benefits of an effective customer complaint management system should contribute to increased operational efficiency by identifying trends and causes of complaints, resolving a greater number of complaints through a more customer-centric approach, engaging employees in new customer service training opportunities, and continuously monitoring and improving the complaint resolution process (BSI Group). Researchers emphasize the potential of complaint management systems and service improvement to enhance customer satisfaction (Smith et al., 1999). All information derived from customer complaints must be analyzed to enable strategic planning for improving the quality of services offered (Merril, 2009). Addressing and resolving complaints should serve as a catalyst for increasing customer satisfaction rather than a result of dissatisfaction (Ramphal, 2016), and also as motivation for improving one's own actions.

Addressing and resolving complaints should occur as swiftly as possible, even if it may seem annoying, time-consuming, and costly. Otherwise, it can lead to reputation damage caused by negative word-of-mouth. Handling customer complaints often represents the organization's last chance to change the customer's attitude and mitigate their dissatisfaction (Vincent, Webster, 2005). Responses to customer dissatisfaction should be embraced as direct customer feedback presents an excellent opportunity for organizations to learn and rectify mistakes (Thøgersen et al., 2003), restore customer trust, and strategically utilize feedback to enhance organizational performance (Johnston, 2001; Ramsey, 2003; Hughes, Karapetrovic, 2006; Ramphal, 2016).

The market associated with the children's industry is enormously demanding in terms of quality and safety. Companies producing products for children strive to introduce innovative and modern technologies. This is because entrepreneurs in the children's industry must meet stringent safety regulations for their products while meeting customer expectations. Articles intended for children entering the European market must undergo testing to determine their compliance with safety requirements specified by standards harmonized with the General Product Safety Directive No. 2001/95/EC (Krynke, Ingaldi, 2017). Every manufacturer of baby

strollers should familiarize themselves with the PN-EN 1888:2012 standard "Child use and care articles - Wheeled child conveyances - Safety requirements and test methods". Familiarity with standards is crucial in the work of baby stroller designers. To ensure compliance with norm requirements, the stroller designer pays attention to the following during the design stage (Rahman et al., 2017):

- Chemical safety of materials.
- Mechanical safety.
- Information for the user.

The materials used in the production of baby strollers, especially those that come into direct contact with the child's skin, should be chemically safe. They must not exceed the permissible limits for heavy metals, phthalates, and polycyclic aromatic hydrocarbons, as presented in Table 1.

Table 1.

The limit values for elements according to the PN-EN 71-3:1994 standard

Element	Permissible concentration
Antimony	60 mg/kg
Arsenic	25 mg/kg
Barium	1000 mg/kg
Cadmium	75 mg/kg
Chromium	60 mg/kg
Lead	90 mg/kg
Mercury	60 mg/kg


Source: Mańczak, 2015.

Exceeding the established limits in the standard may adversely affect the hormonal and reproductive system of children. Materials used in the production should not be flammable. Manufacturers opting for purchasing raw materials for the production of baby strollers should ensure that they are properly tested according to current standards. The stroller's design should not have sharp edges or protruding elements that could cause abrasions or cuts to the child's skin. Braking elements of the stroller should be easily accessible and easy to use for the caregiver, but inaccessible to the child in the stroller. The stroller's construction should be correct and stable. At the design stage, the weight of the child and possible additional loads should be taken into account (Soewardi, Nariswari, 2020). The standard requires the child restraint system in the stroller to include a crotch strap. Foldable strollers should have a locking mechanism to prevent folding while in use. Detailed requirements, test methods, and parameters are defined by the PN-EN 1888 standard. Manufacturers introducing baby strollers to the market are obliged to label them in accordance with applicable regulations. Parents and caregivers should be aware of all hazards associated with improper use and improper adaptation of the stroller to the child's age and weight (Soewardi, Nariswari, 2020). Clear information placed in a visible location for the customer is a basic safety requirement. Manufacturers of

baby strollers and other children's products that meet the requirements specified in the standards are focused on the quality and safety of the products offered (Mańczak, 2015). Key considerations before purchasing a baby stroller are presented in Table 2.

Table 2.

Key aspects when choosing a baby stroller

Safety standards PN-EN 1888:2012	Chemical safety Textile materials must be chemically safe	Flammability Textile materials must not be flammable
Fastenings Child harness system with adjustable crotch strap		Edges No sharp edges and protruding elements
Brakes and locks Easily accessible for the caregiver. Inaccessible to the child in the stroller		Stability During the design stage, the weight of the child and possible additional loads should be taken into account
Folding lock At least one locking mechanism required		Labels Information regarding the manufacturer's name, product name, standard number, and applicable warnings

Source: own study based on Xiaoli et al., 2020.

3. Materials and methods

The article provides an analysis of complaints within the examined company over a selected period. This company has extensive experience in producing car seats and strollers. Quality and safety of the offered products are the company's top priority. Upon receiving a report from the sales department regarding complaints, the management expressed dissatisfaction with the existing situation. In a short period, the sales department recorded 30 types of stroller defects. With a production plan of 3001 units, 183 complaints reached a level of 6%. Due to the lack of acceptance of the current state, the company's management organized a meeting with representatives of key departments such as production, quality, and warehouse. During the meeting, the head of the quality department proposed forming a task force to identify the sources of problems and promptly implement corrective actions. Initially, a Pareto chart was created based on the complaint report, identifying 8 key issues causing the greatest losses in the company among the 30 types of complaints. With the appointed task force, the 5 Whys method was employed to trace the root causes of the problems. Recognizing that employees are a valuable source of knowledge, it was proposed, with the president's approval, to introduce a Kaizen box in the company. Through teamwork, the examined company managed to identify the sources of failures. An innovative solution was implemented by designing and creating templates for in-process and final inspections of the cross-shaped plate at the supplier.

Rush was also eliminated by introducing new standards and piece-rate norms with a quality bonus for employees. Finally, it was decided with the appointed task force to monitor and evaluate the implemented solutions. The procedure for solving problems in the examined company is presented in Figure 1.

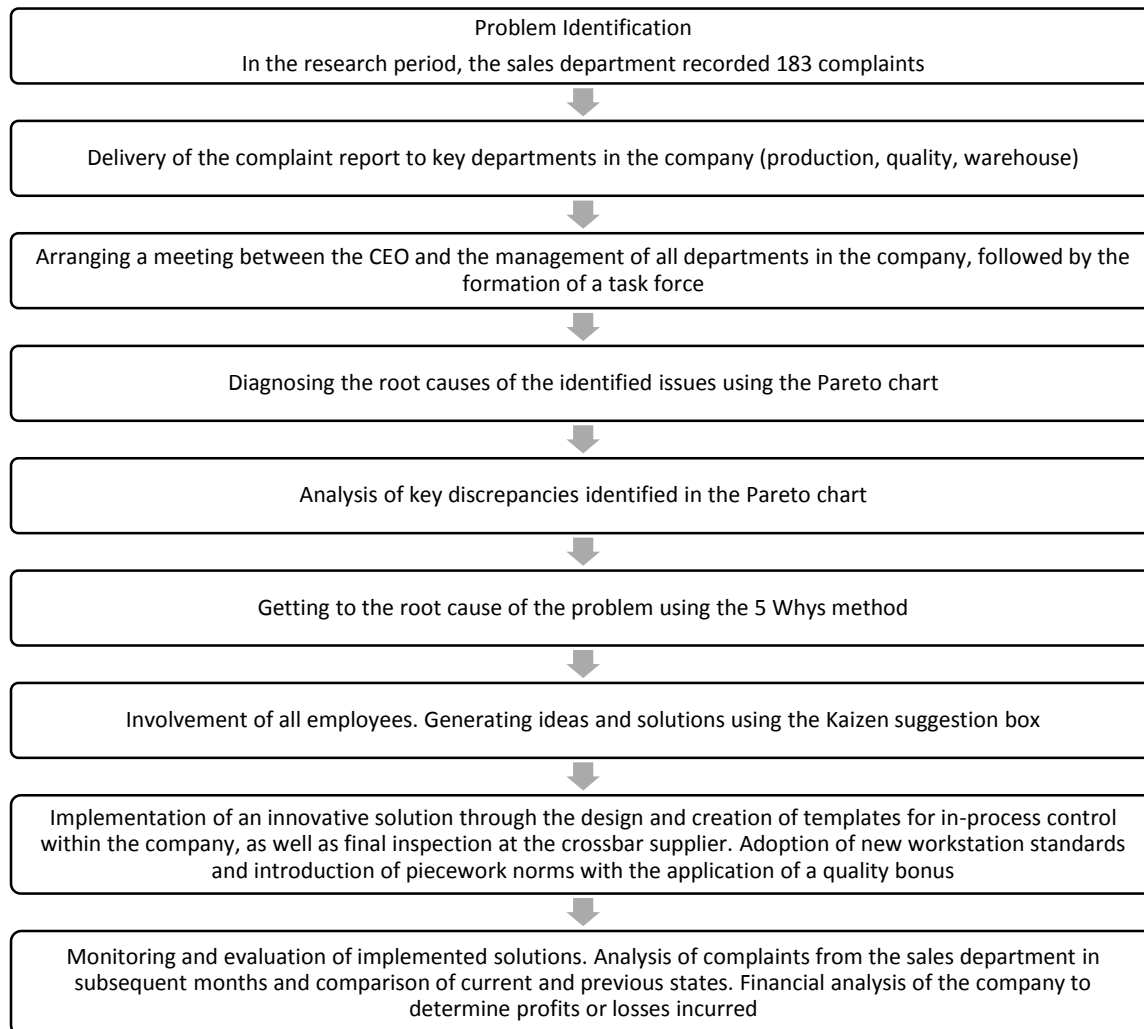


Figure 1. Flowchart of the problem-solving process in the investigated enterprise.

Source: own study based on the material from the research object.

4. Results and discussion

In the initial stage of the investigation, the Pareto chart was employed, based on the theory that approximately 20% of causes account for about 80% of effects. This principle applies not only to manufacturing organizations but also to engineering and natural phenomena. By utilizing the Pareto chart, significant events and causes influencing the quality within the organization can be identified (Borkowski, Ulewicz, 2005). Identifying these events allows us to determine corrective actions aimed at enhancing the quality level within the enterprise.

The Pareto distribution primarily focuses on factors triggering the problem. Consequently, we can address those issues whose resolution will bring the greatest benefits to the organization (Germanova-Kastreva, Dimcheva, 2020). Additionally, it enables us to pinpoint unnecessary costs at their source and thus implement cost-reducing measures (Borkowski, 2012).

Based on the data obtained from the surveyed organizational unit, the Pareto chart was created, as depicted in Fig. 2. In order to gather information regarding the key defects identified by customers, data was obtained from the sales department, as presented in Table 3. It is also worth mentioning the discrepancies that occurred during the production of the finished product. All discrepancies were detected by employees within the production facility before the delivery of the finished product to the customer and promptly addressed.

Table 3.
Prioritization of discrepancies

No	Name of discrepancy	Occurrence	Percentage fraction	Cummulative percentage
1	Wheels: oscillating wheels, layered wheels, damaged rim in wheels, improperly mounted tire on rims, wobbling wheels	72	39.34	39.34
2	Crooked frame	14	7.65	46.99
3	Broken lock in the frame	11	6.01	53
4	Squeaky frame	10	5.46	58.46
5	Faded or damaged material in the bassinet	10	5.46	63.92
6	Damaged backrest in the pushchair	8	4.37	68.29
7	Damaged harness in the pushchair	8	4.37	72.66
8	Damaged recline adjuster in the bassinet	6	3.28	75.94
9	Difficulty in clipping the bassinet onto the frame/adaptor not clipping in	5	2.73	78.67
10	Damaged canopy adjuster	4	2.19	80.86
11	Damaged parasol	3	1.64	82.5
12	Crooked bassinet insert causing improper positioning of the backrest	3	1.64	84.14
13	Pushchair bar not clipping in	3	1.64	85.78
14	Problem with harness adjustment	3	1.64	87.42
15	Problem with wheel locks	3	1.64	89.06
16	Torn handle in the frame	3	1.64	90.7
17	Dented bassinet	2	1.09	91.79
18	Dirty mattress and bag in the bassinet	2	1.09	92.88
19	Loose rivet in the frame	2	1.09	93.97
20	Problem with folding latch in the frame	1	0.55	94.52
21	Improper wheelbase in the car seat	1	0.55	95.07
22	Protruding wire in the canopy of the pushchair	1	0.55	95.62
23	Dented leather in the cross bassinet	1	0.55	96.17
24	Lack of spacing in the frame/looseness in the frame	1	0.55	96.72
25	Lack of axles in the stroller, lack of caps	1	0.55	97.27
26	Damaged plastic in the seat	1	0.55	97.82
27	Lack of screws in the forks	1	0.55	98.37
28	Canopy not aligning properly in the bassinet	1	0.55	98.92
29	Incorrectly packed color of the pushchair	1	0.55	99.47
30	Scratches on the swivels	1	0.55	100
SUM		183	100.00	

Source: own study based on the material from the research object.

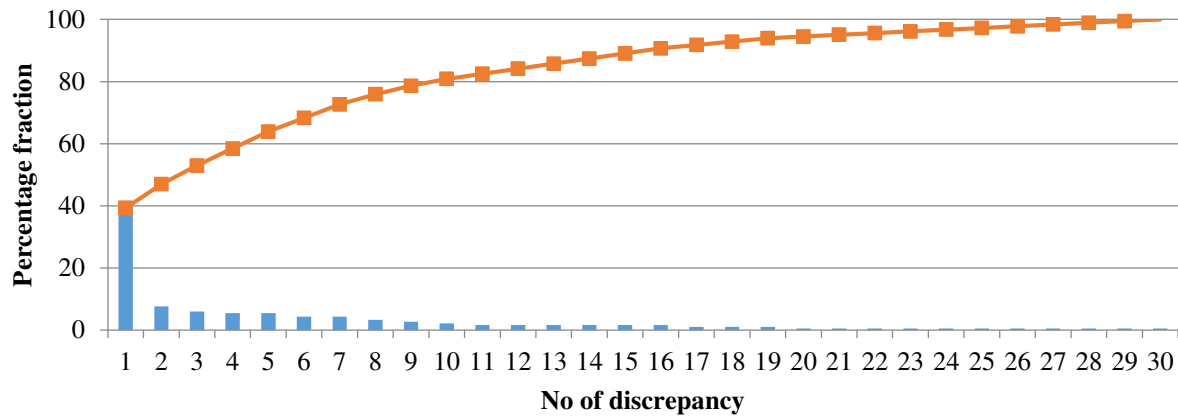


Figure 2. Pareto chart.

Source: own study based on the material from the research object.

During the analyzed period, the manufacturing company produced 3001 units of the finished product. There were 183 complaints recorded for the analyzed batch of strollers. In the studied month, the complaint rate in the company was 6%. Data indicates that over 70% of complaints were due to eight defects, which are presented in Table 4.

Table 4.

Key discrepancy constituting approximately 70% of the complaints in research period

No	Key discrepancy
1	Wheels: oscillating wheels, layered wheels, damaged rim in wheels, improperly mounted tire on rims, wobbling wheels
2	Crooked frame
3	Broken lock in the frame
4	Squeaky frame
5	Faded or damaged material in the bassinet
6	Damaged backrest in the pushchair
7	Damaged harness in the pushchair
8	Damaged recline adjuster in the bassinet

Source: own study based on the material from the research object.

Complaints related to wheels during the investigated period were at 39.34%. Customers reported experiencing the effect of oscillating and wobbling wheels while using the strollers on straight surfaces, which was inconvenient during walks. Additionally, there were cases where the tires on the wheels delaminated or slid off the rims. So far, the company had pneumatic wheels in its product range. Pneumatic wheels are filled with air. Although these wheels are flexible, they also have weaknesses because they are heavy and prone to punctures (Bengtsson, 2019). Before starting the analysis of complaints in the surveyed company, a decision was made regarding the change of wheel assortment. Such a decision was made due to the changing trend in the baby stroller industry. The new solution turned out to be gel and foam wheels. The surveyed company, aiming to meet the new trends, also decided to switch from pneumatic wheels to foam wheels. Foam wheels are much lighter, puncture-resistant, and the stroller is easier to handle (Bengtsson, 2019).

Another key group of defects in the analyzed complaints, at a level of 17.48%, turned out to be damaged components. Customers reported that despite purchasing a new product, it was damaged. The damages most commonly affected the stroller material or components made of scratch-prone materials. Regarding this issue, new packaging standards for baby strollers have been implemented in the company recently, so they will be analyzed in the later period.

The mentioned causes, constituting about 70% of defects in the company, relate to various departments of the organization. These problems concern not only the quality control department but also the production and warehouse departments. After the analysis conducted by the task team, focus was directed towards defects constituting about 19% of complaints during the investigated period. Crooked and squeaky frames, as well as broken locks in the frame, were issues that required immediate corrective actions. If the root causes of these problems are properly eliminated within the company, the overall number of complaints will decrease.

To identify the root cause of a particular issue, the 5 Whys method was employed. This method, also known as root cause analysis, involves asking "why" five times in response to the initial problem (Borkowski et al., 2006). The 5 Whys method is an integral part of Kaizen (Nur Syafie, Binti Shamsudin, 2022). The fundamental principle of Kaizen is continuous engagement and the desire to improve quality within the company. Kaizen is considered a philosophy because it changes the way of thinking, yet in practice, it consists of effective tools for implementing and maintaining changes within an organization. The Kaizen philosophy aims to reduce costs, improve quality, shorten process implementation time, and establish criteria for evaluation and rewards (Borkowski, Ulewicz, 2009).

In the analyzed organization, the Pareto chart indicates a variety of problems occurring within the company. Issues arise in various areas of the enterprise, and solving them by one person would be impossible. The best solutions and improvement ideas come from individuals who are directly involved with the problem. Therefore, as a result, the quality control department implemented an idea box in the company, where every employee could submit their ideas, as shown in Figure 3.

For the organization, the implementation of the Kaizen box proved to be highly beneficial. Gradually, a culture was fostered within the company where employees analyzed their work actively. They were engaged in developing new ideas and started to resist bad habits. The adoption of the Kaizen box was significant for the surveyed organization because, with minimal financial investment, the entire workforce steadily and systematically aimed to improve operations.

The initial ideas explored within the company weren't significant changes but rather small steps. The pursuit of continuous improvement yielded results, and it was found that there was never an endpoint because there was always room for something new. The overarching goal of the entire team was for the company to be better each day than the previous day, utilizing an effective form of employee motivation (Mauch, 2010).



Figure 3. Photograph of a Kaizen suggestion box.

Source: own study.

The first implemented idea from the Kaizen box was the introduction of an information board visible to all employees on the production floor. This board contained information regarding production quantity plans for the month and was updated daily. The team aimed to achieve the goal of producing a specific quantity of baby strollers. As a result, the board streamlined the verification and operation of the production process. Initially, a whiteboard supplemented with markers was used, as depicted in Figure 4. Later on, this board was replaced with a multimedia board.



Figure 4. A photograph of the first idea from the Kaizen box.

Source: own study.

Given the contemporary market conditions, the traditional approach to organizational change is highly inadequate. This applies to both small-scale organizations, such as the one examined, which can be classified as small in terms of the number of employees, and large

corporations. There is a significant need to engage all members of the workforce in the processes of change within the organization. For instance, consider Flextronics International Poland Tczew, which is a Polish branch of a company headquartered in Singapore. The company employs approximately 200,000 workers, with branches in 30 countries. It is involved in designing and producing electronic components and systems. Despite the complexity and variability of its operations, the company achieves excellent results. The company's successes can be attributed to its approach based on continuous improvement. The Tczew branch of Flex has won numerous awards in Lean and quality competitions (Walentowicz, 2016). In terms of Kaizen, it is recognized as the best branch in Europe, partly due to the system of motivating employees for Kaizen, as presented in Table 5.

Table 5.

Key elements of motivating employees for Kaizen

High system efficiency
1. Satisfactory financial rewards
2. Job providing opportunities for self-realization
3. Friendly relations and work atmosphere
4. Good organization of the system
5. Informational feedback
6. Rewards for pro-innovative activity
7. Employee appreciation
8. Climate conducive to innovation
9. Leadership management style and leading by example
10. Teamwork and problem-solving

Source: own study based on Walentowicz, 2016.

Teamwork methods are a specialized group of techniques used in quality management. There are many benefits associated with teamwork. These benefits stem from the parallel problem-solving process and greater possibilities it offers. In teamwork, a wider potential and greater experience can be leveraged. The processes leading to solving specific problems require a team with a broad range of knowledge. Additionally, the team should be characterized by spontaneity and creativity. Specialists from various fields should be appointed to the team, enabling the acceptance of proposed solutions and their immediate implementation (Borkowski, Corejowa, 2004). In the examined company, which is engaged in the production of baby strollers, a team was formed to analyze key defects constituting approximately 70% of complaints within one month, as indicated by the Pareto-Lorenza chart. The team's task was to identify the sources of problems and implement corrective and preventive actions. The team consisted of the following individuals:

- President of the company.
- Logistics and Supply Manager.
- Warehouse Manager.
- Production Department Manager.
- Quality Department Manager.

The team first focused on issues related to the baby stroller frame. Their task was to identify the root cause of problems such as crooked frame, broken lock in the frame, or its squeaking. The team began by asking the question: Why did this problem occur? The question was then repeated until the root cause was ultimately identified, as presented in Table 6. Questions should be posed in such a way as to elicit the best possible answer. The principle of analysis will be correct both in the case of a larger number of questions and if there are fewer questions (Brajer-Marczak, 2015).

Table 6.

Investigating the problem using the 5 Whys method

Why is the frame crooked, squeaky, and why does the lock in the frame break?
The reason may be the right/left crossbar. This element is crucial in the construction of the baby stroller frame.
Why does this element have a negative impact on the stroller's construction?
Because the assembler has trouble distinguishing between the right and left elements, resulting in several discrepancies in the frame.
Why does the assembler fail to differentiate between the right and left crossbars?
The assembler confuses the elements because they are not properly positioned.
Why aren't the crossbars properly positioned?
Because the assembler does not maintain order at the workstation.
Why doesn't the assembler maintain order at the workstation?
The assembler works on a piece-rate system. The main reasons for the lack of order are haste and a lack of consistency, as well as inadequate training in this area.

Source: own study.

Every company possesses four resources. These include financial, informational, tangible, and human resources (Griffin, 2000). Human resources are particularly crucial for a company as the success or failure of the enterprise depends on them. It is important for a company to develop an appropriate personnel management strategy. This involves providing adequate compensation for employees, offering training and development opportunities, and implementing effective career management and planning for employees. Employee compensation should be closely linked to their usefulness to the company while ensuring the employee's satisfaction. In a piece-rate payment system, employee compensation depends on the number of products produced. However, a piece-rate system without established work standards is a flawed system. Established work standards serve as a measure of the effort, efficiency, and quality of work provided by the employee (Ślósarz, 2012).

As the team delved into the root cause of complaints related to the baby stroller frame, it became evident that the rush of the assembly workers was the underlying cause of defects and discrepancies. The workers were compensated on a piece-rate basis without a set work standard, resulting in employees striving to earn the highest possible amount for their work. In pursuit of their goal, they paid little attention to the quality of their tasks, had no time to maintain order at the workstation, and disregarded occupational health and safety regulations.

As corrective measures within the company, piece-rate standards were introduced along with a quality bonus to motivate employees to produce high-quality products. Another concern for the team was that assemblers were mixing up parts and couldn't differentiate between the

right and left crossbars, which were crucial structural elements of the frame. Improper installation of the element resulted in the frame squeaking, the lock breaking, and a large angle of inclination of the mounted bassinet in the frame. This element consisted of two straight crossbars welded together at the appropriate angle, as depicted in Figure 5.

To eliminate human error at the workstation, templates were applied to the baby stroller frame assembly stations. These templates allowed workers to distinguish between the right and left elements and additionally verify the correct angle of welding the two crossbars, which significantly influenced the frame's construction.

As the team dug deeper into the root causes of the problems, it became apparent that not only the rush of assemblers within the company contributed to the issues, but also the haste at an external company. The company outsourced comprehensive welding services, including processing, welding, and cutting of metal components, to an external firm. This firm was tasked with producing a series of components needed for the assembly of the frame within a specified time frame, including the crossbars in this case.

It turned out that insufficient staffing, lack of final product control, the desire for profit, and hurried work resulted in series of elements welded at incorrect angles. Identified defective series were, of course, returned to the supplier, leading to even greater losses for them and production downtimes due to the lack of components. Ultimately, the decision was not made to change the external company, but as a compromise, the contract with the supplier was revised. The supplier will still be able to provide services, but under the condition of final product control and the use of appropriate templates.

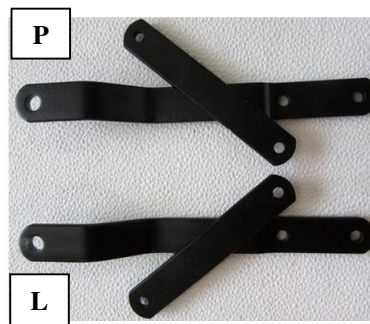


Figure 5. Key element of the baby stroller frame.

Source: own study.

5. Conclusions

Baby strollers are an indispensable part of family life, providing convenience and mobility for both parents and their little ones. However, to ensure that this mobility is risk-free and comfortable for the child, the quality and safety of strollers play a crucial role.

Undoubtedly, the quality of a stroller is of paramount importance for the well-being of the baby and the convenient use for parents. With the increasing number of models available on the market, the criteria for assessing quality and safety are becoming more complex. In this article, the key aspects to consider when choosing a stroller to ensure maximum safety and comfort for the youngest users will be examined.

The market for children's products is highly demanding, with strict safety standards in place. Entrepreneurs face the challenging task of meeting the requirements of customers, who are often parents or guardians. This customer group has elevated purchasing criteria, as every parent desires something that is not only attractive and functional but above all safe for their child.

This work presents an analysis of defects and discrepancies over a one-month period concerning a company producing baby strollers. Using the Pareto chart, a group of defects and discrepancies is illustrated, highlighting the issues that need to be addressed first to minimize their impact. The company should strive more diligently to improve quality within the organization. Every failure in the company is a new learning experience from which appropriate lessons must be drawn to ensure that such situations do not recur in the future.

In the above example, teamwork among key representatives of the organization's departments was utilized to apply the 5 Whys method and identify the root causes of the problems. In this case, haste proved to be the greatest enemy of quality. Employees performed tasks quickly and carelessly because they did not have defined piecework standards. By implementing an appropriate motivational system for employees and introducing the Kaizen philosophy in the company, a positive change was possible, leading to the creation of an organizational culture conducive to improvement.

After conducting the problem analysis, the quality management techniques used were effective in identifying the root cause of the problem. The proposed problem-solving methods in the company can be applied in the future. However, it is essential to consider the limitations and challenges during the implementation of changes in the company. In the case of the analyzed enterprise, two groups of constraints were identified.

The first group pertains to financial factors. Complaints recorded in the sales department signaled problems within the company. The existing situation was unsatisfactory for the enterprise. Implementing corrective actions required financial investment related to project costs and the creation of a template for interoperative and final control at the cross-section plate supplier. During the problem-solving process related to complaints, production downtime often occurred, resulting in financial losses for the company.

The second type of constraint was related to human factors. Resistance to change among employees is inherent in human nature. Employees were unaware of the seriousness of the situation, and fear of the unknown was observed among them. Introducing new standards disrupted their old habits. Honest conversations with employees proved to be fundamental. The company conducted various training sessions to raise awareness among employees.

Management actively engaged employees in the change process, which increased their sense of value.

Human factors also posed a limitation in implementing changes, including resistance from the supplier. The supplier believed that the effort of implementing final control and the associated financial investment would outweigh the benefits. In this case, dialogue with the supplier and emphasizing the benefits persuaded them to continue the collaboration with the company under the new standards.

Analyzing complaints from the sales department in subsequent months will allow for a comparison of the current and previous states and draw conclusions on whether the corrective actions were effective. Additionally, conducting a financial analysis in the company will indicate profits or losses incurred.

The conducted research was not without limitations. The study was conducted over a short period due to the urgent need to address existing problems in the company. It can be assumed that considering a longer period would allow for the identification of other causes of discrepancies.

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SELECTION AND DEVELOPMENT OF OPERATIONAL DIRECTORS' CRITICAL COMPETENCIES IN LIGHT OF THE RESEARCH CONDUCTED

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Purpose: The study aimed to identify the key competencies employers expect from newly hired managers for the position of Chief Operating Officer (COO).

Design/methodology/approach: The preparation of the article was preceded by the observation of economic phenomena and processes and a literature review. Theoretical considerations in this area were supplemented with empirical research: qualitative research methods were used, which include a review of Polish and foreign literature on the subject and an analysis of the content of job offers, which constitute an essential source of information allowing the identification of crucial competencies expected on the labor market in Poland in the context of the position of director operational.

Findings: The implementation of the research objective enabled the identification of key competencies that need to be developed to climb the career path more efficiently and reach the highest-level positions in the organization. The most desired competence was business orientation. The most common social competencies were communication, influencing and negotiating, and building relationships. They appeared most frequently in the group of managerial competencies, team management, and leadership. However, in the group of personal competencies, as many as four recurring competencies can be distinguished: analytical thinking, entrepreneurship - striving for results, self-management, and independence. The most frequently mentioned professional competencies included business orientation, knowledge of foreign languages, and professional knowledge.

Research limitations/implications: In the job offers examined, the most common competencies were from the managerial competence category, while social competencies are less critical, according to the surveyed advertisers. That is undoubtedly inconsistent with the standard view that modern business is increasingly aware of the role that social competencies play in the effective functioning of the organization.

Originality/value: The article contributes to the scientific literature on assessing the competencies of candidates recruited for the positions of operational directors. It also identifies shortcomings in the creation, development, use, and preservation of human capital that need improvement in areas such as education and the social and labor spheres. It indicates areas that need to be improved in the recruitment of managerial staff.

Keywords: managerial competences, chief operating officer, labor market, management staff, soft skills.

Category of the paper: research paper.

1. Introduction

Competencies are a multidimensional concept and may refer not only to a person - an employee, but also to a group, team, or department (Jeruska, 2016), they may also apply to an organization; therefore, in addition to employee competencies, we can distinguish: "management competencies, knowledge and collective memory, competencies in sphere of products and technologies, competences acquired from the outside (through licenses, franchising, benchmarking, consulting, business intelligence, etc.), competences related to shaping relations with the external and internal environment and corporate social responsibility" (Oleksyn, 2014). Competences in the 21st century can be defined as capabilities and abilities. It is a set of related but different behaviors organized around a conscious mental process called intent. Depending on the situation or time, they may manifest themselves in the form of appropriate alternative behaviors.

The study aimed to identify the key competencies employers expect from newly hired managers for the position of Chief Operating Officer (COO). Implementing the research goal made it possible to identify critical competencies that need to be developed to climb the career path more efficiently and reach the highest-level positions in the organization. An advanced solution that enables the analysis of the content of published offers on the Polish labor market using the appropriate categorization key, which is detected and is crucial for the COO function.

According to the adopted methodology, the literature review procedure includes three stages:

- separation of databases and a set of publications,
- selection of publications, development of a database,
- bibliometric analysis, content analysis, and verification of the suitability of the results obtained for further research.

The method of content analysis (documentation analysis) was also used. The content of job offers was analyzed, constituting an essential source of information, allowing the identification of crucial competencies expected in the labor market in Poland in the context of the position of operations director.

A review of Polish and foreign literature on the subject was made. Foreign literature provides numerous definitions of managerial competencies; however, Polish literature identified a research gap in the diagnosis of desired managerial competencies in the positions of operational directors. In order to identify the expected competencies of organizational

directors, a review of job offers published on websites in Poland for the position of chief operating officer (COO) was carried out. The research methods used allowed the research goal to be achieved.

2. Literature Review

The literature on the subject needs to define the concept of competence clearly. Over the years, the research community has yet to develop a standard definition on this issue; there is no clear consensus, and practically every author has developed his definition of competence and a set of adequate arguments. According to literature research (Szczepańska-Woszczyzna, 2016), many authors researched to determine the catalog of critical competencies that effective managers should have. The list clearly shows no single position among researchers regarding creating a closed catalog of critical competencies a manager should have. There is no axiomatic definition of competence in the literature on the subject. However, three main trends in the understanding of competence can be distinguished (Róžański, 2018): observable performance, a specific standard of a person's work, or a qualitatively defined result as an attribute of a person. The very concept of competence among employees appeared at the beginning of the 20th century. The development of interest in the concept itself dates back to the 1970s when D. McClelland researched students to prove that the results of intelligence and personality tests are not determinants that ensure professional success but can be based on motivation, character, attitude, knowledge, and skills to determine whether and how a given person will perform in a specific job position (Sak-Skowron, Skowron, 2020). To achieve the research goal, the scope of the concept of competence was limited to the employee's ability to perform tasks at a specific job position according to the expectations of employers in published job offers.

When reviewing the literature, competencies should be defined concerning the profile of a manager. According to the classic definition of Ricky W. Griffin, a manager is "someone who is primarily responsible for implementing the management process, and especially someone who plans and makes decisions, organizes, leads people and controls human, financial and material resources" (Griffin, 2023). Managerial competencies are one of the critical elements of a company's success in the market. Properly used, they significantly impact the achievement of the company's strategic, tactical, and operational goals. They concern both skills, business knowledge, and motivation to perform the task appropriately entrusted to the manager, consistent with the standards of a given organization.

The literature provides numerous definitions of managerial competencies. Understanding the term "competence" varies in different countries and is determined by organizational culture. In the USA, an attempt was made for the first time to define the concept of "managerial

competence" when the profile of a "competent" manager was outlined. Reference was then made to the work of Boyatzis (Boyatzis, 1982) for the American Management Association, who surveyed two thousand managers and asked them: "What are the characteristics of the best-functioning managers?" In the context of this work, the American meaning of the term "competence" as the most essential feature of a manager is inclusive. "Competence expresses the difference in level between the average and the best performer" (Boyatzis, 1982). Due to the multitude of definitions of managerial competencies, the article focuses on selected characteristics throughout publications in this field. C. Woodruff (1993) believes that a competent manager must meet three primary conditions when carrying out his tasks:

- have the knowledge, skills, and abilities necessary to perform a managerial function in a given organization,
- be motivated to perform a managerial function and be ready to devote the necessary energy,
- have the opportunity to use their competencies in a business environment (Woodruff, 1993).

The next, more recent publications are those in which A. Rakowska and A. Sitko-Lutek (2000) interpret managerial competencies as skills, knowledge, attitudes, and personality traits characteristic of managers achieving high results. However, Sitko-Lutek (2013) additionally emphasizes that the individual activity of an individual involves using competencies to act effectively. Competencies are more than just learned skills. It expands the concept of managerial competencies to include the ability to solve problems using knowledge and experience. In modern, innovative organizations, many unclear situations require flexible use of competencies. The organization allows the individual to act, trusting that he will properly use his competencies. As a result of their research, A. Rakowska and A. Sitko-Lutek (2000) developed a research model of competencies, distinguishing ten basic managerial skills that determine their competencies. These are:

1. technical skills (knowledge);
2. increasing own effectiveness (analysis of your strengths and weaknesses, planning your development);
3. stress management (effective use of time management methods, establishing a hierarchy of activities, increasing mental and physical resilience);
4. communication skills;
5. motivational skills;
6. gaining power and influence (identifying and shaping sources of power;
7. skillful influence);
8. conflict resolution skills;
9. teamwork skills;
10. making changes.

Authors dealing with managerial competencies try to answer which competencies are the most important in rapid economic and organizational changes. Rola-Jarzębowska and I. Malinowska (2011) point out that these are the competencies that support creating a work environment based on mutual trust and employees' independent decision-making. Such behaviors contribute to an increase in the use of employees' potential and, consequently, to an increase in the number of new, creative ideas that are the basis for the development of modern organizations. A different perspective on crucial competencies can be found in other publications, which include global thinking, appreciation of cultural diversity, attention to customer satisfaction, ability to work in a team, focus on partnership relations, creativity, innovation, and independence (Kupczyk, 2009). In the following publication (Gracel, Makowiec, 2017) we find that managerial competencies are being transformed due to the development of the fourth industrial revolution. Changes occurring by implementing breakthrough technology that redefines production and work methods contribute to creating a new type of interaction between people and machines. The competencies that are desired among managers in the modern economy are defined as:

- the ability to recognize innate talents and strengths,
- the ability to chart a development path that is consistent with the requirements of the position and the employee's predispositions,
- a view from the point of view of sustainable development of the team and the company,
- ability to transfer knowledge,
- building an appropriate organizational culture" (Gracel, Makowiec, 2017).

Poland has a low level of social capital compared to other European Union countries (measured by trust). Industry 4.0 requires collaborative management. Thus, the challenges managers face focus on high flexibility and openness, and competencies should be continuously and systematized (Gracel, Makowiec, 2017).

In the context of considerations regarding managerial competencies, a certain systematization can be made depending on the position in the organizational structure. Managers can be divided, depending on their place in the company's organizational structure, into lowest-level managers, middle-level managers, and top-level managers (Zakrzewska-Bielawska, 2012). Entry-level managers merely supervise contractors. They are not superiors to other managers. These include foremen and section managers. They are often referred to as "custodial workers" or "frontline workers". Middle managers supervise the work of other managers and sometimes contractors. Their main task is to control activities leading to the implementation of the company's policy and to balance the requirements placed on them by their superiors with the capabilities of their subordinates. Top-level managers are responsible for the overall management of the organization. They establish operational policy and control the interactions of the organization and its environment. These include general directors, presidents, vice presidents, and members of the management board of capital companies. Various analyses also include the separation of strategic management, which is responsible for

the overall concept of the company's operation in the long term, and operational management, which is responsible for the current activities of individual organizational units. The following essential types of managerial skills that constitute managerial competencies are most often indicated: technical skills, interpersonal skills, conceptual skills, diagnostic and analytical skills.

Conceptual skills are desired at the highest levels of management. Diagnostic and analytical skills allow the manager to properly diagnose the situation and choose the most appropriate response skills. Together with interpersonal skills, they are optimally used at the middle level, while technical skills are recommended for lower-level managers (Zakrzewska-Bielawska, 2012).

Filipowicz (2014) developed the so-called The Universal Competence Model, which presents an approach that allows the division of almost all possible sets of competencies into four basic categories: social, personal, managerial, and professional competencies. The Universal Competence Model by G. Filipowicz contains 36 essential competencies.

Social competencies influence how a given employee performs tasks requiring contact with others and how a person functions in an organization. The level of social competencies directly affects the effectiveness of cooperation, communication, and influence on others. Essential social competencies include building relationships, sharing knowledge and experience, identification with the company, communication skills, negotiations, customer orientation, the ability to work in a team, resolving conflicts, and cooperating within the company. In turn, personal competencies are directly related to the implementation of tasks. Their level proves the quality, speed, adequacy, and reliability of the challenges undertaken and tasks performed. The essential personal competencies include entrepreneurship, innovation and flexibility, analytical thinking, independence, the ability to make efficient decisions and solve problems, conscientiousness (reliability), readiness to learn (professional development), and emotional and decision-making stability. From the perspective of achieving the research goal, the most important are managerial competencies, which are directly related to employee management and include soft skills, work organization, and strategic aspects. It is these competencies that determine the effective management of others. From a theoretical perspective, the essential managerial competencies include the following: building an efficient organization, building teams, assessing and developing subordinates (coaching), delegating, motivating, strategic thinking, planning, leadership, and team management (Filipowicz, 2014). Professional competencies are those that are directly related to tasks requiring specialized knowledge and are dedicated to specific job groups. They often require specific and specific knowledge or skills without which the employee cannot perform the assigned tasks. Sometimes, they refer to having specific qualifications required for a position. The level of these competencies determines the effectiveness of the implementation of tasks directly related to the specificity of the profession or position held or function performed. The primary professional competencies include administration/keeping documentation, business orientation, procedures, knowledge

and application, IT skills, professional knowledge, project management, process management, and knowledge of foreign languages (Filipowicz, 2014).

This article ultimately focuses on the competencies of the operations director. The COO is an executive responsible for business processes and day-to-day internal administration, typically deriving authority from the responsibilities and decision-making rights delegated by the CEO, which can complement the CEO's experience, management style, and knowledge (Bennet, Miles, 2006).

In organizations employing a CEO-COO duo, the CEO emphasizes long-term goals, and the COO implements the CEO's vision through short-term goals (Bendig, 2022). Critics of the CEO/COO duo emphasized that this solution burdened the company with increased costs and reduced the effectiveness of the CEO. In a study (Marcel, 2009), a higher-level perspective was adopted to demonstrate that the presence of the COO can also bring benefits in information processing at the TMT (top management team) level, which, under certain conditions, can improve the company's performance. The research findings highlight a robust positive relationship between the presence of a chief operating officer and two established measures of firm performance: return on assets and market-to-book ratio. The data also suggest that the broader characteristics of the TMT determine these relationships. The job description of the Chief Operating Officer includes the expected competencies. These include high analytical, conceptual, and change management skills. The COO should demonstrate the ability to support a creative and dynamic environment, innovative problem-solving, increasing efficiency, and a high service provision culture. The person in this position is also expected to have interpersonal and conflict resolution skills and to supervise staff effectively, including planning, scheduling, coordination, monitoring, resource allocation, and administration. The Operations Director should be ready to work remotely in the long term and have highly developed written and oral communication skills. He is also expected to be able to manage employees in a multidisciplinary team and, therefore, has well-developed interpersonal, negotiation, and conflict-resolution skills (Officer, 2017).

This article focuses on identifying the managerial competencies of operational directors in the Polish market, where a research gap in this area has been identified. However, when reviewing foreign literature, it is worth citing studies that analyze the role of the characteristics of chief operating officers (COOs) and their relationship with exploration methods, such as patenting and risk-taking (Bendig, 2022). Research findings on U.S. companies demonstrate that different profiles of chief operating officers are associated with organizational exploration efforts. Operating directors with long career horizons are negatively associated with patenting activities, while they have a positive attitude towards corporate activities related to investment projects. Women, as operational directors, have a positive attitude to taking risks. In contrast, COOs with experience in R&D are positively associated with patenting activities and are only slightly associated with ventures. Chief operating officers (COOs) are also responsible for managing the corporation's day-to-day

operations, coordinating and monitoring operations, achieving short- and long-term operational goals, internal operations, and influencing natural earnings management (REM). However, research shows that the presence of a COO reduces the use of REM on average (Cobabe, Doucet et al., 2022). Other sources deal with the behavioral aspects characterizing the chief operating officer. An overconfident COO, taking high risks and failing to take demand fluctuations into account, maintains lower inventories while achieving an inventory reduction strategy. External factors, i.e., whether the market is competitive or concentrated, are a moderator. Thus, individual managerial characteristics and competencies are essential in explaining corporate inventory management policies (Na, Jaeseok, Kim et al., 2018). As can be concluded, managerial competencies are present in the literature in various aspects; however, no sources have been found indicating current research on the desired competencies among employers in a specific job position, such as the operations director.

3. Research Methodology

The preparation of the article was preceded by the observation of economic phenomena and processes and a literature review. Theoretical considerations in this area were supplemented with empirical research that was carried out in 2021. Qualitative research methods were used, which include a review of Polish and foreign literature on the subject and an analysis of the content of job offers, which are an essential source of information allowing the identification of crucial competencies expected on the labor market in Poland in the context of the position of operational director. The following research assumptions were made (Makowska, 2013):

- the research was conducted based on job offers published on popular recruitment portals in Poland and Polish websites,
- job offers were collected for two months in April and July 2021,
- the keyword in search engines was the phrase "operating director",
- a total of 100 published offers covering the entire territory of Poland were analyzed.

Moreover, it was assumed that when analyzing the content of the collected job offers, the researcher could discover the sender's intentions and identify the competencies expected by a given employer, even if they are not indicated directly in the content. In this study, the researcher was interested in the content of job offers and their form.

When analyzing the content, we focused on the information in the section about employers' requirements. Individual job offers were analyzed to identify the qualifications included in the job offer. If the employer did not directly define specific competencies, it was examined whether a given description was consistent with the definition or description of a given concept defining a given competency. For a deeper analysis, an appropriate categorization key was used, prepared based on the Universal Competence Model proposed by G. Filipowicz (2014).

It should be noted here that the research methodology proposed by A. Róžański (2018) was used, where the author emphasized comparing the expectations of employers in various markets in Poland and the USA and identifying critical social competencies. The item mentioned above was the starting point of the research.

The analysis included job offers published by employers on recruitment portals, social networking sites specializing in professional business contacts, building and maintaining professional business relationships, and websites owned by recruitment companies. Job offers were collected in the period from April to May 2021. When searching for offers, the main criterion was the phrase "operating director", then a diagnosis was made in the job offer itself whether a given offer did not require performing a regulated profession. The job offers of employers looking for an employee for the "operating director" position or related positions via the Internet were analyzed. Entrepreneurs were not divided according to the size of employment, share capital, or industry. The only additional search criterion that was used was that the workplace was to be located in Poland. Ultimately, 100 job offers were collected and subjected to thorough analysis using a research technique called content analysis.

4. Research results

A tabular summary presenting the competency expectations towards candidates for the position of operational director in Poland based on the analyzed job offers is included in Table 1.

Table 1.
Frequency of competencies in the analyzed job offers

Competence group	Competencies required in job offers	Frequency of appearance (in 100 job offers in Poland)
Managerial	leadership	64
	team management	64
	building an efficient organization	31
	motivating	31
	planning	30
	strategic thinking	22
	assessment and development of subordinates (coaching)	22
	delegation	21
	team building	20
Personal	analytical thinking	53
	entrepreneurship	48
	self management	36
	independence	35
	innovation and flexibility	29
	decisiveness	20
	problem solving	18
	conscientiousness/reliability	13
	readiness to learn	8

Cont. table 1.

Social	communication skills	47
	influencing/negotiating	39
	building relationships	36
	customer orientation	27
	cooperation within the company	16
	teamwork	10
	conflict resolution	6
	sharing knowledge and experience	1
	identification with the company	1
Professional	orientation in business	67
	knowledge of foreign languages	56
	professional knowledge	54
	process management	35
	IT skills	27
	project management	16
	procedures	6
	administration/maintaining documentation 3	3
	technical skills	1

Source: Own study based on own research.

The research showed that the most common social competencies included communication, influencing, negotiating, and building relationships. However, communication skills appeared in almost half of the analyzed job offers. Other competencies appeared in approximately 40%. In the group of managerial competencies, team management, and leadership appeared most frequently; these competencies appeared in over 60% of the offers. However, in the group of personal competencies, as many as four recurring competencies can be distinguished, namely: analytical thinking - 53 times, entrepreneurship - striving for results - 48 times, self-management - 36 times, and independence - 35 times. When analyzing the professional competencies, the most frequently mentioned competencies included business orientation - 67 times, knowledge of foreign languages - 56 times, and professional knowledge - 54 times. Similar studies were conducted in 2016-2017. At that time, the critical competencies desired in the Polish labor market in given competence groups were building relationships as the most desired social competence, commitment as a personal competence, decision-making ability, and teamwork organization as managerial competencies. In the US labor market, employers most often indicated communication skills and specialist knowledge supplemented with building relationships. Comparing these two studies, it can be concluded that employers in the Polish market are beginning to have similar requirements for competencies in managerial positions in the USA. More and more often, there are job offers that, in addition to the benefits that can be obtained in a given position, also include the amount of remuneration, which, according to research, did not exist before.

5. Conclusions and recommendations

The results presented in the research made it possible to identify the key competencies employers expect for the position of Chief Operating Officer (COO). The most frequently included competencies include business orientation, leadership, team management, analytical thinking, knowledge of foreign languages, and professional knowledge. These competencies were present in more than half of the analyzed job offers. And these are the competencies that need to be developed in order to climb the career path more efficiently and reach top-level positions in organizations on the Polish market. The most desired competence was business orientation because it was expected by employers in almost 70% of the analyzed offers. The most common social competencies included communication, influencing, negotiating, and building relationships. However, communication skills appeared in almost half of the analyzed job offers. Other competencies appeared in approximately 40%. In the group of managerial competencies, team management, and leadership appeared most frequently; these competencies appeared in over 60% of the analyzed offers. However, in the group of personal competencies, there are as many as four recurring competencies, namely analytical thinking, entrepreneurship - striving for results, self-management, and independence. When analyzing the group of professional competencies, the most frequently mentioned competencies included business orientation, knowledge of foreign languages, and professional knowledge.

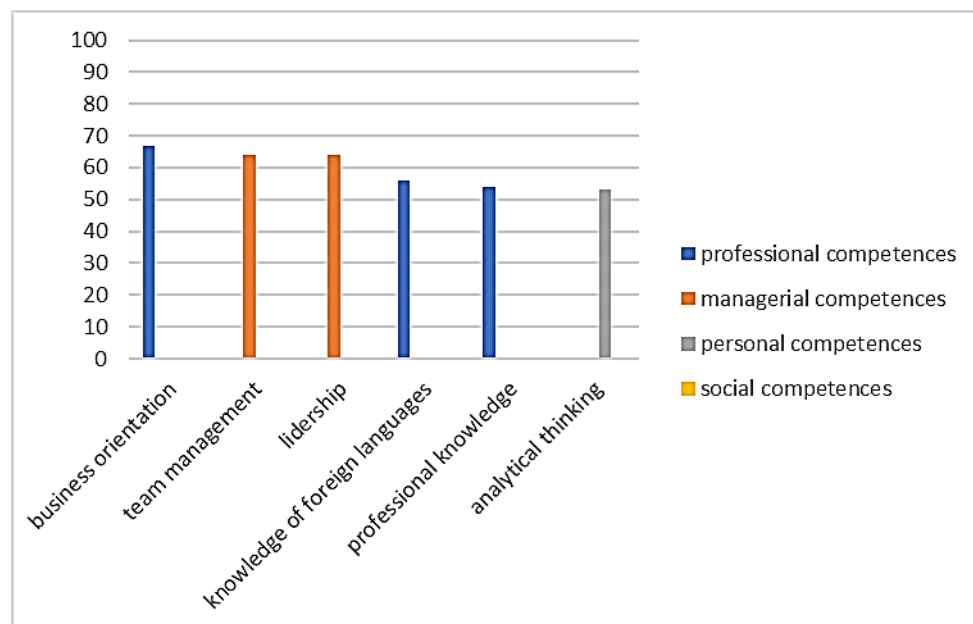


Figure 1. Most frequently occurring competences in the job offers analysed.

Source: Own study based on own research.

The job offer survey was based on a categorization key containing 36 essential competencies divided into four main groups: professional, managerial, personal, and social competencies.

Each cataloged competency appeared in at least one analyzed job offer, indicating a significant diversity among the job market requirements. It is worth noting that competencies such as business orientation, team management, leadership, knowledge of foreign languages, professional knowledge, and analytical thinking are essential for employers in the Polish market (see figure 1). These competencies were present in more than half of all offers analyzed. If we look at the structure of critical competencies, the group of professional competencies dominates and includes three of the six most common ones. Managerial competencies are also necessary. This group also included one personal competence. However, there needs to be more social competencies.

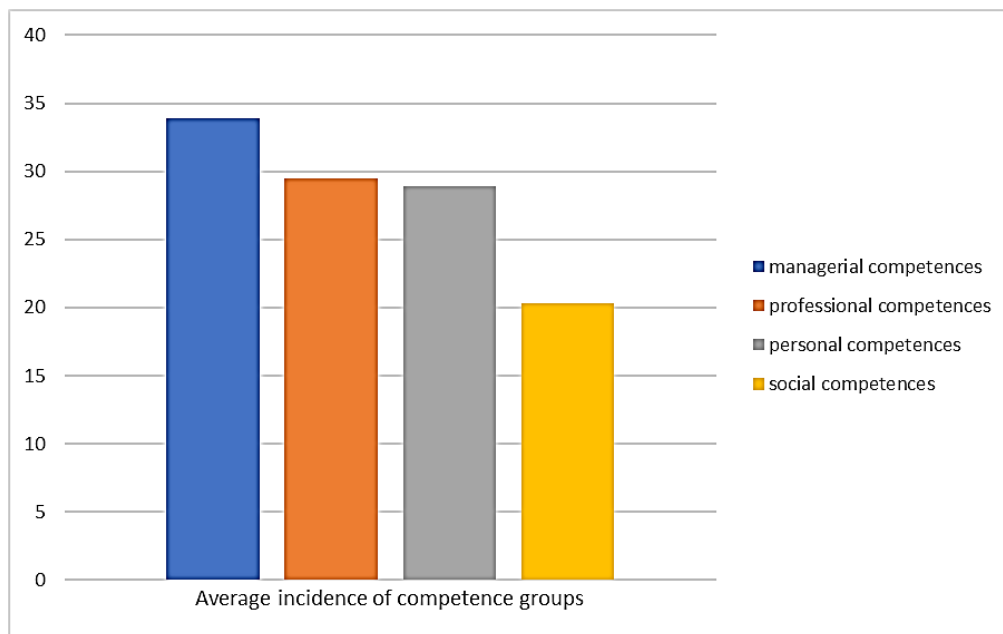


Figure 2. Average incidence of competence groups in the job offers analysed.

Source: Own study based on own research.

Distinguishing the groups of competencies discussed in the earlier part of the study, in the job offers examined, competencies from the category of managerial competencies were most common (see figure 2), while social competencies are the least important according to the surveyed advertisers. This is undoubtedly inconsistent with the standard view that modern business is increasingly aware of the role that social competencies play in the effective functioning of the organization. With technological progress and changes in the business environment, interpersonal skills are essential to professional success in modern business. The prevailing belief is that modern companies increasingly appreciate the importance of interpersonal skills in building effective teams, creating innovative solutions, change management, and customer service. Organizations that emphasize developing the social competencies of their employees are more likely to achieve success in a dynamic and

competitive business environment. As a result, social competencies are also crucial for the COO because they influence effective people management, building relationships, and achieving the organization's operational goals. The person performing this role should be able to communicate effectively, collaborate with various stakeholders, and make decisions while considering social and ethical aspects. However, based on the results obtained from the research, the surveyed companies still placed greater emphasis on hard skills while underestimating the importance of soft skills.

Deepening and developing identified managerial competencies sought among candidates for operational directors can be done formally, informally, and non-formally. Formal learning is institutional and formalized education carried out by education programs that enable the acquisition of qualifications recognized in a given legal system. Methods and techniques for improving managerial competencies include studies in a selected field, exercises, seminars, laboratories, projects, doctoral studies, and postgraduate studies. Informal learning is intended and purposeful (independent learning) and unintentional learning, occurring spontaneously in everyday situations and while gaining experience in the course of work. This form of education needs to be more organized and unsystematic. Methods and techniques for developing managerial competencies include natural social training, self-improvement through informal discussions, meetings, and exchange of views and experiences, and self-development through studying industry publications consistent with individual interests. Non-formal learning is institutional and formalized education. It includes planned, purposeful, and systematic activities through learning from experienced, entrepreneurial employees, attempting to perform tasks differently than before, job rotation, coaching or mentoring, and counseling. Improving managerial competencies can also take place through study visits, both domestic and foreign (Spychała, Branowska, 2019).

Based on the literature review, there are no current studies relating to the analysis and identification of critical managerial competencies in the positions of operational directors. The latest research that is available concerns competencies in relation to various industries, e.g., schools (Gawroński, Kwiatkowski, 2024) or managerial competencies of women in non-governmental organizations in the context of social economy entities, their management styles and business models (Reichel, 2024). On this basis, it can be concluded that the author's research fills the research gap and supplements scientific knowledge with the current state of research. The limitations of the study resulted from the fact that it was based on job offers available on external recruitment portals and social networking sites specializing in building and maintaining professional and business contacts. Due to the availability of data, job offers posted on internal recruitment portals in organizations based on which internal recruitment is conducted were not included in the study.

6. Summary

The article presents the results of a synthesis of interpretive research undertaken to identify the key competencies expected by employers in the Polish market from newly employed operational directors. The analysis included 100 job offers published by employers on recruitment portals, social networking sites, and websites owned by recruitment companies. It has been shown that employers focus on primarily business-oriented people, i.e., operational directors are expected to understand and know the market and the processes that occur in the industry in which a given company operates. The operational director should also be able to manage teams; it was often clarified that these are large teams or teams of middle-level managers. He should also be able to build and implement concepts that are used to achieve the set goals, which are directly related to leadership. He should also think analytically, which directly translates into the analysis of indicators, market trends, financial analysis, and analysis of the current situation, as well as drawing accurate conclusions. He should share his conclusions in a communicative way; he should be able to do it in at least one foreign language while demonstrating sound knowledge of the field in which he works. Research findings on U.S. companies demonstrate that different profiles of chief operating officers are associated with organizational exploration efforts. Based on the research results obtained on the Polish market, it can also be concluded that the surveyed companies still placed greater emphasis on hard skills while underestimating the importance and importance of soft skills, which is recommended for the future by the authors of this study.

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ANALYSIS OF METHODS FOR CONSTRUCTING R&D PROJECT TEAMS – RESULTS OF QUALITATIVE STUDIES

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Purpose: The aim of the article is to present results of qualitative research about constructing teams involved in research and development (R&D) projects and to formulate recommendations regarding their formation.

Design/methodology/approach: The paper utilizes research conducted as part of a master's thesis awarded by IPMA Poland. This is also a continuation of another article published in this journal¹. In general, the whole research was based on a mixed-methods approach, combining quantitative and qualitative methods. A sequential explanatory strategy was employed, allowing for the collection of quantitative data, followed by enrichment with qualitative data for a more in-depth interpretation. This article is about the description of qualitative research, recommendations are written on the basis of full mixed research.

Findings: For constructing teams in R&D projects, recommendations were made: 1) Strive for gender balance in the team, 2) Create teams with a small number of members, 3) Pay attention to the subject matter expertise and experience of the potential leader when forming the team, 4) Introduce a selection process for team members in which the project leader, the project initiator and the group of project initiators have a stake, 5) Value the work of team members and their contributions, regardless of their role in the project, 6) Focus on motivating team members through career development, research curiosity, and the opportunity to collaborate with other scientists, 7) Provide clear rules for project collaboration and accountability, 8) Ensure integration and adequate communication of the team, 9) Support effective management of R&D projects, 10) Monitor and resolve problems within the team. Avoid the occurrence of negative roles and create an environment where team members feel supported and valued.

Research limitations/implications: The article's limitation lies in the potential omission of advanced dependencies from related management fields - from psychology, sociology, or administration.

Practical implications: The research indicates recommendations for the practice of managing research and development projects. Implementing these recommendations may contribute to improving the results of R&D teams.

¹ Dewor, Klaus-Rosińska, 2024.

Originality/value: Filling a research gap on the construction of contemporary research and development teams. Discoveries regarding leader selection, researcher motivation, and the impact of various factors on team performance have significant implications for the practice of managing R&D projects. They are addressed to all individuals involved in research and development activities.

Keywords: research and development projects, team construction, research and development, R&D projects.

Category of the paper: research article.

1. Introduction

The results of the literature review conducted for the research presented in this article were written up in (Dewor, Klaus-Rosinska, 2024), their summary is as follows: (Hackman, Vidmar, 1970; Lencioni, 2002; Kossowska, Soltysinska, 2006; Pawlak, 2006; Chen, Chang, Hung, 2008; Feng et al., 2010; Omar et al., 2011; Krawczyk-Bryłka, 2012; Wirkus, Lis, 2012; Liu, Schuler, Zhang, 2013; Twardochleb, 2014; hrpolska, 2015; Khedhaouria, Montani, Thurik, 2017; Hosseini, Akhavan, Abbasi, 2017; McShane, Von Glinow, 2017; Kisielnicki, 2018; Czahajda, 2019; Kim, Song, 2021; Belbin Poland, 2023).

- R&D projects belong to the category of projects that are both the most challenging and the most significant for the development;
- project managers identifying "the selection of team members for a project and subsequently allocating tasks among them" as an important aspect, and research project participants considering it as a crucial duty;
- various methods for building project teams are available, one of the most popular models describing is the B. Tuckman model;
- regarding the general rules of teams construction (i.e. according to B. Tuckman model), the literature lacks detailed information on the formation of research and development teams;
- among identified motivating factors for engagement in scientific and development projects were: the opportunity for international travel, official orders, financial motivation, the chance to meet other scholars, the opportunity to work on a project led by a renowned scientist, the development of a scientific career, the desire to do meaningful work, and research curiosity;
- research curiosity and the desire to do meaningful work were considered the most important sources of motivation;
- career development in the scientific field was considered a significant issue, like financial motivation.

The aim of the research was an attempt to increase scientific knowledge regarding the construction of teams involved in research and development projects.

2. Methodology of the conducted research

The research on "analysis of methods for constructing R&D project teams" included a mixed methods research. Mixed methods research involves using more than one research method, usually combining quantitative and qualitative methods. It was decided to include both quantitative and qualitative research. Quantitative because of the goal of obtaining discernment with respect to the topic under study among a large number of projects, while qualitative research to obtain detailed, complex answers regarding projects implemented in different types of units. Mixed research, also known as mixed-methods research, opens up new possibilities in the social sciences and health by enabling the integration of different methods and perspectives. The applicability of mixed-methods research lies in the combination of quantitative and qualitative data, which allows for a more complete understanding of the phenomena under study and more comprehensive results. In the social sciences, mixed research can involve the use of survey techniques, field observations, document analysis and statistical data analysis, allowing in-depth analysis and interpretation of various aspects of the society under study. The use of mixed-methods research also allows for verification of results and triangulation of data, which increases the reliability and quality of research, and opens up the possibility of interdisciplinary research that brings together different fields to better understand the problems under study. (Creswell, 2013) In choosing a particular mixed strategy, the need was identified to obtain answers from respondents from a significant number of R&D projects, and at the same time, to obtain comprehensive detailed, complex responses on a specific type of project. The choice was made keeping in mind also the usability of the chosen model, when the quantitative survey yields unexpected results, a sequential exploratory strategy was decided upon. After the quantitative study was completed, a qualitative study was created based on the surprising results of the quantitative study. Both the quantitative and qualitative study were of similar weight.

A sequential exploratory strategy is a popular method of mixed-methods research that involves collecting and analyzing quantitative data in the first phase, followed by qualitative data in the second phase, using the earlier quantitative results. Quantitative data takes priority as the main source of information, mixing with qualitative data. This strategy is particularly useful for interpreting quantitative results through qualitative data analysis. The sequential exploratory scheme is simple to implement and describe, but requires data collection in two phases, which can be time-consuming, especially when the two phases are of equal importance (Creswell, 2013)

This article is about the description of qualitative research only, recommendations regarding formation of R&D teams are written on the basis of full mixed research.

3. Description of qualitative research

Qualitative research is one of the research approaches that focuses on exploring complex phenomena, interpreting their meaning and understanding the social, cultural or psychological context in which they occur. It is characterized by a number of distinctive features. First, qualitative research is descriptive, focusing on detailed description and understanding of the phenomena, processes or experiences under study. It offers a deeper understanding of the topics under study than quantitative research, allowing subtle nuances and contextual aspects to be brought out. Second, qualitative research is holistic in nature, seeking to address multiple aspects and contexts of the phenomena under study. It does not focus only on single variables, but seeks to understand the totality and complexity of the topics under study. Third, qualitative research is flexible, allowing the researcher to adjust research strategies during the research process in response to emerging questions and findings. Researchers often use methods such as interviews, participant observation and document analysis to collect rich, detailed data. As a result, qualitative research provides insightful, contextual interpretations and findings that can serve to build theory, deepen understanding of the human experience and inspire further research.

This study employs a case study research strategy by interviewing the respondent. A case study is a research strategy that involves the in-depth study of a specific case or small group of cases in order to understand a phenomenon in the context of a real-world environment. The method involves collecting a variety of data, such as interviews, observations and documents, to obtain insightful and contextual information. The case study has applications in the social sciences, medicine, business and education. It is used to study social and cultural phenomena, the behavior of individuals, social groups or organizations. A case study offers in-depth analysis, enables theory generation, contextual exploration and inference, although the results cannot be generalized to the entire population.

The sampling strategy and sites were purposive, and each project was selected from area in which they operate: academic work at a university, a research and development institution, an enterprise, a research circle at a university, cooperation between an enterprise and a university, a local government unit. Within these categories, the projects that can be considered the most successful and ambitious, based on publicly available information, were selected. The surveys took place in the interviewee's office or in coffee shops if the interviewee was out of office hours. Quiet places where the person felt comfortable were chosen. All persons were informed of the purpose of the study, how the answers would be disseminated, the number of questions their general scope and the anonymity of the interview. Measures were taken to protect anonymity (e.g., giving a wider age range; omitting information about one situation). No objection was raised to the inconvenience of the interview. The interview was conducted face-to-face (including via instant messenger), had a small

number of questions and a structured format. The procedure for documenting the data was implemented using a protocol for each interview. Interviewees were informed verbally of the instructions for the interview. A non-committal interview was introduced before the interview. Questions that might cause more difficulty were placed at the end. The answers given were noted down manually or with the help of a laptop. Data analysis and interpretation was carried out by continuously considering incoming data, posing analytical questions and taking notes. Analysis of qualitative data took place in parallel with collecting the data, interpreting it and editing reports. During the interview period, earlier interviews were analyzed by annotating the most relevant content that should be included in the final report and systematically organizing its structure. The process followed the model of John W. Creswell (Creswell, 2013).

The subject areas were interconnected to achieve a higher level of analysis and abstraction. Data coding was applied, during which special attention was paid to materials containing:

- codes of topics that the reader can expect based on previous literature and his own thoughts,
- codes that are surprising and unpredictable at the beginning of the study,
- codes that are unusual as one of a kind can arouse the interest of readers,
- codes to open a broader theoretical perspective in the study (Creswell, 2013).

The reliability of the results was checked by stopping appropriate procedures and the reliability of the qualitative research in the dimension of consistency of inclusion with other studies of our own and other authors. Triangulation of data sources was used, consisting of comparing information from different sources, in order to establish a basis for consistent justification of the content provided. Participant testing took place, allowing the reliability of qualitative research to be assessed on the basis of the opinions of participants, who are provided with final reports or specific descriptions or characteristics for evaluation.

The basis for interpreting the results of the analysis was the literature on the subject. It was intended to achieve in the qualitative information on topics that gave surprising results in the quantitative survey, e.g., as many as 55% of respondents reported administrative and economic problems, definitely more than in a similar survey in 2008, this theme was developed during the qualitative research by asking to indicate the problems discussed and then comparing them between projects conducted in different units. The quantitative survey found that only 35% did not have negative roles for their team. The qualitative survey asked about the impact that a person with a negative role had on the team, what the treatment of that person was, or what effects it had. The quantitative survey showed that the main motivation for participating in projects was research curiosity, this was developed further by asking about the observed increase or decrease in it during participation in the project, the events that influenced the change in the level, or the conduct of activities to stimulate the research curiosity of team members. The first, quantitative, research found that for 84% of respondents, research curiosity was the motivation for participating in the project. This theme was developed further in the second, qualitative, research, asking whether it also occurred in the interviewees, whether they

observed an increase or decrease in its level during their participation in the project, if so, what events influenced this change and the activities carried out to stimulate research curiosity in team members. They also asked for a detailed description of the selection of members to the team. There were questions about the person responsible for selecting team members, the selection process, to condemn the issues highlighted in future project participants and to cite the team building method used.

The same set of questions (Appendix) was asked to six people, each from a different unit within which R&D projects are carried out. Interviews were conducted in May and June 2023 stationary in Wroclaw or via instant messenger. After the qualitative research, 6 reports were prepared (each on a separate case).

4. Discussion of the results from the qualitative study

The interviewees were between 24 and 60 years old and male. All of the interviewed groups shared a common goal, values and a sense of responsibility, so they could be considered teams. The size of the teams they came from varied and ranged from 4 to 35 people. The basis on which the project manager was selected also varied in this survey and was consistent with the results of the quantitative survey. Among the answers were: managerial predisposition, substantive knowledge in the area covered by the project, the manager was the originator of the project, the project manager was selected on the basis of experience in acquiring and implementing projects subsidized from external sources (the project was implemented with NCBiR funds), the project manager was the originator of the project and edited the project proposal (the project was implemented with NCBiR funds), substantive experience. In the questions devoted to the selection of members to the team, some relationships were recognized. When the company was responsible for selecting people - this was the case of a company or a consortium (in which the company was the leader) the selection was made mainly on the basis of hard skills. In most of the cases studied, soft competencies were overlooked and team building methods were not applied (Table 1).

Table 1.
Selection of people for R&D project teams – results of qualitative research

	Criteria for selecting people	Omission of candidate competence	Application of team building methods	Person(s) responsible for selection of members	Other
research circle at the university	commitment	knowledge, experience, soft skills	not	three-member board of directors and a specialist of a particular department	eliminated were those focused only on benefits, recruiting for many places at the same time

Cont. table 1.

university research papers	time availability	technical competence, soft skills	not	team leader	paying little attention to selecting the right people
consortium	expertise, scientific achievements	soft skills	not	project manager and scientific director	"were selected such people for whom it was known that you would get high points when evaluating the whole project"; narrow range of specialists - no choice.
company	experience, research sense, willingness to grow in research projects	soft skills	fitting in with the team	manager and the person with the most seniority	-
research and development institutions	hard skills, soft skills, personal culture, administrative skills	-	not	institute's board of directors	searching for candidates on the Internet based on competencies, then inviting them for an interview
administrative unit	substantive knowledge, the cell to which one belongs	soft skills	not	project manager	-

Source: own work.

When asked about the administrative and economic difficulties their teams faced in the initial stages of the work, interviewees identified a variety of problems:

- research circle at the university: - accounting - qualifying costs for tasks, the framework was not fully explained; - the need to specify a specific month (falling in a few/many months) for the performance of an activity when applying for grants; - the requirement to obtain a number of formal approvals on trivial issues; - the lack of support/help initiative by some decision-makers at the university; - some supply chains were broken; - the lack of availability of specialized products several weeks before the competition;
- scientific work at the university: - extensive, variable requirements for documents (internal and external); - administrative and economic staff disproportionate to the needs of the project; - diluted responsibility for the formal issue and the quality of the services provided; - lack of willingness and stepping out of the comfort zone on crisis issues of back-office people and team members; - the project was carried out with public money, the specifics of whose spending did not take into account many internal regulations, leading to extended chains of correspondence and deepening the dilution of responsibility;
- consortium: - the procedure of contracts between the entities of the whole consortium - the length of the procedure, in one technical university, it took three months; - the transfer of property rights - the negotiation of who can and who has the right at all, and what percentage will have intellectual property;

- enterprise: - in order to extend the study by, for example, a week, a huge number of applications had to be filled out, which later had to be accepted by NCBiR;
- R&D institution: - long period of document processing by companies with which the institute cooperated; - time-consuming circulation of documentation (internally and externally);
- administrative unit: - failure to meet deadlines on the part of those who were matched.

Analyzing the administrative and economic problems that arose, one can see a correlation, if the team in question worked within or with a university, they noted problems with obtaining formal approval on not necessarily important matters, a long procedural process, lack of support or initiative from that unit. The theme of excessive documentation required of the unit was mentioned in almost all interviews. Other instances of problems varied depending on where the representative came from. The most common negative role of qualitative research turned out to be Passive (withdraws from the assigned part of the task, mars the work, exposes a lack of interest in the team and the work), in every place where this role occurred it resulted in squandering the time of others, hidden or overt conflict, feeling by the remaining people the behavior of passive as disrespectful to them. When the project had a rigid time frame in the last phase, it was necessary to increase the amount of attention and persuasion towards the people in question. Only in some cases did this have an effect. In most cases, the task entrusted to the passive person was passed on to another person. In a team where mainly commitment was taken into account and checked, the person with the cited role during the trial month gave the impression of being interested and active. After qualifying for the group, there was stagnation. It is conjectured that this may have been related to being accepted into the team and therefore not feeling the need for this person to perform his task. An interesting result from the cited research in the context of the discussed people with a negative role, is one of them (Interview 1 - Blocker: stops the activity of others, does not contribute anything to the team on his own), who responded to the attention and no longer negatively influenced the rest of the team. By inference, not all people with a negative role are resistant to changing their behavior.

Summarizing the information available on the factors affecting the change of negative behavior, and what conditions must be met for this to occur, among others, can be distinguished:

- The person in question must be aware of his negative behavior and understand that it is problematic for himself or for other people.
- The person in question must be sufficiently motivated to make an effort and change his behavior. Motivation can come from a desire to improve relationships with others, to improve one's own well-being, or to improve social perceptions.
- Social support is important because it can encourage a person to change - friends, family, a therapist or a support group.
- The person in question must have the right skills to change his or her behavior. This may include the ability to deal with emotions, communication, conflict resolution,

etc. In some cases, the help of a specialist, such as a psychologist or therapist, may be necessary.

- The individual in question must see the benefits of changing his negative behavior. This may include improvements in quality of life, relationships with others, mental and emotional health, etc. Authors of various texts on the topic under discussion emphasize that changing behavior takes time, effort and perseverance. A person must be determined to work on himself and be willing to overcome difficulties and habits.

R&D teams that did not note negative roles in their team, unlike the other groups, showed support and respect for each other and treated problems as common, trying to solve them together. During the interviews, they also noted an attitude toward knowledge sharing and selfless help. Every team that had at least one person with a negative role felt stress and irritation directly or indirectly because of this. In one team (Interviewee 6) where there was shouting at other people that caused this partial breakup - *The shouting caused the team not to be such a community*. By inference, such a practice has a destructive effect on the team. The elimination of people with negative roles from the team can be controversial. During one interview, such a case was discussed (Interview 1). The person in question had a negative role - Recognition Seeker (realizes the need for applause and approval by pulling team members away from the task). The content of the answer was as follows: *The person participated only as there was an opportunity to "show off." When someone asked her about something she spoke in the form of "we" - we built, we did - despite her lack of contribution to the activities described. The rest of the people were angry with this person, asking her to move to the workshop and not "collect the cream". After several incidents over several months and not responding to criticism, she was thrown out. Posing in this circle was stigmatized, she did not respond to anything, jokes about her became the norm. After she was thrown out, a great calm was felt among the group and there was less "anger in the head," in general "it became calm," the atmosphere improved a lot. The ejected person was surprised, but did not react with anger, the circle meant little to this person, he cared about "showing off". There were never any such people in this circle.* In the body of the statement, the interviewer stressed twice that the person eliminated later did not react to criticism. It is also known that she aroused anger in the other people. The situation lasted for several months, and at a similar time another person from the same organization (discussed earlier - Blocker - Interviewee 1) ceased his negative role. After the person discussed in this section left the team, peace was felt, the atmosphere improved. Based on the analysis of the case, it can be concluded, (not without a subjective element) that in the case where, despite the expression of numerous criticisms taking place over a long period of time, a person with a negative role does not respond by improving his behavior, it is necessary to consider eliminating him from the team. Each case is different, so it should be treated on a case-by-case basis, also taking into account other factors unrelated to the negative role only to the work of the team.

All interviewees indicated that research curiosity was one of the factors that motivated them to work, although the qualitative study showed that its intensity differed between individuals. The way it was felt or the factors that were associated with it differed from one representative to another. Statements were quoted about research curiosity, the most common motivating factor for researchers. Researchers told whether they observed an increase or decrease in its level in themselves during their participation in the project, what events affected the change in the level, and whether they conducted activities to stimulate research curiosity in team members:

- research circle at a university: asking "why?" questions, stimulating fascination with the project, emphasizing the opportunity to learn construction skills, soft skills, doing something a few times better in relation to practice. Highlighting opportunities for development. The impact on changing the level of curiosity of the interviewee was the realization in his knowledge and very rapid development which was also supported by rapid promotion in the wheel and winning awards. Activities to stimulate research curiosity were aimed at younger members who had not gone far in their studies. This involved showing that theory is different from practice, instilling industry and curiosity, going to places related to activities, soliciting articles and conferences;
- scientific work at a university: the motivation of the interviewee was research motivation, and no change in its level was noticed during the project (despite numerous adversities). The interviewee carried out activities aimed at stimulating research curiosity and initiative skills (encouraged by the nature of the project) in team members, but did not receive any response or understanding. The formal leader made no such attempts;
- consortium: *Research curiosity yes, but my task was, so to speak, more of a curiosity to manage people from different fabrics, to make it work at all [...] For me, the research curiosity was not so much about content as it was more about coordination and management.* For the rest of the team, the main motivation was to achieve the goal of the grant. There were no activities to stimulate the research curiosity of the team members. No change in the level of research curiosity was noticed over the course of the project.
- the company: *I think my motivation for participating in the project was, among other things, research curiosity. During the course, I saw an increase in research curiosity due to the fact that the project is quite heavily research-based, and here the entire 3/4 of the project time is focused solely on research and on developing a solution that must work. At the beginning of the project I had much less skills than I currently have. Over the course of the project, I developed intensively and increased my skills in terms of research, interpretation of results, or research "skill" in general. The main events that influenced the change in the level of inferential curiosity, it seems to me, were the challenges posed to me during the project, due to the fact that research projects are characterized by the fact that a lot of tasks require identifying a problem, making some kind of thesis/hypothesis and verifying or rejecting it. Here there is no clear-cut solution*

to a given problem, you have to find this solution yourself, develop and test it, and verify it at the end. Each task required a tremendous amount of work to complete it - to analyze everything and at the very end to verify the action. We have such a policy that we share research news in our topic (in our scope of work) a couple of times a week, and if someone finds a tidbit of information, they toss that information to the 147 team to check in our project or anywhere else to colleagues - whether they use it, for example, somewhere in another project where they also work.

- research and development institution: - *Yes, the motivation for participating in the project was research curiosity. It was observed to increase after the positive reception of the project topic by the environment. I do not carry out activities aimed at stimulating research curiosity.*
- administrative unit: - *The motivator was the result. In short, the trigger for activity was that there was a foreseen goal and it was motivating, maybe less research curiosity. An advanced research and development project it was not, while the idea was to have this tool so that the province would have an advantage over others. There were no activities to stimulate the research curiosity of its team members, except perhaps in smaller subgroups.*

Analyzing the above statements, it can be seen that the research curiosity of those interviewed is the result of or co-occurs with passion in them. All the people talked about their work with excitement, boasted about the team's achievements, were proud of them and visibly enjoyed them. This is consistent with the opinions they express in other conversations - emphasizing the role of passion using the phrases "you need passion," "if you don't have passion, you know," or commenting on another person's outstanding achievements "you can see that he is passionate." Men who recalled well the project in which they participated spoke of a feeling of personal growth. It was noted that there was a directly proportional satisfaction in the men in relation to the evaluation of their development in the project. All of the people interviewed had achieved success within an R&D project and were characterized by a proactive attitude towards the environment (especially evident in the case of the institute's president, who himself searches the Internet for potential future staff), one can assume a relationship between these factors, however, it should be noted this is a small sample of observations. Being proactive means taking initiative, taking control of one's own life and taking action, rather than waiting for circumstances or other people's reactions.

As with the quantitative survey, the qualitative study also asked respondents if they would like to share additional thoughts related to the topic under study. A representative from a higher education research work environment (Interview 2), shared the following thoughts: *I see the problem primarily in the lack of willingness, in the case of many people currently working at the university, to engage in projects of a scientific and organizational nature that are not directly aimed at earning money (grassroots initiatives), while requiring them to get out of their broadly defined comfort zone. It is exacerbated by a general languor in terms of willingness to*

expand one's horizons, placing the emoluments of scientific work above the needs of larger communities, poor organizational-scientific interdisciplinarity, broadly understood "shoddiness" and diluted responsibility in the case of social projects, often nurtured by people who, in theory, should counteract it. All this makes initiatives of this type depend almost exclusively on informal leaders, and when these lack the support of people with similar qualifications or willingness, and these, over time, are ready to abandon even the most valuable idea - not so much because of the inability to implement it, but because of the lack of understanding of it in their immediate environment. This can only be changed by strong and conscious managers, who bring to their surroundings - operating on similar patterns and value system as the leader himself - not only lucrative projects, but also cultivate a philosophical attitude to the modern academic world.

5. Conclusions

In the qualitative study, the interviewees were men between the ages of 24 and 60, belonging to teams of varying sizes (from 4 to 35 people). All teams shared a common goal of value and a sense of responsibility. The project manager was selected based on various criteria, according to the quantitative survey results. These criteria included managerial aptitude, subject matter expertise, project experience and ingenuity.

The process of selecting members for the teams differed depending on the person responsible for the process. In selections made by a company or consortium, hard skills were prioritized, and soft competencies were often overlooked. In other cases, such as academic circles, academic work at a university or research and development institutions, a wider range of competencies were considered. Teams encountered administrative and economic problems, such as lengthy document procedures, excessive paperwork, lack of support from individuals and extensive documentation requirements. In the case of teams associated with universities, problems often included obtaining formal approvals and a lengthy procedural process.

Qualitative research revealed the presence of negative roles in teams, such as Passive or Blocker, which caused problems and conflicts. However, some people with negative roles were open to criticism and were able to change their behavior. Factors were also identified that could influence a change in negative behavior, such as awareness of the problem, motivation, social support and having the right skills. Research and development teams that did not have negative roles were characterized by cooperation, mutual support and respect.

Passion and research curiosity are key motivating factors for R&D project participants. Those who engage passionately show greater satisfaction, satisfaction within the project. A proactive approach is common among participants in the projects surveyed. These individuals take control of their own lives, take initiative and engage actively with their surroundings,

which can contribute to their success. A lack of willingness to get involved among some people working in the higher education environment presents challenges for scientific and organizational projects. Low motivation to broaden horizons, a focus on remuneration over community needs, and a lack of accountability can negatively affect initiatives of this type. It is worth noting that the above conclusions are based on a limited dataset and do not necessarily reflect all cases. Additional research and analysis may provide a more comprehensive picture regarding R&D teams.

6. Recommendations for building teams in research and development projects

Based on the research, the following recommendations can be made for building teams in R&D projects: 1. Strive for gender balance in the team or a similar percentage of men and women. 2. Create teams with a small number of members, the preferred number is seven or less. Larger teams may encounter a greater number of problems and negative roles, which may affect the team's performance evaluation. 3. When forming a team, pay attention to the subject matter expertise and experience of the potential leader. The leader should be knowledgeable in the project area. The study showed that when he or she is also the originator of the project he or she usually receives higher ratings. 4. Introduce a selection process for team members in which the project leader, the project initiator and the group of project initiators have input. Such a selection process can contribute to higher grades for the team. 5. Value the work of team members and their contributions, regardless of their role in the project. The team leader's evaluation should be objective and independent of his/her function in the project. 6. Focus on team members' motivation through career development, research curiosity and the opportunity to collaborate with other scientists. Motivation of team members affects the effectiveness of teamwork. 7. Provide clear rules for cooperation and responsibility for the project. Team members should share a common goal, values and a sense of responsibility for the project. 8. Ensure integration and adequate communication of the team by organizing meetings, talks, trips, conferences and seminars. Integration activities can influence positive evaluations of team performance. 9. Promote effective management of research and development projects. The role of the management of the scientific institution, the skills of team members, clearly defined goals and expectations are key to achieving positive results. 10. Monitor and resolve problems within the team. Avoid the occurrence of negative roles and create an environment where team members feel supported and valued.

The above recommendations are based on scientific research and can be tailored to the specific needs of R&D projects. It should be noted that the recommendations presented are based on a limited set of data and do not necessarily reflect all cases. Additional research and analysis can contribute to a more comprehensive view of R&D teams.

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Appendix

Attachment Interview form

1. The project is/was conducted under:
2. Age:
3. Gender:
4. Does your group have a common purpose, values and sense of responsibility?
5. Team size:
6. On what basis was the project manager selected? (e.g., subject matter expertise in the area covered by the project; managerial aptitude; the manager was the originator of the project)
7. Who was responsible for selecting team members? What did the selection process look like? What issues were paid attention to in future project participants? What methods of team building were used?
8. What administrative and economic problems did you face during the implementation of the R&D project in the initial stage of work?
9. Which negative role did the person play in the team? What impact did the person have on the team? What was/is your behavior toward the person in question? What effects did/does your behavior have?

Dominant: consistently, also by deception pursues power, neglects team interests and tasks.

Blocker: stops the activity of others, by himself does not contribute anything to the team.

Recognition-seeking: realizes the need for applause and approval by pulling away team members from the task.

Playboy: attracts group attention through extravagant, controversial, behaviors.

Victim: constantly in trouble, requires support from others, uses their energy at the expense of the group's work.

Advocate for others: without authority, speaks on behalf of others taking care of mainly safeguard one's interests.

Passive: withdraws from the assigned part of the task, mars the work, exposes lack of interest in the team and work.

Aggressor: builds relationships using aggression, attack, resentment directed at the address of selected individuals, spoils the atmosphere of cooperation, generates conflicts.

10. Is/were your motivation for participating in the project, among other things, research curiosity? Did you observe an increase or decrease in its level during your participation in the project? What events influenced the change in level? Do you conduct activities to stimulate research curiosity among team members?

ANALYSIS OF METHODS FOR CONSTRUCTING R&D PROJECT TEAMS – RESULTS OF QUANTITATIVE STUDIES

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Purpose: The aim of the article is to analyse and evaluate methods for constructing teams involved in research and development projects and to formulate recommendations regarding their formation.

Design/methodology/approach: The paper utilizes research conducted as part of a master's thesis awarded by IPMA Poland. The research project was based on a mixed-methods approach, combining quantitative and qualitative methods. This combination was chosen to fully understand the phenomenon under study. A sequential explanatory strategy was employed, allowing for the collection of quantitative data, followed by enrichment with qualitative data for a more in-depth interpretation. The adopted model facilitated a comprehensive examination of the subject and enabled an interdisciplinary approach to identified problems.

Findings: The research reveals that some factors, for example team size, do not significantly impact the team's performance assessment. Larger teams report more negative roles. Motivations of participants in R&D projects differ from those in a 2008 study. Currently, career development and networking with other researchers are more important than in the past. Research curiosity is still the most cited motivation for R&D work but by a smaller number of individuals. Teamwork assessment is associated with the number of team issues. The number of roles according to M. Belbin's classification does not influence the team's performance assessment.

Research limitations/implications: The article's limitation lies in the potential omission of advanced dependencies from related management fields – from psychology, sociology, or administration.

Practical implications: The research indicates that key success factors for the practice of managing research and development projects include the appropriate selection of the team leader and effective management of team members' motivation. The number of reported team issues has an inversely proportional relationship with the team's performance assessment. Implementing these practices may contribute to improving the results of R&D teams.

Originality/value: Filling a research gap on the construction of contemporary research and development teams. Discoveries regarding leader selection, researcher motivation, and the impact of various factors on team performance have significant implications for the practice of managing R&D projects. They are addressed to all individuals involved in research and development activities.

Keywords: research and development projects, team construction, research and development, R&D projects.

Category of the paper: research article.

1. Introduction

Research and development projects require the application of highly specific management methods and belong to the category of projects that are both the most challenging and the most significant for the development of organizations and society (Kisielnicki, 2018). A team, however, is defined as a group of individuals with complementary skills, sharing a common goal, value system, and approach for which all members feel responsible (Kossowska, Sołtysińska, 2006).

The selection of team members for a project and subsequently allocating tasks among them is one of the initial tasks falling within the responsibilities of the project manager. Managers recognize the significance of this matter, with over 84% of project managers identifying it as an important aspect, and as much as 94.7% of research project participants considering it a crucial duty (Krawczyk-Bryłka, 2012).

The size of a project team depends on the specificity of the given task, interaction capabilities, but for ensuring effective collaboration, according to M. Pawlak, the number of individuals should range from 4 to 10. This considers the individual characteristics of team members, such as learning ability, intellectual proficiency, and willingness to work collaboratively (Pawlak, 2006).

A much older study aimed at finding the optimal number of individuals in a team that would ensure the satisfaction of individual members with the outcomes of collective work was conducted by J.R. Hackman and N. Vidmar as early as 1970. A team consisting of 2 to 7 people worked on various types of tasks requiring collaboration and effective goal achievement. Each participant answered one of two questions to assess whether the group was too small or too large compared to the task requirements. The results showed that participants did not consider the group too small if it consisted of 7 people. However, as the number of members decreased, they increasingly agreed that the group was too small to effectively perform the task, and they felt uncomfortable in situations with limited resources. On the other hand, in the inversely worded questions, not many people felt that a group consisting of 2 or 3 individuals was too large compared to the assigned task and comfort of work. The optimal number of people in the team in this study was 4.6, suggesting that it is best to form teams consisting of 5 individuals, the closest odd number (Hackman, Vidmar, 1970).

In the book edited by M. Wirkus and A. Lis titled "Managing Research and Development Projects", a study from 2008 conducted by the Information Processing Centre is included. The study focuses on motivating factors for engagement in scientific and development projects

(Wirkus, Lis, 2012). Among the motivating factors identified were the opportunity for international travel, official orders, financial motivation, the chance to meet other scholars, the opportunity to work on a project led by a renowned scientist, the development of a scientific career, the desire to do meaningful work, and research curiosity. Individually, research curiosity and the desire to do meaningful work were considered the most important sources of motivation (Krawczyk-Bryłka, 2012). The two factors mentioned, research curiosity and the desire to do meaningful work, were indicated by 100% of the surveyed individuals at that time.

In the cited study, career development in the scientific field was also considered a significant issue, planned in 60% of the projects. For 70% of the participants, financial motivation was important, while approximately 25% of participants observed a discrepancy between individual interests, team interests, and the overall project. Despite some discrepancies, 95% of research team members were satisfied with their participation in the project (Krawczyk-Bryłka, 2012).

In the study conducted in 2008 by the Information Processing Centre, research and development teams were asked to identify problems within their teams. According to 26% of the participants, their groups lacked clear cooperation principles. Only 25% of respondents identified the entire team as responsible for carrying out individual project stages, while 52% indicated a lack of dedicated tasks for specific project participants (Wirkus, Lis, 2012).

M. Belbin developed a theory of team roles, indicating that the roles individuals play have an impact on the quality and effectiveness of teamwork. In his theory, he identified nine team roles that occur in organizations:

- Task-oriented roles include Shaper/Implementer/Completer Finisher;
- People-oriented roles include Coordinator/Team Worker/Resource Investigator;
- Intellectual roles include Plant/Monitor Evaluator/Specialist (Belbin Polska, 2023).

The studies conducted in 1995 and 1996, along with a systematic evaluation of the Belbin Model in 2001, questioned the credibility of this model. Statistical analyses indicated that the model does not allow for accurate predictions of reality, and factor analysis challenged the structure based on four pairs of roles. While examining theoretical validity, it was found that the model exhibits some correlation with other measures assessing the same traits, suggesting a certain convergent validity. However, there is an emphasis on the lack of evidence for the existence of differential validity, i.e., independence from traits that should not be related to team roles.

Additionally, a significant issue is the overlap in the definitions of certain roles and imprecise role descriptions, leading to the reparameterization of roles and making their clear definition more challenging. Therefore, despite the model's simplicity and popularity, its credibility has been seriously questioned based on the conducted research and analyses (hrpolska, 2015).

Various methods for building project teams are available from different sources, in addition to the mentioned Belbin Team Role Theory (Belbin Polska, 2023). These include Stochastic Optimization of Belbin's Team Roles (Twardochleb, 2014), DiSC D3 Team Map (Effectiveness, 2023), Sociometric Techniques (Lucius, 1996), Taguchi Parameter Design Approach (Tsai, Moskowitz, Lee, 2003), Rough Set Theory (Omar, Syed-Abdullah, Mohd Hussin, 2011), S.L. McShane and M.A. Von Glinow's Team Role Division (McShane, Von Glinow, 2017), Negative Team Roles by M. Taraszkiewicz, K.F. Nalepa (Taraszkiewicz, Nalepa, 2007), Extended DISC® (DiSC Polska, 2020), Six Professional Personality Types (Lencioni, 2023), Utilization of Individual and Team Performances (Feng, Jiang, Fan, Fu, 2010), Five Dysfunctions of a Team Model (Lencioni, 2002), MBTI in Project Team Building (Kopczewski, Szwarc, 2009), Competency Models (Pauli, 2007), FRIS® - Flexible Resources Integration System (FRIS®, 2023), Gallup's Strengths-Based Talents - Talent Dynamics (Drażkiewicz, 2022). These methods offer diverse approaches to team construction, each with its unique principles and applications.

It is worth examining the development of small groups to distinguish various typical phases that occur during the formation and evolution of each group. One of the most popular models describing these phases is the B. Tuckman model, which is frequently cited in literature and encountered during managerial training. However, there are other models, such as those developed by D. Kezsbom and K. Edward, that describe a model like B. Tuckman's concept. Undoubtedly, the B. Tuckman model is illustrative and aids in understanding the processes that occur during group formation. It is also applied to describe the team-building process, considering the distinctions between the concepts of "group" and "team" (Pawlak, 2006). Meanwhile, according to the B. Tuckman model, in the development of a group, certain characteristic and non-overlapping phases can always be observed, occurring in varying intensities and forms.

Critics of the B. Tuckman model point out that he labelled his model as a hypothesis and noted that this phenomenon was most visible in therapeutic groups. They emphasize that for a hypothesis to become a theory, it must be proven. At the same time, a significant majority of critics agree on one crucial aspect - all five group phases can occur in any environment, but they differ in intensity, sequence, duration, and sometimes some phases simply do not take place. They note that in an ideal corporation where work norms are clear, and everyone accepts them, a new group may not need to create these rules from scratch, thereby skipping one stage of the B. Tuckman process. However, this model originated in a different era with a different context. Critics also believe that a significant flaw in the discussed model is the definition of conflicts because B. Tuckman assumed that all conflicts occur simultaneously, while scientists identify several different sources of conflict in a team, such as: misunderstanding of goals, conflicting interests, the need for independence from the group, disagreement on group structure, and interpersonal conflicts. These conflicts arise at various moments in the life of a group and interplay with each other (Czahajda, 2019).

In the literature, there is a recommendation that the articulated goal of a team should result from common agreements, enhancing its acceptance and providing a sense of interdependence and shared responsibility for achieving specific and ultimate outcomes of work (Krawczyk-Bryłka, 2012).

It is worth noting that, in addition to the above information regarding the general construction of teams, the literature lacks detailed information on the formation of research and development teams. Available sources focus on the formation of teams for other types of projects or are general, not considering the specificity of these kinds of projects. Nevertheless, the thematic aspects of research and development activities are often discussed in a valuable manner.

The aim of the scientific article was an attempt to fill the mentioned gap in scientific knowledge regarding the construction of teams involved in research and development projects.

2. Materials and methods

As part of the diploma thesis, mixed methods research was conducted, utilizing both quantitative and qualitative approaches. These studies enabled a holistic understanding of the phenomena under investigation and yielded comprehensive results. A sequential explanatory strategy was chosen, combining the analysis of quantitative and qualitative data to facilitate a more in-depth interpretation of the findings. The selected research methods included a diagnostic survey and a case study. The diagnostic survey employed surveying techniques, while the case study was conducted based on interviews.

The quantitative study, based on a survey, aimed to generalize data from a sample of 51 research and development groups in Poland in the year 2023. The population of respondents consisted of participants in research and development projects. The sample selection procedure was one-stage, with 9% of the individuals who received the survey responding. Data were collected using the "Google Forms" tool and processed using Microsoft Excel. The data collection procedure included pilot tests and sending surveys to the mailboxes of individuals associated with research and development projects. Email messages were sent in waves, with each wave consisting of approximately 100 recipients. Between waves, there was a period of 2 to 5 days, and no differences were observed in responses between the waves. The applied scale ranged from integers 1 to 10, where 1 indicated low and 10 high.

Within the qualitative study, a case study strategy was employed through conducting interviews with six representatives from different research and development projects. This research strategy allows for an in-depth understanding of a specific case, expanding on the most interesting and surprising results from quantitative research. The case study method is

applicable in social sciences, although the results may not be generalizable to the entire population.

Careful sampling procedures and interview locations were applied, deliberately selecting representatives from various areas where research and development projects are conducted. All individuals were informed about the purpose of the study, measures were taken to protect anonymity, and interview procedures were structured. Data analysis was conducted concurrently with data collection, following J. W. Creswell's model, incorporating data coding and source triangulation to ensure the credibility of the results (Creswell, 2013).

3. Results

In the quantitative study¹ conducted through a survey, a total of 51 responses were obtained. The study encompassed all generations actively involved in research and development projects. The age range was broad and balanced (Figure 1). The youngest participant in the study was 22 years old, while the oldest was 78. Analysing the chart, one can observe the presence of both female and male representatives in each age group. The percentage of women in the study was 49%, and for men, it was 51%. The mentioned sample aimed to eliminate results that could be influenced by generational or gender differences.

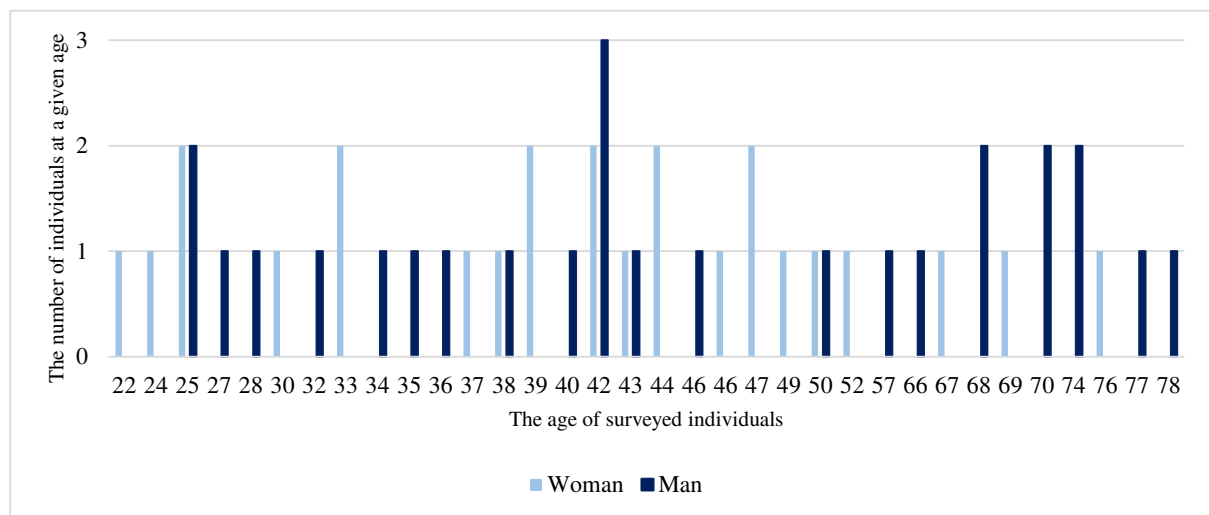


Figure 1. Age and Gender of Respondents.

Source: Own research.

It was examined whether all respondents come from teams based on the definition by M. Kossowska and I. Sołtysińska, stating that a group is a team when it has a common goal, values, and a sense of responsibility (Kossowska, Sołtysińska, 2006).

¹ This article contains the results of quantitative research only.

As many as 86% of the respondents came from teams, 8% found the question challenging or did not know the answer to the question (Figure 2). Only 6% of the participants denied that their group had a common goal, values, and a sense of responsibility - surveys with this response were excluded from the analysis focused on studying teams.

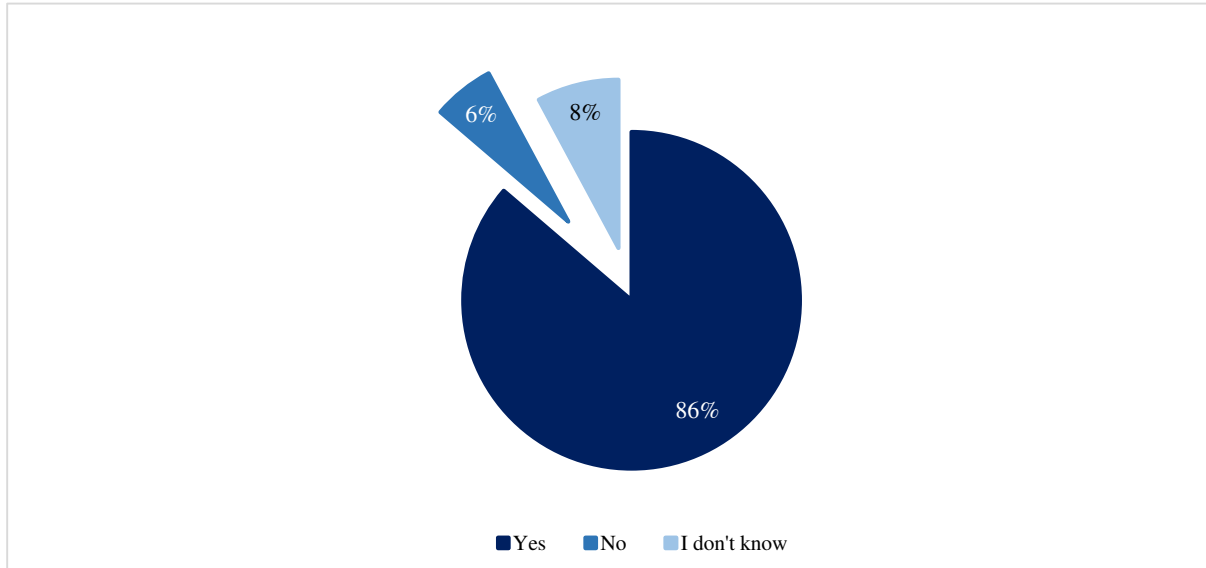


Figure 2. Having a common goal, values, and a sense of responsibility among the surveyed groups.

Source: Own research.

The study also includes diverse data regarding the size of the groups (Figure 3). The research covers small, medium, and large teams. It can be observed that the majority of groups have a small number of members. Groups with up to seven people account for 63% of all surveyed. Eight or more members were reported by 37% of groups.

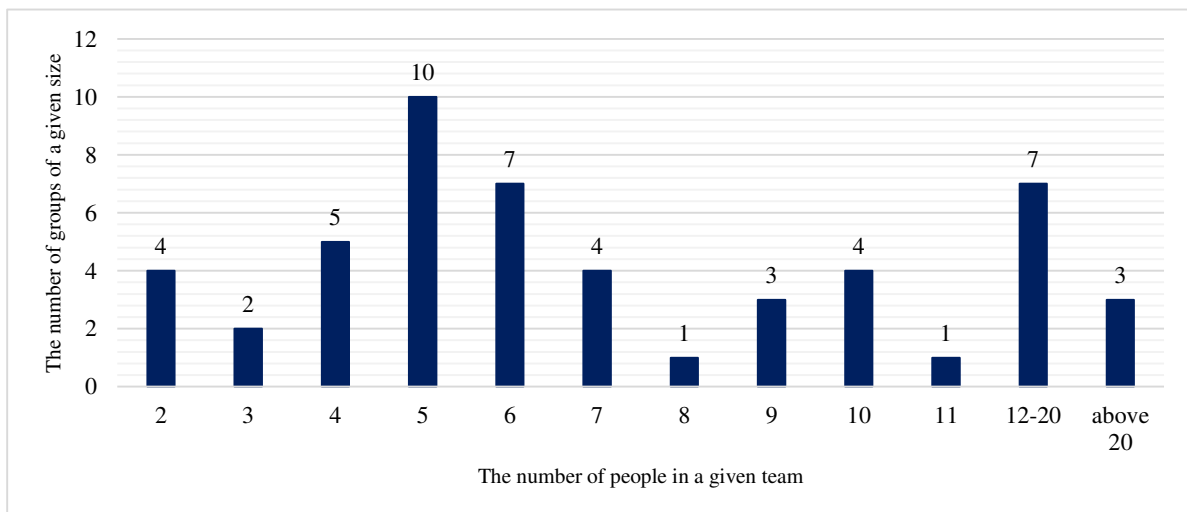


Figure 3. Size of the surveyed groups.

Source: Own research.

Each type of organization in which R&D projects are conducted had its representation in the study. (Figure 4) The highest number of projects were conducted within academic research (43%) and research and development institutions (33%).

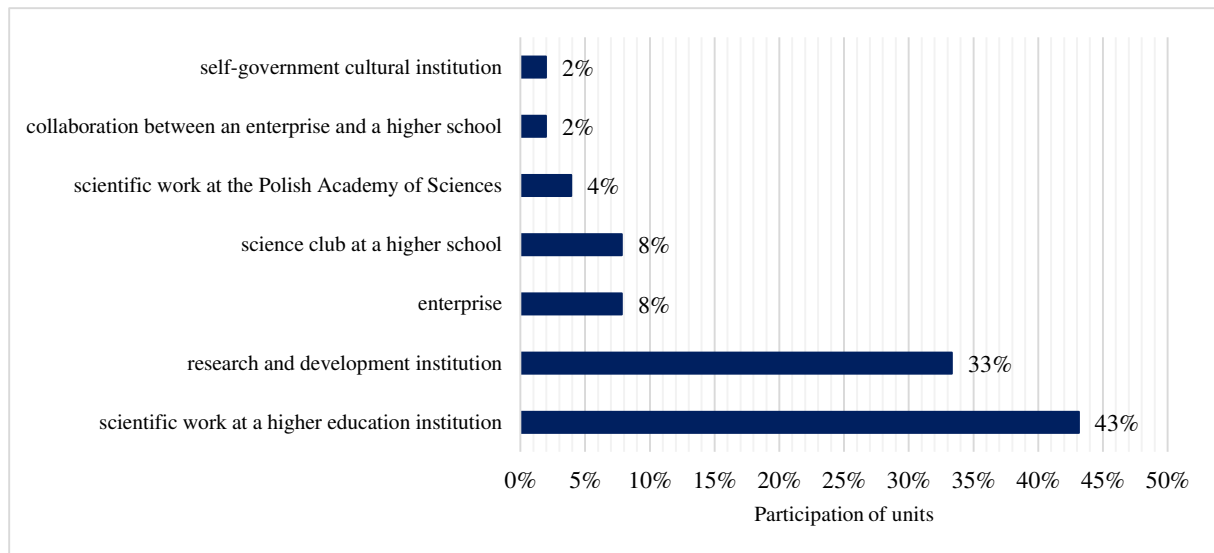


Figure 4. Units within which R&D projects were/are conducted.

Source: Own research.

Multiple times it was indicated that the project manager was also the initiator of the project (78%). (Figure 5) This is a factor that influenced the choice of the project manager. Substantive knowledge in the project area was also important in selecting the project manager (57%). In several cases, it was mentioned that the project manager had to possess this knowledge. Sometimes the selection of the project manager depended on managerial predispositions (18%).

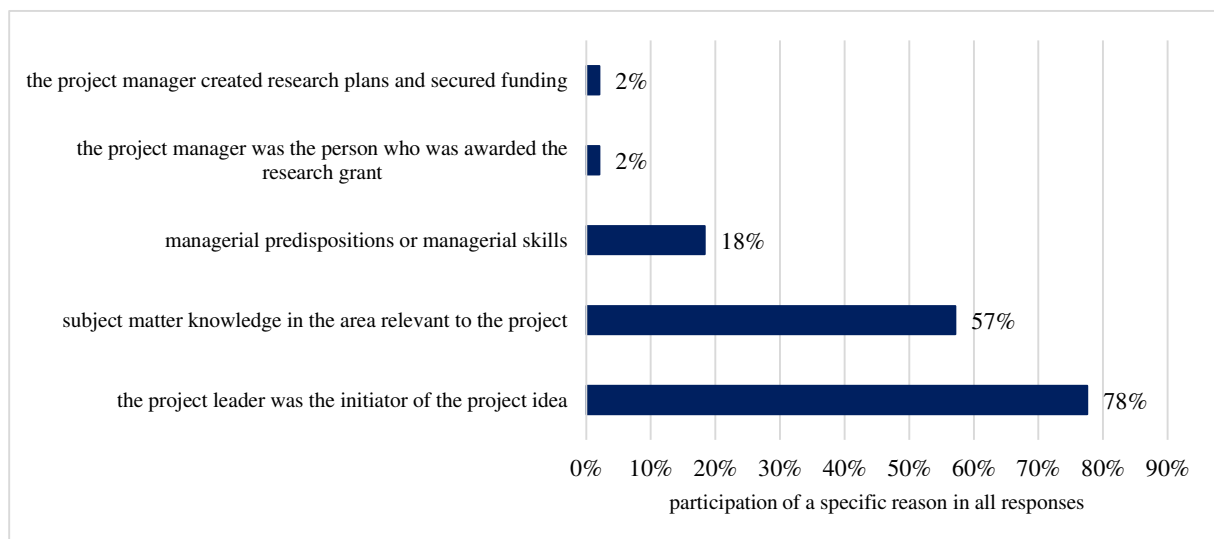


Figure 5. Reasons for choosing the team leader.

Source: Own research.

An analysis of simultaneous reasons for choosing the project manager was also applied (Figure 6). The most common combination is substantive knowledge in the area the project pertains to and being the initiator of the project. However, during this analysis, the project manager who was the initiator of the project as the sole reason still gains the highest percentage share.

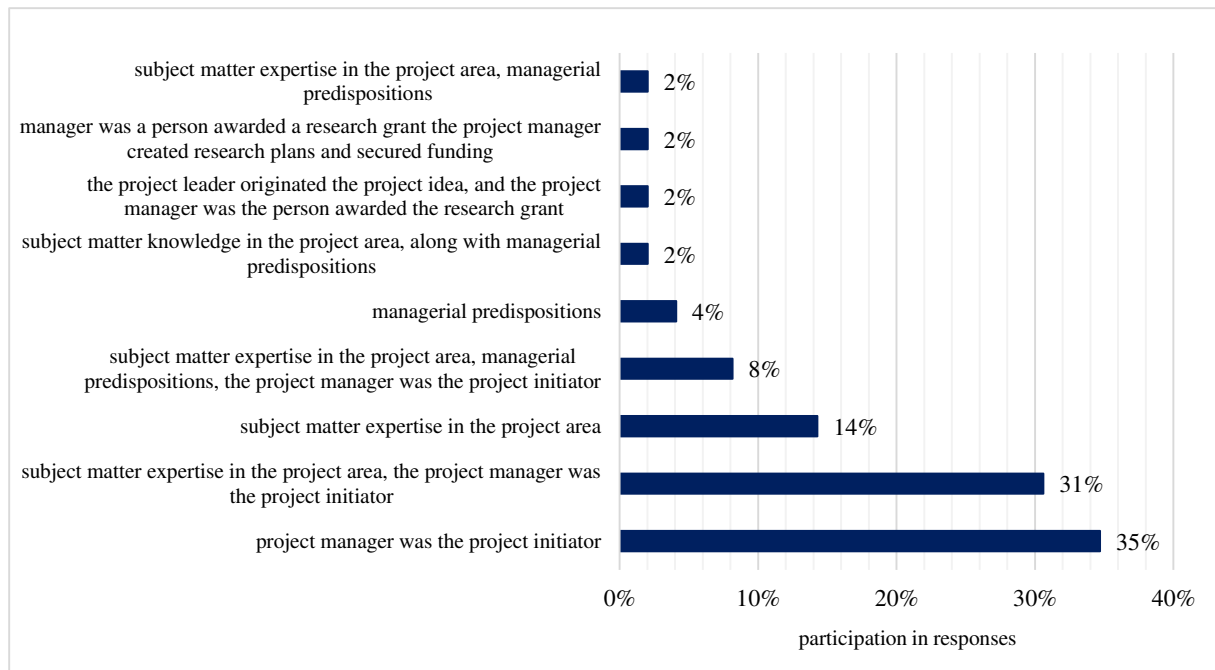


Figure 6. Comparison of the indicated reasons for choosing the team leader.

Source: Own research.

The study involved individuals serving various roles within the project team. Team leaders constituted 69%, team members 25%, while informal team leaders and subject matter experts accounted for 3% each.

Ratings given to the leaders of the surveyed groups were average, high, and very high. The most awarded grade (on a scale from 1 to 10) was 8 (in 31%) and 7 (27%). The maximum rating was obtained by 16% of team leaders.

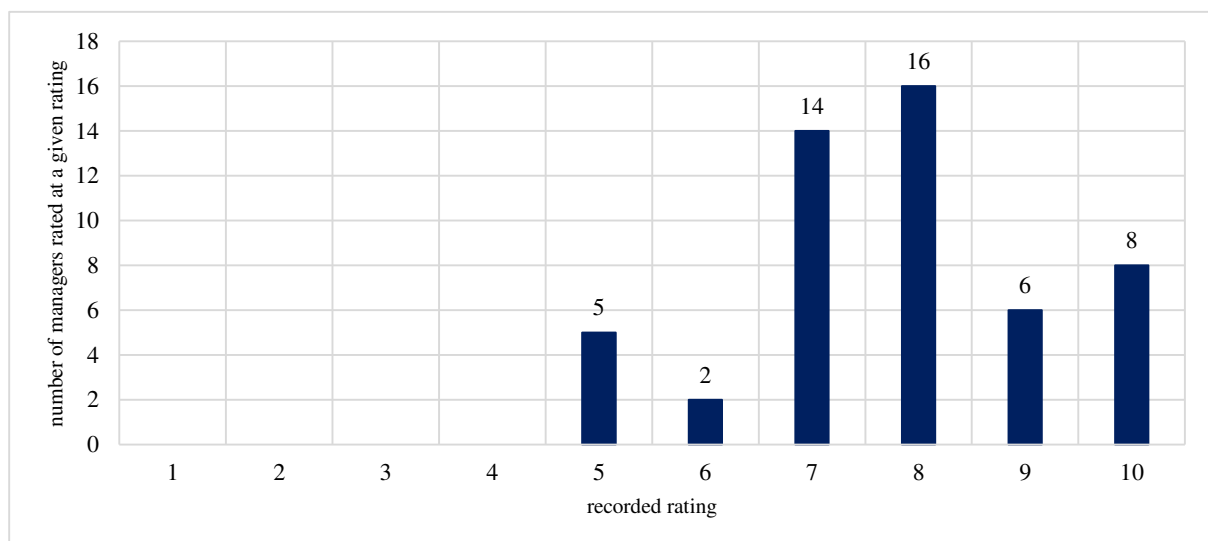


Figure 7. The evaluation of the work of the leaders of the surveyed groups.

Source: Own research.

The evaluation of the team's work ranges from 3 to 10, like the evaluation of the leader, which fluctuates between 5 and 10 (Figure 8). Just like in the case of project team leaders, the most frequently awarded grade was 8 (in 42% of cases). Other popular grades were 9 (in 22%) and 10 (in 17%). The calculations did not include groups that did not have a common goal, values, and a sense of responsibility because, according to the definition, they do not qualify as teams. These types of groups received ratings: 3, 4, 8. A grade of 3 was the lowest among the assigned ratings.

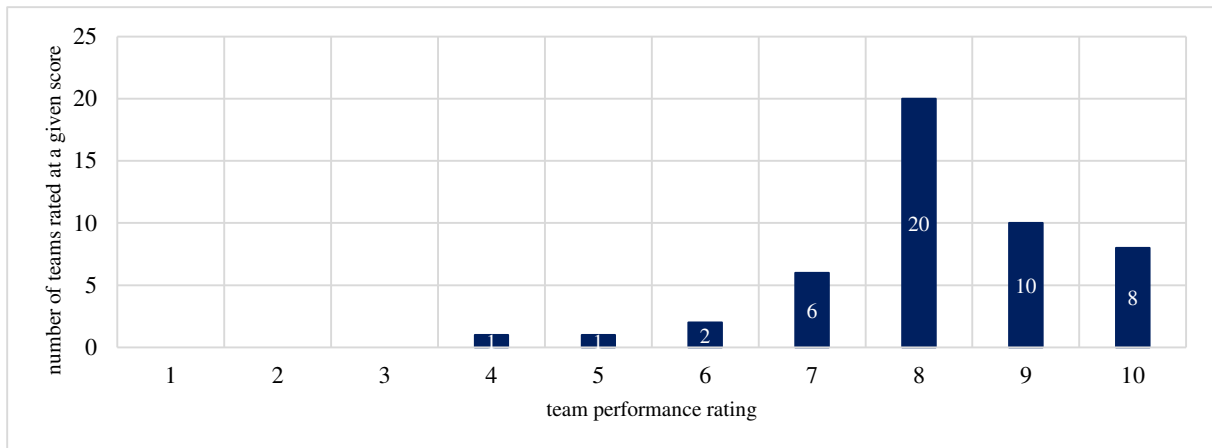


Figure 8. The evaluation of the work of the surveyed teams.

Source: Own research.

The results indicated that there is no clear rule regarding the person entrusted with the selection of team members (Figure 9). Responsibility for team member selection is often assigned to the project manager (46%), but also to the project originator or a group of project originators. In some cases, the team was also given influence over the selection of some individuals.

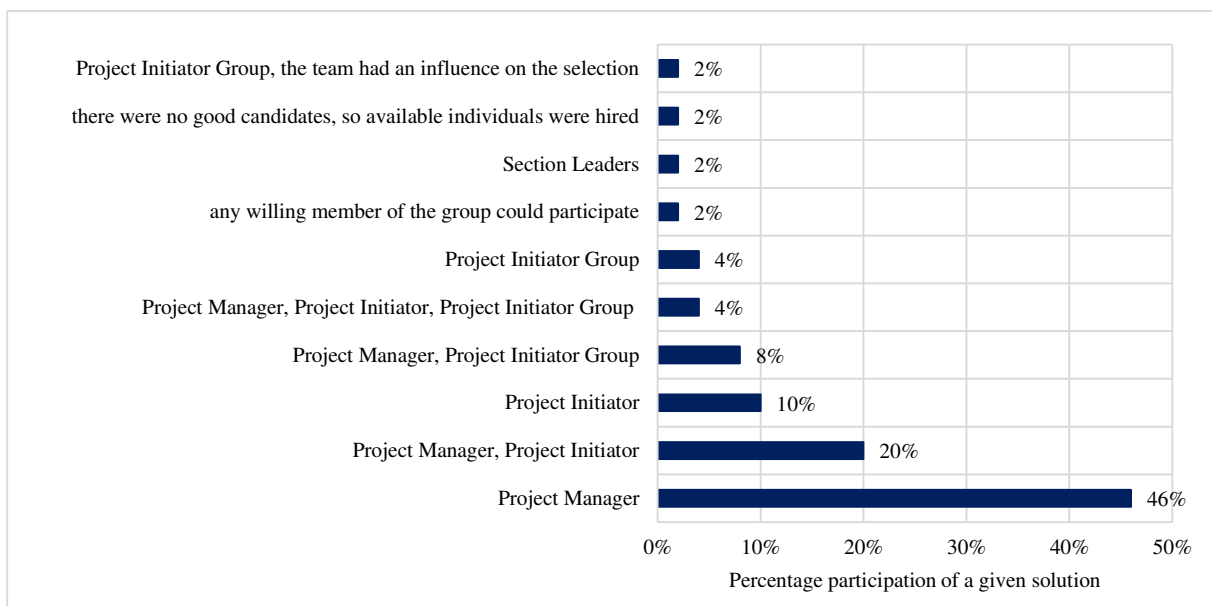


Figure 9. Individuals responsible for selecting team members.

Source: Own research.

Exactly 74.5% of the surveyed individuals are unfamiliar with methods for formulating project teams. Only 25.5% of those operating within research and development teams have knowledge about methods for forming project teams.

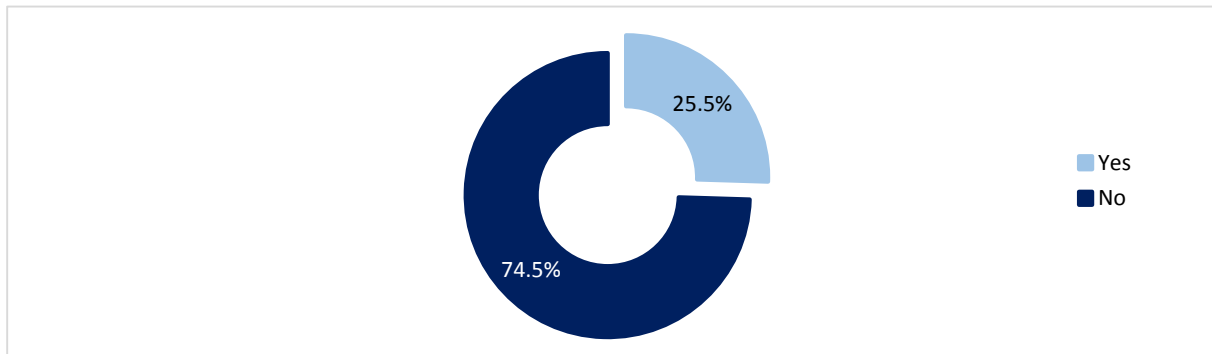


Figure 10. Familiarity with methods for formulating project teams among surveyed individuals.

Source: Own research.

As part of the master's thesis research, an investigation was conducted to determine whether the factors that motivated researchers in research and development projects in 2008 have a correlation with research and development projects in 2023. Additionally, respondents were given the opportunity to identify other motivating factors in the survey. The results of the study indicate that only a portion of the factors align with those published in 2008.

In the older study, factors such as research curiosity and the desire to do meaningful things were indicated by almost 100% of the respondents. In the current study, we can observe that research curiosity is indicated at a level of 84%, and the desire to do meaningful things is at 47% (Figure 11). Interestingly, about 9 percentage points more respondents in the current study indicated a motivation for career development compared to the earlier study. Previously, approximately 40% of respondents indicated the opportunity to work on a project led by a renowned scientist; in the current study, only 8% did so. The opportunity to meet other scholars was important for about 50% of respondents in 2008, and in the current study, it was significant for 22%. Financial motivation was indicated by approximately 45% of respondents in the earlier study, and in the current study, a similar value was observed – 43%.

In 2008, as motivating factors for engaging in research and development projects, less than 20% of respondents declared official orders and the opportunity for international travel. In 2023, official orders were significant for only 4% of individuals, while the possibility of international travel was more popular, with 24% indicating its importance. Respondents also pointed out other factors, including the desire and ambition to conduct scientific research (2%) and the preparation of a doctoral thesis (2%).

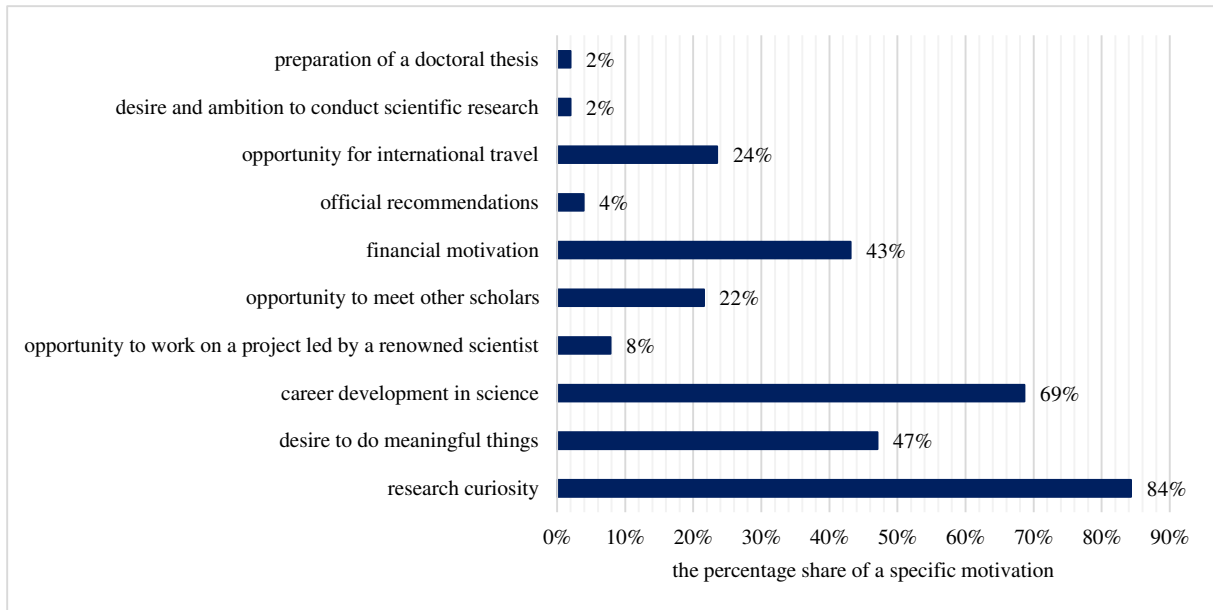


Figure 11. The motivations of respondents to participate in research and development projects.

Source: Own research.

The most frequently reported roles in research and development teams were Specialist (76%), Coordinator (70%), and Creator (68%). The least common role was Implementer (26%) (Figure 12). Only in 8% of teams were all roles noted. The average number of roles in teams was 4.57, with a median of 4.

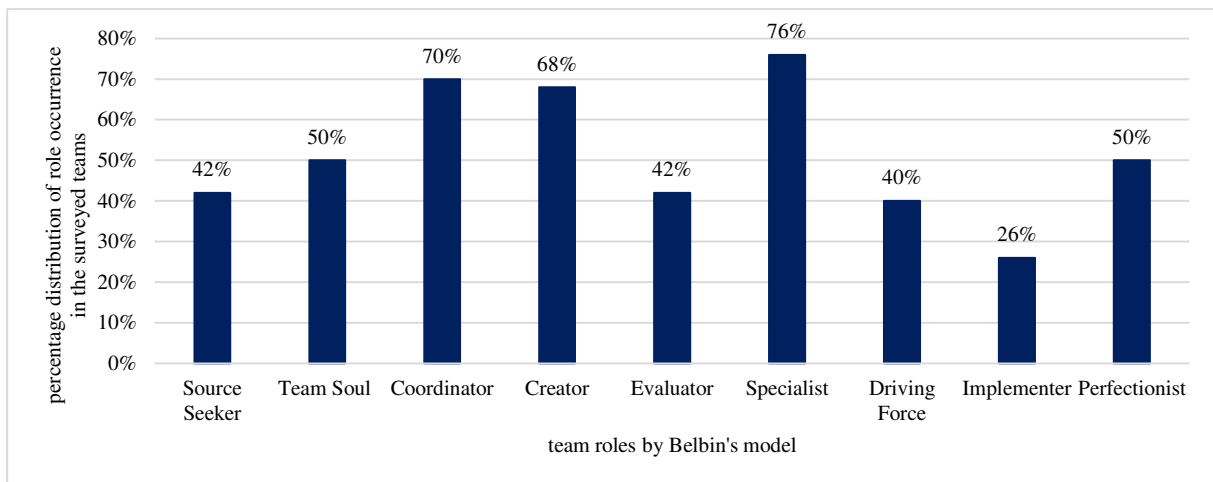


Figure 12. The roles identified by M. Belbin present in the surveyed teams.

Source: Own research.

Research and development teams vary in terms of the percentage of women's participation (Figure 13). The majority of teams (34%) have a percentage of women in the range of 41-59%. As the percentage of women decreases or increases, the number of teams with such participation decreases. It can be observed that values on the right side of the chart are a few percentage points lower than those on the left side with a higher percentage of women's participation.

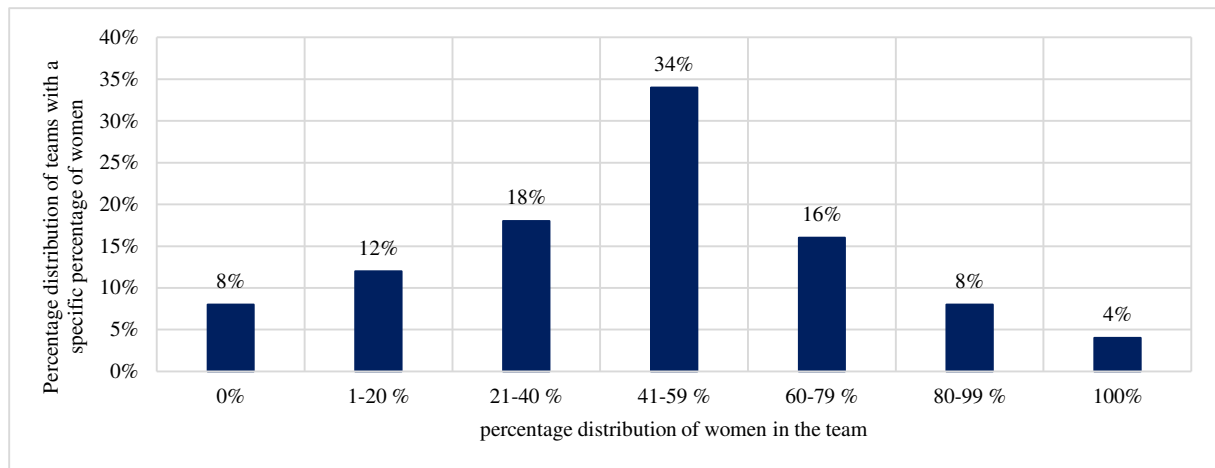


Figure 13. Percentage of women's participation in the surveyed teams.

Source: Own research.

From the research conducted as part of the master's thesis, different results were recorded than those previously published in 2008. Only 8% of participants did not have clear collaboration rules (compared to 26% because of the earlier study). The most significant problem faced by over half of the teams (55%) was administrative and economic issues. Insufficient sense of responsibility for the project by members was also a frequently reported problem (35%). Only 20% of teams declared no problems.

Individuals participating in research and development projects within a scientific circle at a higher education institution face an average of three problems. Those involved in similar projects as part of academic work at a higher education institution and research and development institutions reported about half fewer problems (1.59), and the average for scientific work at the Polish Academy of Sciences was even lower (1.50). The average for businesses is much lower at 0.5.

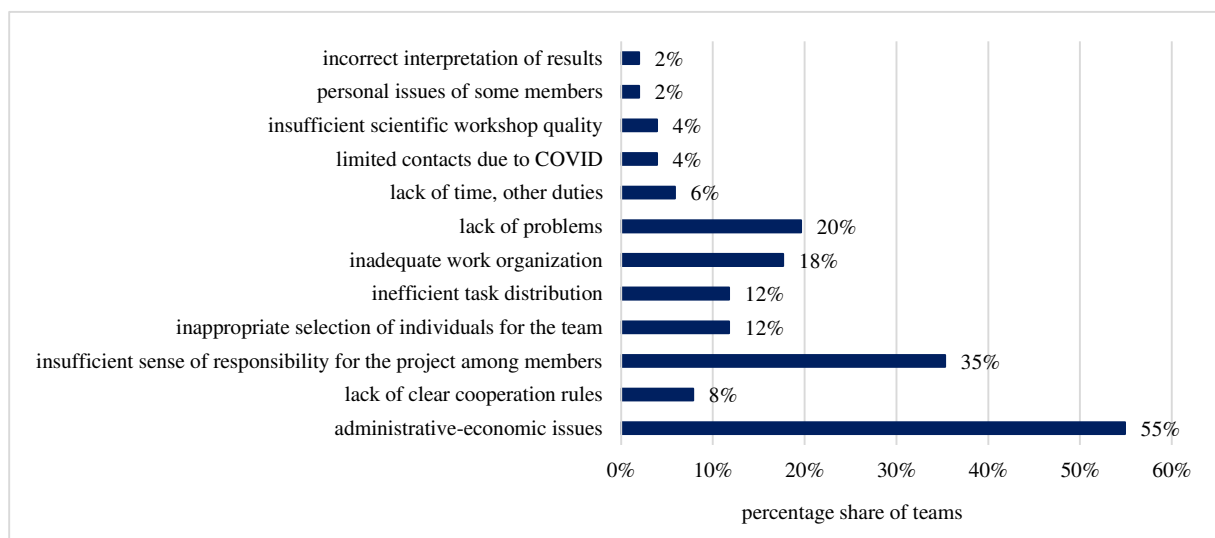


Figure 14. The most significant problems reported by the surveyed project teams.

Source: Own research.

As many as 63% of the surveyed teams reported the occurrence of negative roles within the team (Figure 15). Only 35% declared the absence of such roles. Two percent of respondents found it difficult to respond to this question. The most reported negative roles in the surveyed teams were Passive (37%), Victim (29%), Blocker (20%). The average number of negative roles within a team was 1.29, with a median of 1.

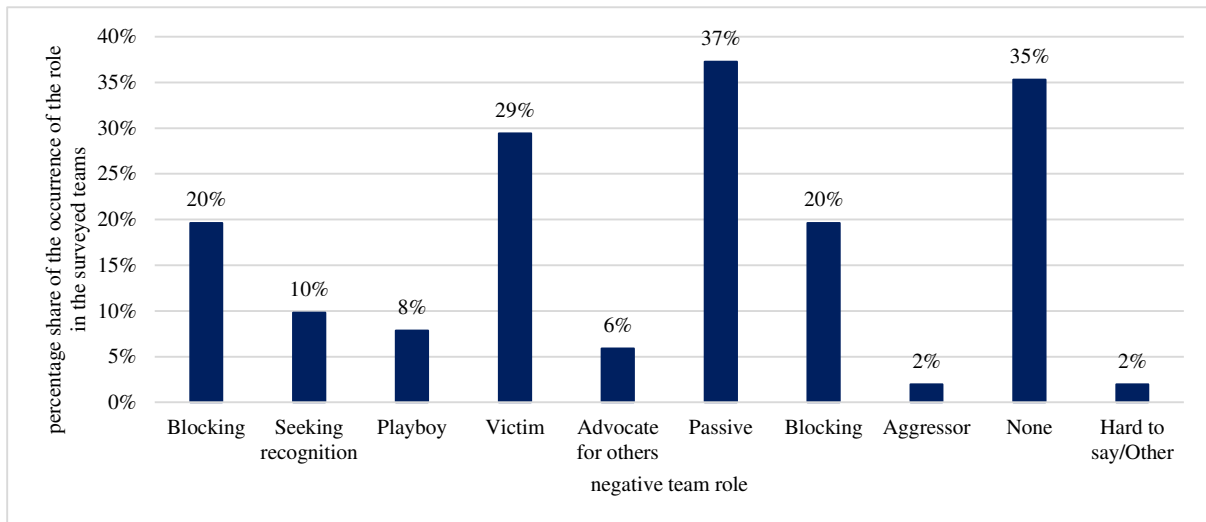


Figure 15. Negative roles observed in the surveyed teams.

Source: Own research.

Ten respondents reported that their group is at more than one stage simultaneously. One respondent indicated three stages, while the remaining nine mentioned two stages. The most frequently mentioned stage was the execution stage.

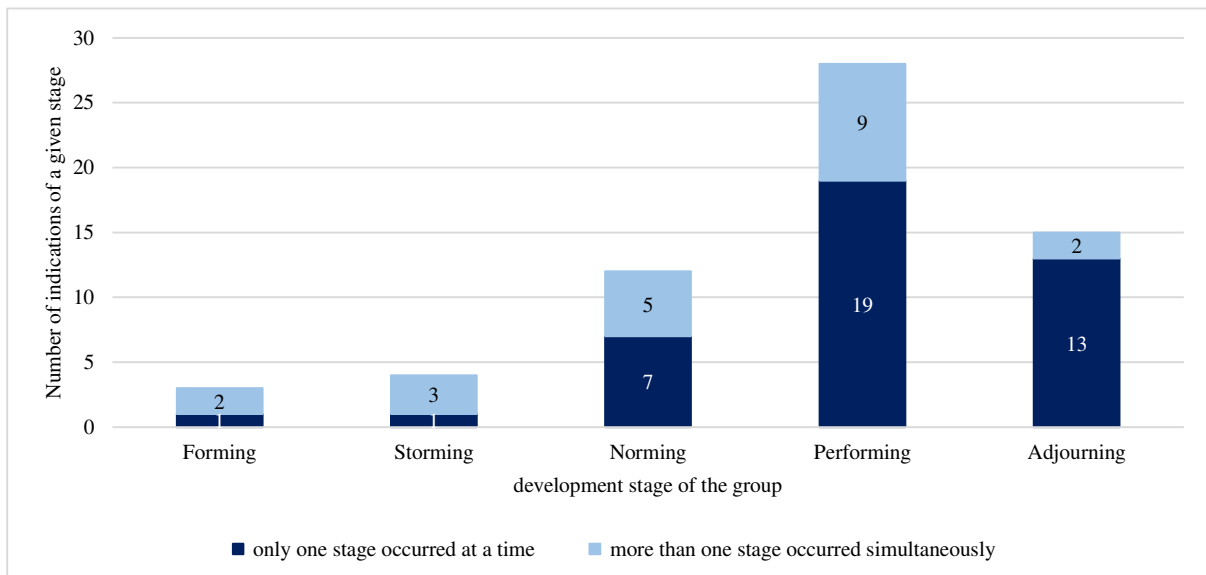


Figure 16. Stages of development of the investigated teams.

Source: Own research.

It can be observed that in 53% of groups (27), an increase in engagement was noticed among individuals participating in setting the goal during its implementation (Figure 17). No such effect was observed in 6 teams, constituting 35%.

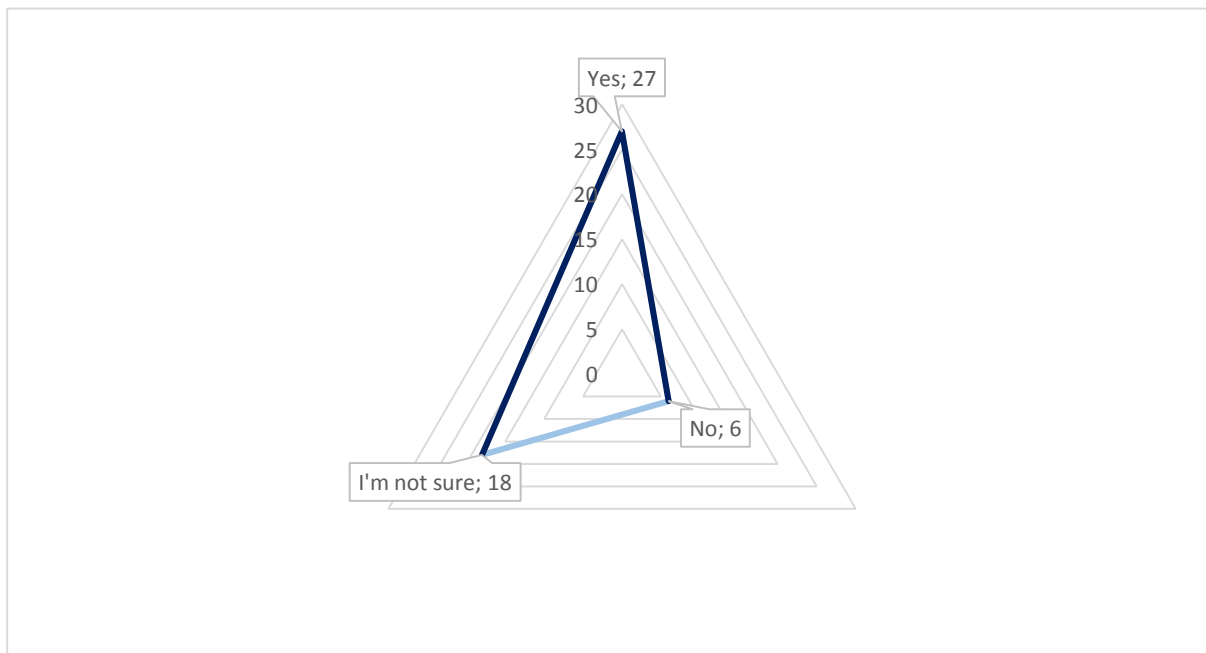


Figure 17. Engagement in the achievement of the goal by individuals involved in its definition.

Source: Own research.

The obtained data were converted into values for which it is possible to calculate the Pearson correlation coefficient (r-Pearson). Based on declarations regarding the positive roles present in the team, the number of these roles was calculated for each survey separately. A similar method was applied to negative roles. The counting of responses was also carried out for the indicated problems that the team faced and the number of stages it was at.

Respondents who declared that their group had a common goal, values, and a sense of responsibility (marked "yes") received a score of 1 for this response, while those who marked "no" received 0. Participants indicated percentage ranges for the proportion of women in the team and the percentage of people focusing on tasks or relationships. To calculate the correlation coefficient, the ranges were converted into the minimum and maximum values of each range.

In the case of the selection of individuals by the leader or initiator, previous analysis led to conclusions suggesting a positive and strong impact on the team's performance. To verify these findings in the case of selection by the mentioned individuals, a score of 1 was assigned, and the rest were marked as 0. Other variables subjected to correlation calculations were collected as numerical variables (Table 1).

Table 1.*The values of the Pearson correlation coefficient (r) for the variable data*

	Team performance evaluation	Assessment of the team leader's performance	Familiarity with methods of team formulation	The number of Belbin roles in the team	Common goal, values, and a sense of responsibility	The percentage of women in the team (min)	The percentage of women in the team (max)	The percentage of team focused on tasks (min)	The percentage of team focused on tasks (max)	The selection for the team by the manager or the originator	The number of reported issues	The number of negative roles within the team	The number of stages at which the team operates	The age of the surveyed individual
Team performance evaluation	1													
Assessment of the team leader's performance	0.45	1												
Familiarity with methods of team formulation	-0.17	-0.04	1											
The number of Belbin roles in the team	0.06	0.14	0.13	1										
Common goal, values, and a sense of responsibility	0.48	0.26	-0.24	0.07	1									
The percentage of women in the team (min)	-0.09	-0.09	-0.07	-0.09	-0.03	1								
The percentage of women in the team (max)	-0.10	-0.12	-0.02	-0.08	-0.05	-	1							
The percentage of team focused on tasks (min)	0.20	0.12	-0.19	0.00	0.17	-0.08	-0.12	1						
The percentage of team focused on tasks (max)	0.26	0.20	-0.12	0.03	0.17	-0.08	-0.11	-	1					
The selection for the team by the manager or the originator	0.05	0.01	-0.33	-0.25	0.24	-0.03	-0.05	0.32	0.13	1				
The number of reported issues	-0.43	-0.34	0.13	-0.07	-0.09	0.05	0.07	-0.10	-0.03	-0.16	1			
The number of negative roles within the team	-0.08	-0.08	0.34	0.29	-0.20	-0.05	-0.10	0.00	-0.03	-0.04	0.03	1		
The number of stages at which the team operates	-0.25	0.01	0.22	0.06	-0.43	0.02	0.05	-0.03	0.00	-0.18	-0.02	-0.02	1	
The age of the surveyed individual	0.04	-0.18	-0.17	-0.24	0.18	-0.06	-0.01	-0.05	-0.17	0.25	-0.14	-0.32	-0.28	1

Source: Own research.

The highest value of the Pearson correlation coefficient (0.48), indicating a moderate degree of dependence, is observed for the relationship between having a common goal, values, and a sense of responsibility and the team's performance assessment (Table 1). The team leader's performance evaluation also moderately correlates with the team's performance assessment (0.45). Conversely, the number of reported issues is inversely proportional to the team's performance assessment (-0.43) and assumes a moderate value. There is a moderate and inversely proportional correlation between having a common goal, values, and a sense of responsibility, and the number of stages at which the team operates (-0.43). A very low correlation coefficient is noted between the number of positive roles in the team (according to M. Belbin's classification) and the team's performance assessment (0.06).

4. Discussion

The participation of women and men in the study was balanced, and no discrepancies arising from the gender proportionality of respondents should occur.

Analysing the data, it can be observed that familiarity with methods of formulating project teams has a minimal impact on the team's performance assessment. Some cases show that team members with knowledge receive higher ratings, but this is not consistent. There are also instances where team members without such competence receive high ratings. Therefore, it cannot be conclusively stated that familiarity with methods of formulating project teams has a strong positive impact on performance assessment. Other factors, such as skills, commitment, or team efficiency, may have greater significance for assessment.

Familiarity with team-building methods is not dependent on the individual from whom the surveyed person originates. No correlation was observed between the motivations guiding an individual to participate in a research and development project and the unit of origin; responses were highly diverse.

Based on the data, there seems to be no relationship between the project's location and the size of the team. The team's size does not significantly differ based on the project type and unit; all have both small and large teams.

A considerable number of groups with five members can also be noticed. This may relate to the concept mentioned in the introduction, stating the optimal number of people in a team, calculated to be 4.6, suggesting that it is convenient to form teams consisting of five participants, which is the closest odd number (Hackman, Vidmar, 1970).

It cannot be conclusively stated whether the group size directly influenced its performance assessment. The data suggest that the team's performance assessment generally remains stable and independent of the number of team members. For instance, groups of varying sizes (from 4 to over 20 people) received similar performance ratings, such as 8, 9, or 10.

Analysing the data reveals a relationship between team size and the number of roles. Larger teams (10-11, 12-20, above 20) tend to exhibit a higher number of negative roles, such as 3, 2, or 4. In smaller teams (4, 5, 6), the number of negative roles is diverse but more often amounts to 0 or 1.

Considering the relationship between team size and the number of issues, dependencies can also be observed. Larger teams (10-11, 12-20, above 20) tend to report a greater number of issues - 2, 3, 4, or 5. In smaller teams (with 4, 5, or 6 members), the number of issues is varied but more frequently takes values of 0, 1, or 2.

An interesting aspect is the reason for choosing the team leader in research and development projects and whether it differs depending on the executing unit. The results indicate that substantive knowledge in the area relevant to the project is essential to become a project leader within academic work at a higher education institution, scientific work at the Polish Academy of Sciences (PAN), or a research and development institution.

A notable trend is that the project originator often becomes the project leader, especially in cases of collaboration between a company and a higher education institution or a research and development institution. No other dependencies between the reason for choosing the project leader and the type of unit were detected. Similarly, in the selection of the person responsible

for selecting members for project implementation, it is not significantly dependent on the executing unit.

A study conducted among research teams in 2008 showed that usually (in 86% of cases), the choice of the project leader resulted from substantive knowledge in the area to which the project pertained (Krawczyk-Bryłka, 2012). At that time, project leaders were individuals who originated the idea in 73% of cases and were typically researchers with no prior project management experience. It can be noted that over the years, the reasons for choosing a team leader have changed.

Analysing the data reveals a correlation between the team's performance assessment and the basis for selecting the team leader. The results suggest that the team's performance assessment is higher when both of the following conditions are met:

- The team leader has substantive knowledge in the area to which the project pertains.
- The team leader was the originator of the project.

When these two factors are present, the team's performance assessment is 8 or higher. However, it was not recorded how the team's performance assessment is attributed to individual factors and is also associated with the team leader. Therefore, it cannot be conclusively stated what impact each of these factors has on the team's performance assessment. It should be noted that the team's performance assessment may also be based on other factors beyond those provided by respondents, such as task efficiency, team communication, collaboration, and innovation.

A relationship was noted regarding the role performed in the team and the assessment of the team leader's performance. Individuals who were not team leaders assessed their leader's performance more positively than individuals who held this role while assessing their own work (Table 2).

Table 2.

Assessments of the team leader's performance

	Assessment of the team leader's performance	
	individuals who are not team leaders	by the team leader
Average ratings	8.40	7.53
Mean ratings	9	8

Source: Own research.

Based on the data, it can be observed that a team leader's performance rating of 10 was mainly given by team members, while ratings of 7, 8, and 9 for their own work were primarily awarded by team leaders. This suggests that team leaders may assess their own work lower than their team members do, possibly underestimating their contributions. No ratings below 5 were given for a team leader's performance, which may be related to the awareness of individuals participating in research and development teams regarding the high competency requirements for team leaders.

From the obtained ratings of team leaders and the basis for their selection, a certain pattern can be discerned. Leaders who possessed high substantive knowledge in the project area and were the originators of the project typically received higher ratings than other leaders. Other factors, such as managerial predispositions or the ability to create research plans and secure funding, may also influence the assessment of a team leader. However, based on the collected data, it cannot be conclusively stated how these factors impact the evaluation of the leader.

It is important to note that the assessment given to a project leader can be interpreted as a subjective score based on individual criteria and expectations. In some cases, the team and project leader assessments align (e.g., 10-10, 8-8), but there are also instances where the ratings differ (e.g., 8-5, 9-7). This implies that there is no direct correlation between these assessments. The evaluation of a project leader may also result from other factors, such as leadership skills, team management, communication, or achieved goals. It may also depend on the subjective preferences and expectations of the evaluator.

However, it is worth noting that the team and project leader ratings are somewhat correlated, as in some cases, similar ratings are assigned to both the team and the project leader. Nevertheless, there are also cases where the assessments differ for both sides. No clear correlation was observed between the team's performance assessment and the role played in the project.

Based on the collected data, associations between motivation and the role performed in the team can be observed:

- Team members demonstrate motivation primarily through research curiosity, career development, and the opportunity to meet other scholars. This may stem from their desire for learning, knowledge acquisition, and personal growth.
- Team leaders often mention financial motivation and career development. They may be more interested in earnings and professional advancement.

From the available data, it can be presumed that an individual's motivations for participating in a project influence the team's performance assessment, although it is not straightforward. Team members with strong motivations, such as research curiosity, career development, a desire to do meaningful work, financial motivation, or the opportunity for international travel, often gave higher ratings for teamwork.

However, individuals who reported fewer motivational reasons tended to give lower scores. Motivations can influence engagement, engagement affects team efficiency, and team efficiency is often assessed. Motivations can also influence the involvement and commitment of team members in project goals, collaboration, communication among team members, problem-solving ability, and creative thinking. However, it is important to note that the team's performance assessment may also depend on other factors, such as skills, communication effectiveness, collaboration ability, work organization, or resources available to the team.

Motivations are one element that can influence the assessment but are not the sole determining factor.

The impact of the number of roles according to M. Belbin's concept on the team's performance assessment is not conclusive. The calculated correlation coefficient is very low (0.06), indicating a very weak positive correlation between the number of roles performed and the team's performance assessment. This value is very close to zero, suggesting no significant linear relationship between these two variables based on the available data. No nonlinear relationship was observed either.

Based on the collected data, it is not possible to conclusively determine which role has the strongest impact on a high team assessment. However, concerning teams receiving the highest ratings (9 or 10), it can be observed that they often include individuals with roles such as Creator, Specialist, Perfectionist, Evaluator, Coordinator, Implementer. These roles have different characteristics and skills that are important for effective teamwork.

There seems to be some influence of the percentage of women in the team on the team's performance assessment. Of course, this is not the sole determining factor, but certain tendencies can be discerned. Teams with a percentage of women ranging from 41-59% tended to receive ratings of 8, 9, or 10. Teams with a higher percentage of women tended to receive slightly higher ratings. However, this is not a strict rule, as there are also cases where teams with different percentages received different ratings. The results would, however, support the advantages of gender-diverse teams.

One can also observe a certain relationship between the number of problems and the team's performance assessment. The lower the number of problems reported by the team, the higher the team's performance rating. For instance, most teams reporting only 1 or 0 problems received very high ratings ranging from 8 to 10. Conversely, teams reporting a higher number of problems, such as 3, 4, or 5, tended to receive lower ratings in the range of 4 to 7. However, it should be noted that these data do not account for other factors that may influence the team's performance assessment. Other factors, such as problem-solving effectiveness, work efficiency, team communication, and many others, may also be relevant to the team's performance assessment.

Based on the provided data, relationships between the type of problem occurring in the team and the team's performance assessment can be identified:

- Administrative-economic problems: Many teams reporting administrative-economic problems received ratings in the range of 8-10. Problems of this type did not have a significant negative impact on the team's performance assessment.
- Insufficient sense of responsibility among team members: Teams reporting an insufficient sense of responsibility among team members received various ratings, but most commonly ratings ranged from 8-10.

- Inappropriate selection of individuals for the team and ineffective task allocation: Teams reporting problems related to the inappropriate selection of individuals for the team and ineffective task allocation received varied ratings, but often lower ratings in the range of 4-7.
- Lack of problems: Teams reporting no problems received varied ratings, but most commonly ratings were in the range of 8-10. The absence of problems does not necessarily guarantee a high rating, but it can be a favourable factor.

Further analysing the issue of problems, one can notice a certain impact of the number of problems on the assessment of the team leader's performance – the lower the number of problems, the higher the leader's rating. However, there are also cases where, despite a higher number of problems, the leader's rating remains high. Thus, while the number of problems may have some impact on the assessment, it is not the sole determining factor. Other factors, such as effective problem management, an approach to problem-solving, and the overall quality of the leader's work, also influence the assessment. Administrative-economic problems in the project have a negative impact on the leader's rating. Additionally, inappropriate selection of individuals for the team, ineffective task allocation, and improper work organization also affects the rating. On the other hand, the absence of problems or a limited number of project-related problems contributes to a higher leader's rating.

Staying on the topic of problems, it is challenging to unequivocally determine which role has the worst impact on the team's performance rating because the ratings are diverse, and there is no clear trend. However, based on the available information, one can observe that the 'Victim' role often appears in the context of a negative team performance rating. An individual in this role constantly faces difficulties, requires support from others, and utilizes their energy at the expense of the group's work. Also, the 'Passive' role, which withdraws from the assigned task, marks work and highlights a lack of interest in the team and the work, is also often associated with negative ratings. However, the team with the lowest received score (a rating of 3) was the only one to note the 'Aggressor' role in their team. Critics of B. Tuckman's model suggested that a team may be at more than one stage simultaneously (Czahajda, 2019). The results of the research conducted among research and development teams confirm this argument (Figure 16).

There is a correlation between the team's performance evaluation and the stage at which the team is situated. The results suggest that the team receives higher ratings when it is in the execution phase, working efficiently, implementing new creative solutions, and benefiting from a goal-oriented atmosphere. The evaluation is also positive in the normalization phase, where the team transitions from conflicts to substantive discussions, openness to exchanging views, and mutual support. However, in the forming phase, where the team is cautious, uncertain, searching for direction, and avoiding conflicts, the team's performance evaluation is lower. Similarly, in the storming phase, where conflicts manifest in all aspects of the team's functioning, the evaluation also tends to be lower. In the closure phase, when collaboration ends due to goal achievement or when all members leave the team, the team's performance evaluation remains stable at the level of 8 or 9.

5. Conclusions

Considering the presented data and analysis, it can be inferred that evaluating the team's performance in the context of various factors, such as the developmental stage, the number of reported issues, or participants' motivations, sheds new light on the dynamics of research and development teams. Identifying connections between these elements allows for a better understanding of how different aspects impact the effectiveness and assessment of team performance. However, it is worth emphasizing that evaluating team performance is a complex issue, dependent on various factors, and requires a holistic view of the functioning of the R&D team. These findings may serve as a starting point for further research on team building in project teams and can be inspirational for practitioners aiming to optimize collaboration in R&D teams.

What is necessary to emphasize is that this article presents the results of quantitative research without considering qualitative research. These will be presented in the next article.

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EMPLOYER BRAND PERSONALITY: THE SCALE AND RESULTS OF MEASUREMENT

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Purpose: The aim of the article is to demonstrate the employer brand personality scale (previously validated under Polish conditions) and to estimate (using this scale) whether the employer brand personalities can be considered expressive.

Design/methodology/approach: The literature review and survey were used. Research was carried out among 576 people. The paper fits into the topic of employer brand personality that has been investigated for years.

Findings: It was established that the Polish-language employer brand personality scale is a two-dimensional construct. Using a validated employer brand personality scale, it was also learnt that although employers can be 'rather' characterised as solid, it is difficult to determine whether they are stylish. Therefore, the study showed that the employer brand personalities (of the organisations represented by the respondents) are difficult to categorise as strong or expressive.

Research limitations/implications: The study does not meet the condition of statistical representativeness. Limitations are also related to the research technique and measurement scales used. Future research may focus on the relationship between employer brand and human personality. The impact of employer brand personality on employee loyalty is also worth analysing.

Practical implications: The developed employer brand personality construct (in Polish) can be used in practice. We encourage employers to measure employer brand personality. This is important because the strong employer brand personality can help the organisation to become an employer of choice, that is, an employer that has no problems with attracting and retaining talented employees.

Originality/value: Research conducted is pioneering in Poland. Until now, no work has been done in Poland to design and validate the employer brand personality scale; no one identified the employer brand personality on the basis of a previously validated (culturally adapted) scale either. The recommendations contained in the paper can be an inspiration for researchers and managers who are interested in investigating and strengthening the employer brand personality.

Keywords: employer brand personality, dimensions, facets, measurement.

Category of the paper: Research paper.

1. Introduction

The term ‘personality’ is associated with mainstream psychology and the applicators that power researchers such as Freud, Jung, Guilford, and Eysneck. However, as a result of one of the trends in science, which is anthropomorphisation, personality is also of interest to representatives of management sciences, who relate the category of personality not only to a person (as an internal or external customer) but also to an organisation as a system, a city, or a brand. In studies on brand personality, research often focusses on the product brand. But given that, over the past decades, brand management has been evolving toward the creation of a company/corporate brand (Urbanek, 2012), considerations of brand personality are moving from the product/service level to the organisational level. And as many institutions act as employers, the employer brand personality also becomes the subject of scientific research. This is evidenced by regularly published texts on employer brand personality, including the studies conducted by Livens (Livens, Highhouse, 2003; Lievens, 2007) or Davies (Davies et al., 2004; Davies, 2008; Davies et al., 2010). The situation is different in the Polish-language literature, where it is very difficult to find studies on employer brand personality. Confirmation can be the result of searching for the phrase ‘employer brand personality’ (written in Polish) with the help of the Google search engine. According to the search results (7 March 2023), there were only four text elements that corresponded to the query on the Internet. These were: an article published more than ten years ago devoted to the role of respecting employees’ interests in building a strong employer brand (Wojtaszczyk, 2011), and published on the domain dbc.wroc.pl; the website gojtowska.com established by a consultant in the field of employer brand management; the website RocketSpace.pl, which advertises itself as the job portal of the future, where texts on human resource management are published; translation of ‘brand personality’ in Polish (glosbe.com). The results of this simple search lead to the conclusion that there is a research gap related to the employer brand personality in our country. To fill this gap, we dedicate this text to the employer brand personality.

The aim of our article is to demonstrate the employer brand personality scale (previously validated in Poland) and to estimate (using this scale) whether the employer brand personalities (represented by the respondents) can be considered expressive, that is, conducive to creating relationship with candidates and employees. Introducing the topic (in the theoretical background section) we first focused on the role of personality in management science. Then the idea of brand personality and approaches to measuring brand personality were presented, and controversies related to the identification of brand personality were indicated. This part of the paper is based on a literature review. The analysed texts were searched in the Scopus and Web of Science databases; Google Scholar and ResearchGate resources were also used. The empirical part of the article begins with a description of the methodology of the research carried out. Our research was carried out using the CAWI (Computer Assisted Web

Interview) technique and 576 people participated in the research. Conclusions indicate that although employers (represented by respondents) can be 'rather' characterised as solid, it is difficult to state whether their personalities are stylish. The results of our study proved that it is difficult to categorise the employer brand personalities as strong or expressive. The empirical research we carried out does not meet the condition of statistical representativeness. Although this did not weaken the outcomes of the previous validation of the employer brand personality construct, the research results presented in this paper cannot be generalised. Nevertheless (in our opinion), the content presented in the article meets the criterion of scientific novelty and is a step towards addressing the research gap related to the identification of employer brand personality under Polish conditions.

2. Theoretical background

2.1. The concept of personality in management science

'Personality' is a term used primarily by psychologists. Due to centuries of research traditions and a variety of trends in analysing the personality phenomena, there is no universally accepted definition of human personality today. Therefore, research on personality continues to attempt to describe the mechanisms of their functioning and determine the features that distinguish individuals or groups (Buksik, 2000). The beginnings of the study of personality traits go back to the first half of the twentieth century. The Allport theory of personality is considered classic, based on which personality consists of central / cardinal and secondary traits (John, Pervin, 2002). Trait theory has been (and still is) developed by many researchers. Costa and McCrae (1994) are the authors of the so-called the Big Five concept, which is currently one of the most popular trait theories (Cieciuch, Łaguna, 2014). Under the idea of the Big Five (in great simplification), human personality can be described by five dimensions/cardinal traits, and each of them consists of more specific and numerous patterns of thoughts, feelings, and behaviours, called secondary traits or facets (Strus, Cieciuch, 2014). The dimensions of human personality, according to the Big Five, are: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Neuroticism means that a person is susceptible to experiencing negative emotions and is expressed by excessive enthusiasm and greater anxiety. Extraversion reflects the individual's involvement in interpersonal contacts. Openness to experience reflects the degree of curiosity about the external and the inner world. Agreeableness determines the attitude (positive or negative) towards others. A high level of agreeableness means trust, willingness to cooperation, and being helpful. Conscientiousness is usually accompanied by attention, punctuality, reliability, discipline, diligence, and diligence.

However, personality is not only analysed by psychologists. As a result of anthropomorphisation (Bogdanienko, 2017; Łukaszewicz, 2018), personality is also of interest to representatives of management science. Management experts, as interdisciplinary researchers, are obviously interested in human personality (employee, job candidate, client). Nevertheless, since the 1970s, scientists have also explored organisational/corporate personality (Markham, 1972; King, 1973). Moreover, the brand personality concept has been developed since the end of the last century. And the research concerns not only the product or service brand, the idea of personality is transferred to other types of brand, such as the employer brand as well (Slaughter et al., 2004; Davies et al., 2004).

2.2. The brand personality

The consequence of the assumption that a brand has a personality is to describe it in terms of personality traits attributed to a person. Brand personality is therefore a set of characteristics of human personality that can be associated with a brand and that are important for it (Azoulay, Kapferer, 2003). The importance of brand personality is expressed in the fact that a strong/expressive brand personality helps to build the consumer's emotional relation with a given product or service, and influences the level of trust the brand (Sung, Kim, 2010), which in turn promotes loyal attitudes and behaviours of consumers. Plumer (2000) argues that, in an era where the quality of products and services is comparable, the brand personality is what distinguishes a particular brand from its competitors. Therefore, the brand personality should be treated as one of the key determinants of consumer choices and, thus, a substance of brand value. For this reason, today brand personality is considered a tool to strengthen the brand equity. Consequently, the brand personality is a strategic asset for brand differentiation and the creation of brand-consumer relationships (Guèvremont, Grohmann, 2013).

Although there is agreement that personality is one of the sources of brand strength, there is no full agreement on the 'location' of personality in the brand construct. Some researchers (e.g. Upshaw, 1995; Kapferer, 2008) believe that personality is a component of brand identity. Others scientists (e.g. Kotler, 1994; Kall et al., 2006; Keller, 2008) treat personality as one of the dimensions of brand image. However, taking into account that brand identity (as a result of broadly understood communication processes) is offered to consumers, in whose minds a brand image (interpretation of the brand) is created, it seems reasonable to recognise brand personality not by collecting opinions among owners (who are the main creators of brand identity), but among clients.

2.3. The brand personality identification

Interest in identifying brand personality (through research among consumers) began with the publication by Aaker (1997) of the results of pioneering research on the measurement of brand personality. Aaker, inspired by the concept of the Big Five, developed the first personality scale for brands. The scale includes forty two items (specific features). Each item is assigned

to one of the fifteen secondary traits that make up the five dimensions of the brand personality (Figure 1). Three of the mentioned basic dimensions can be related to the human personality traits described by the Big Five: sincerity is associated with agreeableness and conscientiousness, excitement is expressed in similar aspects to extroversion, and competence is represented by aspects that can be found in the facets of conscientiousness and extraversion (Geuens et al., 2009).

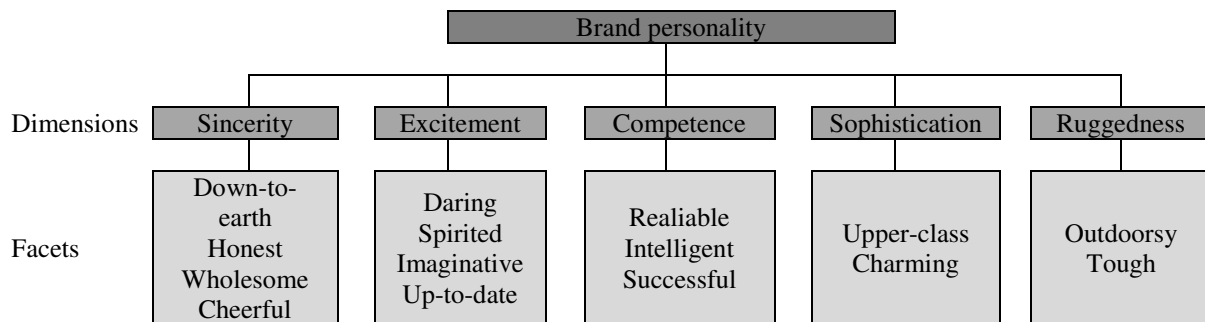


Figure 1. The Aaker brand personality model.

Source: Aaker, 1997.

The Aaker scale was modified by the author herself (Aaker, 2000; Aaker et al., 2001) and by other researchers (e.g., Sung, Tinkham, 2005; Muniz, Marchetti, 2012). The reason for the changes introduced was criticism of the original concept. The objections included the fact that Aaker used not only personality traits to describe the brand personality, but also personal characteristics such as gender or age (Azoulay, Kapferer, 2003).

Based on empirical research, it was also established that while the Aaker scale (or its lexically modified version) can be used to identify the product brand personality, the specificity of the organisation brand, city brand, or employer brand may require the use of slightly different dimensions and facets (Chun, 2005; Rojas-Méndez et al., 2013). Therefore researchers develop their own scales to measure the personality of a specific type of brand. Ranjbar (et al., 2010), referring to selected product brands, discussed that in the case of different brands, the scales for measuring brand personality may have a different number of dimensions. For example, the Nivea brand personality scale is four-dimensional (sincerity, excitement, competence, sophistication), and in the case of the Samand brand, the scale has only three cardinal traits (sincerity, competence, ruggedness). Ariff (et al., 2012) proved that in the case of laptop brands, the brand personality scale has six dimensions, with four dimensions coming from the Aaker scale (sincerity, excitement, competence, ruggedness), and two additional dimensions (diligent, modern) were discovered by the authors. Davies (et al., 2018), based on the analysis of twenty-one studies published between 1997 and 2016, identified sixteen different dimensions used to measure the personality of various types of brands, with the most commonly used solution being to supplement the Aaker scale with additional central and secondary traits.

Researchers have also noticed that the perception of personality (including brand personality) is strongly culturally conditioned. Therefore, Aaker's dimensions of brand personality are not transferable between different cultures (Anandkumar, George, 2011). This observation corresponded to the accusation that Aaker did not take into account the psycholexical approach, according to which (in the simplest sense) differences in the perception of a particular feature are caused by how it is encoded in the national language (De Raad, 2000; Gorbaniuk, Włodarska, 2015). Then, followers of lexical analyses raised the need to be empirically proved whether individual dimensions of brand personality can be considered universal or can be used only in a selected culture or cultures.

The need to adapt the brand personality scale to the specificity of a particular culture and language led to the creation of its Polish-language version. Theoretical and content validation was carried out by Gorbaniuk (et al., 2010). The content validation was related to cultural adaptation, or more precisely, linguistic adaptation. Thanks to the independent translation of the Aaker scale by two judges and the reconciliation of discrepancies, it was possible to adapt the questionnaire for use in Poland. On the other hand, theoretical validation served to limit the number of cardinal and secondary traits. Consequently, the Gorbaniuk brand personality scale consists of four dimensions represented by thirty-six adjectival facets (Figure 2).

As Calderón-Fajardo (et al., 2023) has stated, it can be concluded that brand personality research has undergone remarkable developments, with important repercussion on brand management theory and practice since the 1990s.

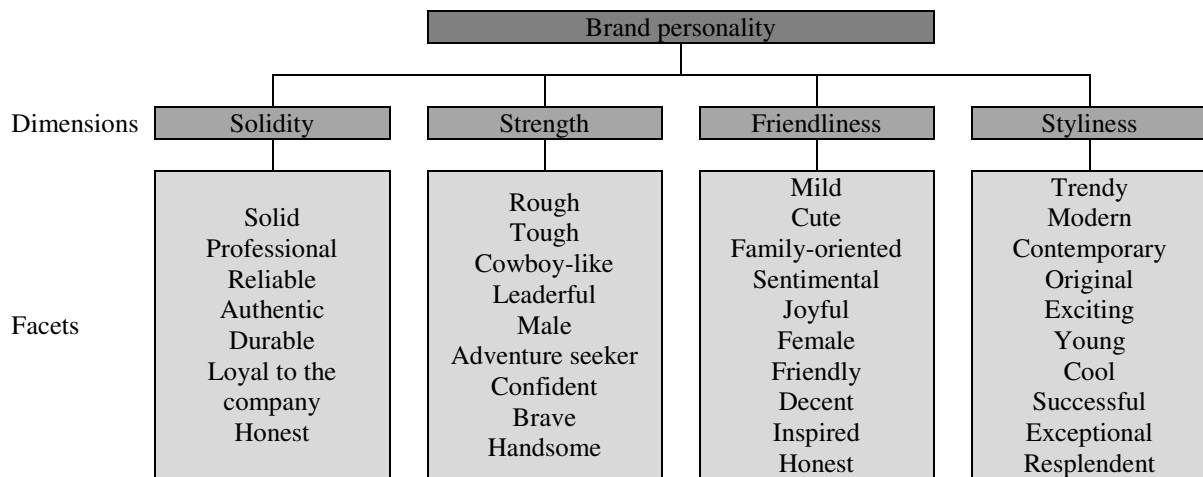


Figure 2. The Gorbaniuk brand personality model

Source: Gorbaniuk et al., 2010.

2.4. The employer brand personality

Despite doubts about the Aaker brand personality model, the idea of measuring the brand personality is used in practice to determine the personality of a product or service brand, but also the personality of an employer brand. Lievens and Highhouse (2003) carried out the first research aimed at identifying employer brand personality. With the help of the Aker scale

(lightly modified), they described employer brand personality with following four dimensions: innovativeness, competence, prestige, and excitement. Davies (et al., 2004) developed the 'corporate character scale' with seven dimensions: agreeableness, enterprise, chic, competence, ruthlessness, informality, and machismo. Slaughter (et al., 2004) identified a list of organisational personality traits with five broad dimensions: boy scout (e.g., honest, attentive to people, family-oriented), innovativeness (e.g., original, creative, unique), dominance (e.g., big, successful, popular), thrift (e.g., simple, low-budget, undersized), and style (e.g., trendy, up-to-date, stylish). One of the newer studies on employer brand personality (Schätzle et al., 2022), pertaining to the healthcare sector, show that the employer brand personality can be operationalised as a higher-order construct with the dimensions of status, warmth, competence, and trustworthiness. Other analyses of employer brand personality can be found in the texts: Davies et al., 2004; Lievens, 2007; Davies, 2008; Davies et al., 2010; Rampl, Kenning, 2014. It should be noted that most of the above-mentioned studies are based on modified (compared to Aaker's construct) brand personality scales and they contain the results of validation of the constructs used in the research.

One of the reasons for carrying out research on employer brand personality is the development of the employer branding. Like all other types of brand, the employer brand has its own personality. Almost twenty years ago, Lievens (2007), in the study conducted in the Belgian Army, proved that the personality of the employer brand plays a significant role in assessing the employer's attractiveness, which not only helps to attract candidates, but also retains those who are already employed in the company. Managing the employer brand personality is also important for other reasons (Grębosz-Krawczyk, 2020). First, as a result of brand personification, the defensive reactions of potential members of the organisation before deciding to accept a job offer are weakened. Second, the bond between an internal client and a brand with a unique personality is stronger. Third, a properly developed brand personality helps build relationships with the brand, create trust in the brand, and develop loyal behaviour toward it. In the context of job choice behaviour, an employer brand that exhibits personality traits that match a job seeker's actual or ideal personality increases affinity for the employer, because it satisfies underlying self-esteem and self-consistency needs (Slaughter et al., 2004). In contrast, some researchers point out that a lack of self-congruence makes the employer less attractive (Turban et al., 2001; Kissel, Büttgen, 2015). In the case of the employer-candidate relationship, matching a person's personality to the employer brand personality can be conducive to attracting candidates to the company and efficiently implementing selection and adaptation procedures. In turn, in the case of the employer-employee relationship, the compatibility of the employer and employee personality not only helps retain the employee in the company but also increases the level of their commitment and motivation.

In Poland, no research on the personality of the employer brand has been carried out. The only studies of this type that have been found are the studies by Wojtaszczyk (2012). However, these analyses are not comparable to those indicated above. Firstly, because the

personality of the employer brand (treated by Wojtaszczyk as one of the elements of the brand image) was not related to the Aaker concept. Secondly, because the employer brand personality was described using only five items: learning or studying, modern, independent, kind and friendly to people, one with which you cannot get bored with. Thirdly, because the measurement tool had not been validated.

3. Method and participants

The lack of studies related to the employer brand personality under Polish conditions was the main motivation that prompted us to do empirical research. In our research, the CAWI technique was used. The study was carried out asynchronously. The tool was a questionnaire designed with the Webankieta wizard. In the first part of the questionnaire, respondents were informed about: the purpose of the study, the structure of the form, the method of answering, the time necessary to complete the questionnaire, the voluntary nature of participation in the study, the anonymity of the study, the use of the results, the researchers (including e-mail addresses for possible contact). Each participant received the following instructions: 'Imagine your current employer as a person. This sounds unusual, but we suggest you think about the features you associate with your employer. For example, when you think about the Tchibo brand, you can think of such human-specific features as friendly, energetic, elegant, reliable, etc. It is similar to employers, each of them (whether recognised or not) has its own brand, which can also be described using human traits. We are curious what traits you attribute to your current employer. There are thirty-six of these characteristics below. Indicate which of them describes your employer. Answer each of the features listed. In the substantive part of the questionnaire, we used the Polish version of the brand personality construct (Gorbaniuk et al., 2010) (Figure 2). Two modifications were introduced: the statement 'loyal to the company' was changed to 'loyal to employee', the phrase 'family-oriented' was reformulated into 'employee's family-oriented'. The employer brand personality construct was presented in the questionnaire as a closed, multiple-choice matrix question. Responses were recorded on a five-point Likert scale, but in the questionnaire scales included only descriptive categories. When assigning values to the answers, the principle was followed that the assigned values should increase according to the nature and direction of the defined characteristic. In results analyses the following values were assigned to the answer: 'I disagree' - 1, 'I rather disagree' - 2, 'neither yes nor no' - 3, 'I rather agree' - 4, 'I agree' - 5.

The study involved people who were doing (at the time of the study) hired work. Potential respondents were reached through email and social media. In both cases, potential respondents received an active link to the survey questionnaire. Some study participants (of their own will), according to the snowball sampling technique, passed information about the study on to other

people. No gratification was offered to the volunteer participants. Despite this, the percentage of completed forms (in relation to views) was high and amounted to 44%. Due to the actions taken, 576 people were encouraged to participate in the study (58% of them were women). The largest group of respondents were people aged 21 to 25 years (52%). The young age of the research participants was reflected in their work experience. During the study, 46% of the respondents had been active in the labour market for not less than one year but not more than five years; 45% declared that they had been employed in their current job for 1 to 5 years. Most of the respondents (84%) did not hold managerial positions. More than three-fourths (76%) of the respondents worked in the private sector. The participants represented local, national or international organisations (Table 1).

Table 1.
Characteristics of the research participants

Gender	Female				Male			
	58				42			
Age (in years)	Less than 21	21-25	26-30	31-35	36-40	41-45	46-50	More than 50
	6	52	10	10	8	6	5	5
Total work experience (in years)	Less than a year	1-5	6-10	11-15	16-20	21-25	More than 25	
	11	46	14	11	6	7	5	
Work experience at the current place of employment (in years)	Less than a year	1-5	6-10	11-15	16-20	21-25	More than 25	
	34	45	11	6	2	1	2	
Current position	Managerial				Nonmanagerial			
	16				84			
Sector	Private				Public			
	76				24			
Scale of companys operation	Local		National		International			
	23		32		45			

Note. Data in %.

Source: own work.

First, the modified Gorbaniuk brand personality scale (for the purposes of employer brand research) was validated¹. The following analyses were used to validate the employer brand personality construct: reliability and position, convergence validity, discriminant validity, and the possibility of common method error. The descriptive statistics (mean, median, dominant, standard deviation, skewness, kurtosis) were used to assess the significance of primary and secondary employer brand personality traits. Analysing the mean values, it was assumed that: for $1 \leq M \leq 1.50$ – dimension/facet does not characterise the employer brand personality; for $1.51 < M \leq 2.50$ – the trait rather does not characterise employers;

¹ The validation procedure and its results are described in detail in another paper. Due to the fact that validation is not the purpose of this article, only the most important findings related to the assessment of the scale used are presented in this article.

$2.51 < M \leq 3.50$ means that the respondents were unable to determine whether a specific feature is characteristic of the employers' personality; $3.51 < M \leq 4.50$ means that the feature rather characterises the employer; $4.51 < M \leq 5$ - according to the respondents, the particular trait characterises the organisation as an employer. It was also checked whether there were significant differences in the respondents' statements due to demographic variables.

4. Results

The Gorbaniuk (2010) scale used in the study, although it takes into account linguistic conditions, was created on the basis of data on ten selected product brands. Due to the limitations indicated above related to the 'transfer' of the product brand personality scale to other types of brands, we decided to check whether the scale can be used to recognise the personality of the employer brand. Consequently, construct validation was performed. In the validation process, we omitted the stage of cultural adaptation and focused on theoretical validation, i.e., checking the reliability and validity of the scale. Based on the validation results, it was determined that: it is necessary to remove seven facets from the construct (reliable, durable, rough, cowboylike, tough, female, young); the strength dimension does not meet the criteria of convergent validity; the requirement of discriminant validity is met only when the scale consists of a maximum of two dimensions, which are solidity and styliness². Therefore, to measure the employer brand personality (under Polish conditions), it is best to use a two-dimensional scale consisting of fourteen facets (Figure 3).

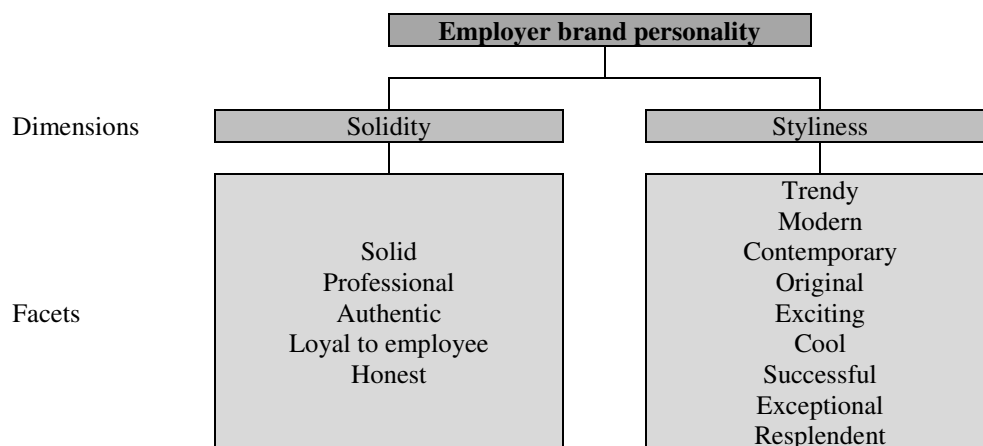


Figure 3. The employer brand personality construct.

Source: own work.

² Each of the four dimensions can, of course, be used separately.

In Polish, ‘solidity’ is a characteristic attributed to a person who can be trusted and who performs tasks carefully and responsibly. A solid item is strong, durable, and solid. With regard to the mean values of the facets assigned to the subscale of solidity (Table 2), it should be noted that the highest rated aspect of the employer brand personality (of our respondents’ employers) is professionalism ($M = 3.97$). In turn, the trait that can be least related to the respondents’ current employers of the respondents is loyalty to the members of the organisation (3.51). The answer chosen most frequently for all items on the solidity subscale was ‘I rather agree’ ($Do = 4$); the central value was also 4. It should be added that almost one-five of the participants had a problem in determining whether their employers were solid - on average, 18% of the respondents chose the answer ‘neither yes nor no’. In the case of styliness, the results are slightly different. First, most of the respondents found it difficult to determine whether a given personality trait could be attributed to their employers. Our participants had the greatest problems with the adjectives ‘exceptional’ and ‘resplendent’ - in both cases, the relatively highest percentages of respondents (41% and 37%, respectively) chose the option ‘neither yes nor no’. The highest rated trait on the styliness subscale was ‘successful’ (Table 2). It is worth to emphasise that this feature has the highest mean value ($M = 4.10$) among the 14 facets analysed of employer brand personality. The styliness subscale also includes the lowest rated feature, which is ‘resplendent’ ($M = 2.70$). For five of the secondary traits of the styliness subscale (cool, trendy, modern, successful, contemporary), $Mdn = 4$; for the remaining four aspects $Do = 3$. The middle values in the series of individual secondary employer brand personality traits are as follows: $Mdn = 3$ (for exciting, trendy, resplendent, exceptional), $Mdn = 4$ (for cool, modern, successful, contemporary).

Among the secondary traits, there are no factors that do not characterise the personality of employers - none of the mean values calculated for specified facets of the employer brand personality is lower than or equal to 2.50. Respondents did not indicate that any of the secondary traits definitely characterised the organisations they worked for (there were no facets with a mean value greater than 4.50). Taking into account all the analysed aspects of employer brand personality, employers represented by our participants can be described primarily as successful, professional, honest, solid, and modern (Table 2).

Table 2.

The employer brand personality facets: The descriptive statistics

Dimensions	Facets	Mean <i>M</i>	Median <i>Mdn</i>	Dominant <i>Do</i>	Standard deviation <i>SD</i>
Solidity	Solid	3.85	4	4	1.06
	Professional	3.97	4	4	1.07
	Authentic	3.70	4	4	1.08
	Loyal to employee	3.51	4	4	1.22
	Honest	3.88	4	4	1.09

Cont. table 2.

Styliness	Trendy	3.35	3	4	1.23
	Modern	3.72	4	4	1.16
	Contemporary	3.80	4	4	1.17
	Original	3.33	3	3	1.21
	Exciting	2.87	3	3	1.16
	Cool	3.53	4	4	1.15
	Successful	4.10	4	4	0.95
	Exceptional	3.08	3	3	1.21
	Resplendent	2.70	3	3	1.12

Source: own work.

Considering the statistics for the central traits of the employer brand personality (Table 3), it should be noted that, according to the respondents, the organisations that employ our participants are ‘rather’ solid as employers ($M = 3.78$). However (under the adopted ranges of mean values), the respondents were unable to decide whether their employers were stylish ($M = 3.39$). The medians and mode values for both dimensions are 4. The standard deviation for each dimension is greater than 1 (on a scale of 1-5), which confirms that the respondents found it difficult to estimate whether their employers were characterised by solidity or styliness. Moreover, the skewness of both scales is less than zero. The variables have left-skewed distributions, which means that a large number of respondents rate the employer brand personality traits higher than the mean values. Furthermore, in the case of solidity, the kurtosis is higher than zero, i.e. the variables have leptokurtic distributions. For this dimension of employer brand personality, the probability of encountering extreme answers, i.e. ‘I disagree’ or ‘I agree’, increases.

Table 3.*The employer brand personality dimensions: The descriptive statistics*

Dimensions	Mean <i>M</i>	Median <i>Mdn</i>	Dominant <i>Do</i>	Standard deviation <i>SD</i>	Skewness	Kurtosis
Solidity	3.78	4	4	1.12	-0.84	0.05
Styliness	3.39	4	4	1.23	-0.44	-0.70

Source: own work.

Gender, age, and work experience (in general and at the current place of employment) do not differentiate the responses of the respondents. There was a significant correlation (at the 0.05 level) between the styliness assessment and the position of the respondent and the company scale of operation ($r = 0.107$ and $r = 0.091$, respectively). This means that the assessment of the styliness rises with higher positions in the organisation and with the scale of company operation.

5. Discussion

Our research fits into the discussion of measuring employer brand personality. We confirmed previous reports that even a culturally adapted product brand personality scale cannot be used to measure employer brand personality without prior modification. The employer brand personality scales developed by Lievens and Highhouse (2003) or Schätzle (et al., 2022) had four dimensions, the Slaughter (et al., 2004) scale was five-dimensional, and the Davies (et al., 2004) scale had even seven central traits. Our Polish-language employer brand personality scale, which is a bit of a surprise, but as confirmed by the reliability and validity measures, is much simpler because it only has two dimensions (reliability and strength). However, due to our analyses, we managed to specify the employer brand personality construct and adapt it to the Polish culture. Furthermore, using the validated employer brand personality scale, we found that although respondents' employers are 'rather' solid, it is difficult to clearly state whether their personalities are characterised by styliness. Taking into account secondary traits, most of the employers represented by the respondents were 'successful'. In turn, the adjective that the respondents used the least often to describe their employers was 'resplendent'. The results of the study indicate that the personalities of the employers represented by the respondents are difficult to categorise as strong or expressive. Therefore, it can be concluded that organisations that employ our respondents cannot use employer brand personality to build a competitive advantage or do not recognise the role of employer brand personality in management practices.

The empirical research conducted has limitations. The most important of these is that the study is not representative. The sample was not randomly selected, the number of participants did not meet the minimum sample size requirements, and researching volunteers' opinions generates problems (Hewson et al., 2003). Consequently, our results cannot be extended to the entire population of employed people (in Poland). In addition, the research was of nomothetic nature, which means that the explanation is not complete and does not allow conclusions about the role of the employer brand personality (compared to other factors) in organisational management. It should also be added that the use of Aaker's concept may be questionable, as her scale involves imposing adjectives on the respondent to describe brand personality. Consequently, the brand personality becomes the result of the researcher's intentions and does not reflect the client's imaginaries (Karpińska-Krakiowiak, 2018). And finally, which may be particularly glaring from a branding point of view, the study did not take into account specific employer brands (referred to by name), but collected (from the researchers' perspective) information about anonymous employer brands. The justification for this is that the research did not aim to evaluate individual employer brands; we conducted cross-sectional studies aimed at characterising and analysing variables (at a given time). The weaknesses of our research also relate to the data collection technique used, i.e., the use of

the Internet as a means of communication with respondents. The use of a five-point measurement scale can also be questionable, as it implies indicating a central response and thus increases the probability of a central tendency error. Furthermore, which may (but does not have to) be related to the oddness of the scale, a large part of the respondents' indications are the so-called contentless answers. Therefore, it is necessary to consider whether in future research (despite good validation results) we should simplify the construct by removing the items that generate content-free responses to the greatest extent (Wierzbiński et al., 2014) or reformulate the questions.

The limitations indicated motivate us to carry out further studies on employer brand personality identification. Future research appears to be important because the phenomenon of employer brand personality is not adequately explored in Poland. As many current research focusses on the relationship between brand personality and human personality (Kumar, 2018), it is worth cooperating with psychologists and expanding the analyses to include aspects related to the personality of candidates or employees. It is also worth taking a more critical look at the scale we used and (perhaps) engaging experts to take up the challenge and try to develop a completely original employer brand personality construct. This seems important because, as Kumar (2018) emphasises, the popularity of the Aaker model has resulted in blind faith of some scholars to adopt it in their studies without modification. It should be noted that the results of preliminary correlation analyses for the two-dimensional concept of employer brand personality are promising. Secondary traits of employer brand personality are not highly correlated with each other (all correlations are significant at the 0.01 level), which may be a good predictor of using the construct to build structural models. In the future, we plan to attempt to create a model of the impact of employer brand personality on loyalty to the employer.

6. Summary

The theory of brand personality has been present in management science for years. However, it still raises controversies. Some researchers still question the possibility of transferring human personality traits to the brand (e.g., Heere, 2010; Huang et al., 2012; Kang et al., 2016). Others point out that there is a certain set of consumer goods to which it is extremely difficult to attribute human characteristics. For example, examining the brand personality of toilet paper, batteries, tires, or cooking oil would be a semantic abuse, as it is difficult to imagine building deep consumer relations with these products (Karpińska-Kraskowiak, 2018). Still others emphasise that only chosen human personality characteristics can be used to identify a brand personality (Ambroise, Valette-Florence, 2010; Bishnoi, Kumar, 2016). Despite these controversies, we decided to attempt to measure employer brand

personality, and the measurement was preceded by the validation of the construct (the Polish-language employer brand personality scale). Validation results showed that, under Polish conditions, to assess the employer brand personality, it is best to use a two-dimensional scale consisting of fourteen facets. Such a construct, including the solidity and styliness subscales, meets the reliability and validity requirements.

The research we conducted is pioneering in Poland. So far, no empirical studies have been carried out on the design and evaluation of the personality construct of the employer brand in our country, and no one identified the employer brand personality on the basis of a previously validated (culturally adapted) scale either. We are convinced that employer brand personality is worth exploring, and there is a need to improve the employer brand personality measurement tools. It is particularly important in a country like Poland, where the labour market is an employee's market and where employers have complained for years about recruitment and retention problems of talented employees. The shortage of labour markets forces employers to use new methods of recruitment, selection, and solutions to prevent excessive turnover (Wosiak, 2021; Amsolik, Chomątek, 2022; Korjonen-Kuusipuro, Wojciechowski, 2022). If only an employer brand personality that is expressive and fits the personality of the candidate/employee, can help to attract applicants and to prevent excessive fluctuations, it is worth to consciously strengthen this personality. Such an approach will benefit not only the organisation but also candidates/employees who, thanks to identification with the employer brand, will feel comfortable at work (or during job interviews), which may result in them recommending the company (and the products or services it offers) to others. Perhaps, in the near future, it will turn out that the employer brand personality is the main source of the employer brand strength and a critical factor that determines whether the organisation is called an employer of choice. As authors of this article, we hope that our research results presented in this study will inspire and engage domestic employers to consciously create employer brand personalities.

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INFLUENCE OF RECRUITMENT PROCESS ON TEMPORARY WORK QUALITY

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Purpose: The purpose of the article was to analyze and evaluate practices related to the recruitment process of temporary workers in enterprises in the logistics and warehouse industry (provision of services). At the same time, the aim of the article is to indicate the directions of actions in the field of the recruitment process that can be undertaken by the management of such enterprises in order to improve the quality of services provided by improving the quality of work.

Design/methodology/approach: The study was preliminary and based on conducting a pilot qualitative study using the method of individual in-depth interview (IDI). The study covered the subject of the recruitment process of temporary workers in logistics and warehouse companies operating in the Great Poland region, and the subject of the study were the temporary workers themselves. The article presents the results of the study conducted among 25 temporary employees.

Findings: The main aspects, covered in the study, regarding recruitment process are related to the way the recruitment meetings are handled, how the basing employment information are being passed to the candidate and whether what has been proposed is covered in the reality. As there have been gaps identified in those recruitment elements the author suggests some recommendations to the companies.

Research limitations/implications: The presented results of the initial pilot study may be subsequently verified in the actual study. At the same time other human resources management processes, in the field of temporary workers, may be subjected to additional study. On this basis, it is possible to build a full picture of the practices used in enterprises, affecting the quality of work by temporary workers, and to indicate the directions of changes in order to improve the achieved results in terms of quality.

Practical implications: The results of the study might be used by the companies interested in the form of temporary work and companies struggling with lowering quality of products or services as a result of employing temporary employees.

Originality/value: As the temporary work in Poland usage is significant and increasing it is important to understand the factors influencing the quality of temporary employees' work. This area has not been explored enough through research study.

Keywords: temporary employment, agency, job quality, services.

Category of the paper: Research study.

1. Introduction

The dynamically changing market situation requires the management of companies to quickly adjust their production capabilities to market demand (Bartoll, Ramos, 2020). From the point of view of the company's management, ensuring such flexibility is inherent in the use of appropriate solutions in the field of human resources management. An example of solutions that allow for the adjustment of resources directly related to the production of goods or the provision of services is the implementation of flexible solutions in the field of the working time system and settlement period, as well as the training of employees to perform various tasks as part of the so-called "multiskills" programs. However, a very important element for enterprises is the possibility of using the form of temporary work, which is important not only in the case of enterprises with seasonal work, but also those for which production volumes fluctuate over a longer period of time. The ability to quickly and adequately change the level of employment seems to be crucial for maintaining the effectiveness of the organization (Haberer, Arlinghaus, 2021).

Even before the outbreak of the coronavirus pandemic and the war in Ukraine, according to Eurostat data, in 2018, 14.1% of workers aged 15-64 in the European Union were temporary workers. In Poland, the share of temporary workers was significantly higher than the average in the European Union at 24.3%, placing Poland in second place, right after Spain, with the share of temporary workers at 26.9% (Eurostat, 2024). A significant share of temporary workers in the employment structure in Poland proves that the management of enterprises is willing to use this form of employment, ensuring flexibility in adjusting the level of employment to the production needs. However, regardless of the form of employment, all persons working in the company are expected to achieve the assumed effects of work, including the effects of meeting the required level of quality of manufactured products and services.

The research conducted so far indicates that increasing the number of temporary workers in the employment structure in a company affects the deterioration of the level of quality of manufactured products and provided services (Wiengarten, Onofrei, Fynes, Humphreys, 2020). The level of quality in question is, in turn, the result of the quality of the work carried out by temporary workers. Temporary workers, despite the temporary nature of their work, rely on a number of human resources management processes in the company, such as the recruitment process, the onboarding process, the competence development process, or the process of terminating cooperation. The way these processes are carried out in a company is one of the elements influencing how employees perform their tasks (Nowakowska, 2011). The process that has been chosen for the purposes of this publication is the recruitment process, through which company verifies e.g. the candidate's fit with the organization and the organization's match with the candidate (in this case, the temporary worker with the employer-user and vice versa). At the same time, as part of this stage, the candidate should be presented

with the scope of tasks, responsibilities, requirements and other important issues for both parties that may affect potential cooperation.

Based on the above, the aim of this article is to analyze and evaluate practices related to the recruitment process of temporary workers in enterprises in the logistics and warehouse industry (provision of services). At the same time, the aim of the article is to indicate the directions of actions in the field of the recruitment process that can be undertaken by the management of such enterprises in order to improve the quality of services provided by improving the quality of work.

It is assumed that a properly planned, effective and efficiently implemented recruitment process for temporary workers has a significant impact on the quality of their work, and thus on achieving the assumed level of quality of products and services (Govand, Shukur, 2015).

2. Temporary work in Poland and temporary employees' recruitment process

The form of temporary work is certainly an interesting legal construction, consisting in the so-called borrowing of an employee, in order to ensure flexibility of work in the company. Certainly, important features of temporary work include three-parties construction and limited duration of this form of employment. The three-parties construction referred here is understood in the presence of three entities and the relations between them. These three entities include a temporary employment agency, a temporary worker and employer-user. A temporary employment agency can hire a temporary worker and assign him or her to work at the employer-user, i.e. it plays the role of an employment agency. At the same time, a temporary employment agency is a formal (from the point of view of legal regulations) employer of a temporary worker. The employer-user, on the other hand, is the entity to which the temporary employment agency directs the temporary worker and for whom the temporary worker will perform the work. In the context of this article, the employer-users are the companies in the logistics and warehousing industry. The last subject of this three-parties agreement is the temporary worker, i.e. a person employed by a temporary employment agency and performing work for the employer-user.

The form of temporary work is regulated in Polish legislation and in accordance with Article 2(2) of the Act of 9 July 2003 on the Employment of Temporary Workers (Act of 9 July 2003), a temporary worker is an employee employed by a temporary employment agency solely for the purpose of performing temporary work for and under the direction of the employer-user. However, the moment when employer starts using the work of a temporary worker depends on a number of factors. One of the most important factors is to make arrangements between the temporary employment agency and the employer-user in the following scope: the type of work

to be entrusted to the temporary worker, the qualification requirements necessary to perform the work, the expected period of temporary work, the working time of the temporary worker and the place where the temporary work is to be performed (Act of 9 July 2003).

The use of temporary work can be attributed to almost every industry (Majewska, 2014). However, logistics and warehousing, in the broad scope, is one of the largest industry employing temporary workers in Poland. Temporary workers are hired for a variety of tasks, such as packing, sorting, loading, and unloading goods. The reason for the large scale of temporary workers in logistics and warehouse centres is, of course, the so-called peak periods, which fall on the period of, for example, Christmas or the so-called Black Friday. Right after the logistics and warehousing industry, we can distinguish the manufacturing and construction industries, where we can also find great interest in the form of temporary work, followed by the hotel, food and retail industries (Nurzyńska, 2009).

Due to the nature of temporary work, the main group of employees performing such work includes line workers who directly perform operational tasks and often work in shifts. Operational tasks, on the other hand, should be defined as those that are mainly physical in nature and consist in performing specific activities, for example, at the production line (Urbaniak, Sobczak, 2014).

First of all, temporary work allows for quick adjustment of the number of employees to changing market conditions, which are reflected in the planned volume of manufactured products or services. On the one hand, specialized temporary employment agencies are able to acquire, in a short period of time, a large number of candidates, and on the other hand, the legal structure of this form of employment in Poland allows for a quick reduction in the number of people providing temporary work¹. Acquiring a large number of candidates by a temporary employment agency in a short period of time is an undoubted advantage of this activity and definitely constitutes an added value for organizations that want to take advantage of this form of employment. However, the pool of candidates for temporary work must be verified during the recruitment process². The methods and tools used to implement this stage will determine the human potential of the organization, and thus its achievement of the assumed effectiveness (Snopkiewicz, 2011). The basic elements of the recruitment process include (Snopkiewicz, 2011):

- analysis of application documents (CV, cover letter, references, etc.),
- conducting a job interview (e.g. recruitment meetings),
- conducting professional aptitude tests.

Of course, each organization will conduct the recruitment process according to its own needs, reflected in the procedures and tools used.

¹ This is due to the fact that a temporary employment agency may conclude a large number of contracts with a temporary worker for short periods (e.g. for a week).

² As the literature indicates, this stage should be comprehensively defined as the recruitment and selection stage (for the purposes of this article, it will be referred to as the recruitment process).

The process of recruiting temporary workers can take place in various configurations (recruitment meetings), whereas, as the author's experience shows, the most effective process is the one in which the temporary employment agency conducts an initial recruitment (the pool of candidates is reduced only to those who meet the basic conditions set by the company), and then the second stage of recruitment takes place in the company where the temporary worker would work. This gives a full picture of the situation for both the employer-user and the potential temporary worker. Elements of the recruitment process, important from the point of view of both parties, are discussed during such a recruitment meeting. The activities included in the recruitment process may have an impact on how the temporary worker will perform his or her work (the quality of the work performed) and, consequently, whether the required quality of manufactured products and services will be ensured.

3. Quality of temporary work

The quality of manufactured products and services referred to in this publication is considered in the context of internal and external quality. The internal quality level may be characterized by the indicator of non-conformities identified in the company, while the external quality level may be measured by the number of requests from external customers concerning non-compliance with previously established assumptions (Grzybowska-Brzezińska, 2007).

Employees, performing their work in accordance with the rules adopted in the company, and included in the form of work procedures and instructions, are to ensure that the products and services produced by the organization are compliant. For the purposes of this publication, other errors that may occur and are directly independent of the work of a line worker are omitted, e.g. inconsistent design of the product and service, or improper design of the process of manufacturing the product and providing the service. Regardless of whether the work in the organization is performed by a permanent³ or temporary worker, the same quality of work is expected, i.e. work in accordance with procedures and instructions, and thus achieving the expected quality results of products and services (Pollio, Landini, 2023).

The subject of the quality of work and job satisfaction is a broad topic that has been discussed many times in the literature on the subject, from philosophical considerations to research carried out in enterprises. There are many factors influencing how employees perform their work, and the most frequently mentioned ones include the quality of life in general, wage and non-wage terms of employment, relations between employees, the atmosphere in the organization, the involvement of superiors in employee development, and how processes are carried out in organizations, including processes related to human resources (Islam, 2012).

³ An employee employed by a company on the basis of an employment contract.

Temporary work, despite its advantages, also has some drawbacks that can have a negative impact on the approach of temporary workers to the quality of their work (Striler, 2020). Due to the nature of the publication, examples of shortcomings related to the recruitment process will be discussed.

On the one hand, the advantage for the employer-user is the presence of a temporary employment agency, relieving the company of the recruitment process, while on the other hand, it is an additional intermediary between the temporary worker and the employer. This intermediation may cause some communication noise, already at the stage of the recruitment process, in terms of providing information about tasks, responsibilities or working conditions. One may ask whether a representative of a temporary employment agency will be able to present to a temporary worker the specifics of the processes carried out in the company and the related quality requirements in relation to products and services. The lack of a comprehensive picture by the representatives of temporary employment agencies may be reflected in the fact that the employee will assess the reality differently than it was presented at the recruitment stage.

The above-mentioned communication shortcoming can be further strengthened when the employer-user shifts the entire burden of responsibility for the recruitment process to the agency and the employer's representatives do not engage in any stage of the process at all. Then it is the employees of the agency itself who will ultimately decide who will do the work in the organization.

Another example of the disadvantage of temporary work, for people who perform it, may be, as a rule, the lack of stability of employment. Based on the characteristics of temporary work, it can be concluded that it is a natural element of this form of work, which makes the organization flexible. This is not a drawback of the recruitment process, however, organizations often declare to temporary workers the possibility of later employment, directly in the organization, after meeting certain conditions. However, the provision of such information must take place in the recruitment process, as it seems to be an important aspect of encouraging the candidate to take up the job and perform it as intended.

Elements resulting from potential shortcomings of the process of recruitment of temporary workers were questions in the study, the results of which are presented in this publication.

4. Temporary employees' recruitment process based on companies from logistics and warehouse industry

4.1. Metod of the study

The study was preliminary and based on conducting a pilot qualitative study using the method of individual in-depth interview (IDI). The study covered the subject of the recruitment process of temporary workers in logistics and warehouse companies operating in the Great Poland region, and the subject of the study were the temporary workers themselves.

The scope of the study included 25 temporary workers who are line workers, as defined earlier in this article. Employees who met the criteria of at least two years of experience in working through a temporary employment agency (in the logistics and warehouse industry and/or in the goods manufacturing industry) and as part of this experience had at least six months of work experience with an employer-user from the logistics and warehouse industry, were invited to participate in the study. At the same time, employees who currently work for an employer-user in the logistics and warehouse industry were selected for the study. The temporary workers who were subjected to an in-depth study came from four companies located in the city of Poznań and within a radius of 50 km from the city of Poznań.

The study group consisted of both men and women, with a share of 52.6% of women and 47.4% of men. Half of the respondents (50%) are young people, aged 25-31. People aged 39-45 accounted for 20% of respondents, followed by 18-24 and 32-38 aged 15% respectively.

The majority of respondents were of Polish nationality (65%), followed by employees of Ukrainian nationality (20%). People from Belarus and Georgia accounted for a smaller percentage of respondents, 10% and 5%, respectively.

As part of the identification of the surveyed group, temporary workers were also asked about the number of employer-users for whom they had provided work in the last two years. The vast majority of employees (75%) worked for one or two employer-users, while the remainder (25%) worked for three or four employer-users.

4.2. Results of the study

As part of the in-depth interview, temporary workers were asked to answer questions related to how the recruitment process was carried out at the current employer-users. The questions that were asked of temporary workers focused on whether they had been provided with all the necessary information during the recruitment process, including the scope of tasks and quality requirements, relevant to the decision to start a job. Equally important was the question of whether the declaration of the temporary employment agency and the employer-users in terms of working conditions was reflected in reality. At the same time, the respondents had the opportunity to indicate potential changes to the process of recruitment of temporary workers so that through this process a better match between the employee, the employer and the work performed would be ensured.

Almost half of the surveyed employees (48%) completed the recruitment process both at the headquarters of the temporary employment agency and at the premises of the user's employer. This has certainly enabled employees to obtain a wide range of information about what the temporary employment agency itself and the employer offer to them. Five employees (20%) held a recruitment meeting only at the premises of the temporary employment agency, and 7 employees (28%) only at the employer-users. While a recruitment meeting at the employer-user seems to be a natural approach, a meeting at the agency itself may not have given employees a sufficient picture of the future workplace and the working climate there. Figure 1 shows the distribution of responses to the question about the place of the recruitment process.

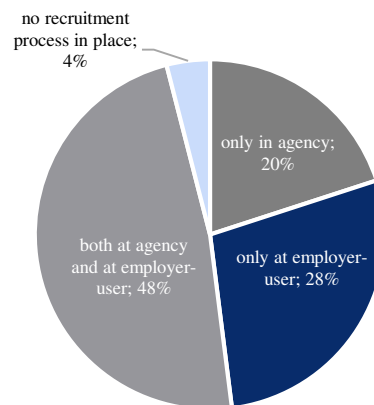


Figure 1. Place of recruitment process performance.

Source: Own study.

Among the employees who participated in the recruitment process, at the premises of the employer-users (including a previous meeting at a temporary employment agency or without such a meeting), the vast majority of respondents (over 70%) indicated that they had the opportunity to see the processes carried out in the company (during the interview itself, the employer-user presented the employee's workplace, machinery and equipment, etc.). Such a possibility certainly increases the probability that the employee's (at this stage the candidate's) decision to take up employment will be more thoughtful, and the employee will remain in the employment for a longer period of time (of course, assuming a positive assessment from the employer). Reduced turnover, in turn, will result in processes being carried out in a more stable and repeatable manner by the same team of employees. Such a state of affairs should be reflected in the achievement of the assumed level of quality by the company (this applies in particular to enterprises where the implementation of processes is largely dependent on the employee). With regard to the question about the possibility of seeing the processes in progress at the employer's premises, more than 65% of employees answered in the affirmative to another question about whether this influenced the employee's decision to take up work. This confirms the above-mentioned assumption that this is an important element of the recruitment process, on which it is worth devoting resources on the part of the employer-user.

An important element of the recruitment process is to present candidates with what tasks they will perform in a given position and what quality requirements must be met during the implementation of processes. In the vast majority of cases (almost 90%), temporary workers confirmed that during the recruitment process they were presented with the tasks they will perform at their workplace and what quality requirements must be met. The results for these two questions are presented in Figure 2 and Figure 3 respectively. At the same time, according to the author's experience, candidates often, already at the stage of the recruitment process, getting to know the specifics of the job and the quality requirements, resign from further participation in this process. They feel that the presented processes are too complicated for them or they simply do not have the desire to learn new processes. On the one hand, such an approach will save the company's time for onboarding an employee, and on the other hand, if the candidate does not feel that this is a place for them at this stage, the likelihood of making mistakes due to the lack of a positive approach to the tasks performed decreases.

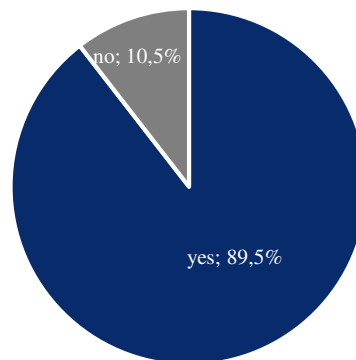


Figure 2. Submitting of tasks to temporary employee.

Source: Own study.

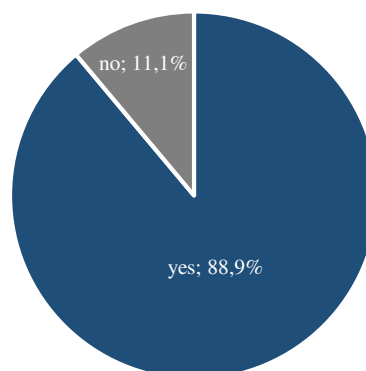


Figure 3. Submitting of quality requirements to temporary employee.

Source: Own study.

In the scope discussed above, employers should continue (or start, if they do not do so) the practice of presenting candidates for temporary work with the tasks for a given position and quality requirements, which will certainly affect a better match between the employer, the employee and the work, and this in turn will translate into ensuring the required level of quality.

Continuing the aspect of transparency of the employer-user (so far understood as presenting employees with the scope of tasks and quality requirements), the respondents were also asked whether they had been thoroughly informed about the salary and non-wage conditions that would apply to them during the recruitment process. Figure 4 presents the results in relation to:

- basic salary (grades);
- conditions for granting bonuses (if any);
- non-wage benefits (if any) and
- conditions for switching to an employment contract with the employer-user (more stable employment conditions and the possibility of benefits that do not occur during employment by a temporary employment agency).

Within this question it was not analyzed whether the information was provided by representatives of the temporary employment agency, representatives of the employer-user, or both parties concerned (this depended on where the recruitment process took place). At the same time, the conditions in question could be offered by both the temporary employment agency (as the official employer, the temporary employment agency also has the option of offering non-wage benefits) and the employer-user.

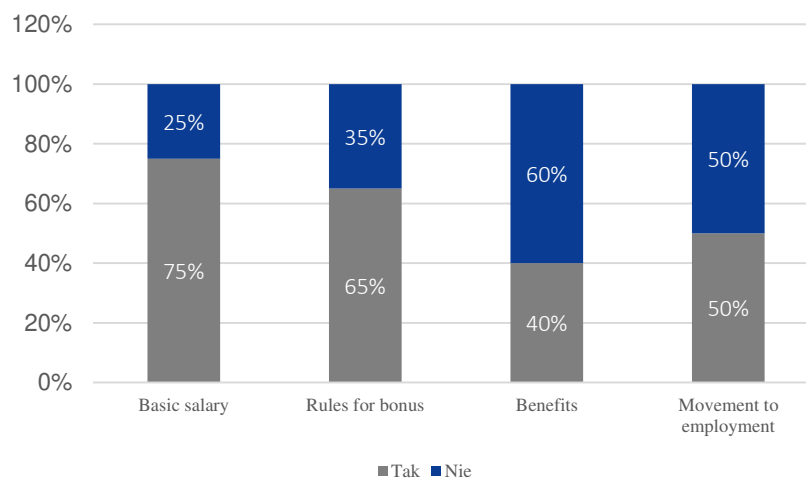


Chart 4. Submitting of working conditions (salary and benefits) to temporary employee.

Source: Own study.

On the basis of the data presented in Figure 4, in terms of basic salary, 75% of temporary agency workers declared that they had received information about the basic salary and the share of those employees who declared that they had received information about the conditions for granting bonuses was similar (65%). While in the case of bonuses, in the author's opinion,

the result is not particularly surprising (as a rule, employees themselves focus less on the bonus as it is not a fixed part of the salary), the result concerning the basic salary is surprising. This is the base component of compensation that employees are always most interested in. There can be many reasons for this, but the most likely ones include ineffective communication between the temporary employment agency and the employer-user, as well as verbal (only) presentation of the terms of employment to the temporary worker.

In the event of ineffective communication between the temporary employment agency and the employer-user, the agency representatives may not have had detailed information about the salary structure of the employer-user and the values offered for each position. Such a state of affairs makes it impossible for the agency's representatives to present such information to the employee, e.g. by referring to the fact that when the employee is physically at the employer's place, he or she will receive all the information. At this point, it should also be noted that 25% of recruitment meetings took place only at the headquarters of the temporary employment agency, which coincides with the percentage of respondents declaring a lack of knowledge about the basic salary.

The second reason given was only the verbal presentation of the conditions of the grade to the employees. This, in turn, makes it impossible for the temporary worker to return to this information at a later date, causing some of the workers to believe that they have not received it. In the case of both the first and the second reason, it may be a good practice to create so-called cover letters, in which the main terms of employment (and other useful information for temporary workers) would be described. This letter would not serve as a letter of intent but would serve as a written statement of the main information about what the employee can expect from the user's employer. Standardizing communication in this area can help both the temporary employment agency and the user's employer to provide clear and consistent information.

The percentage of people who received information on non-wage benefits is not high and amounted to only 40%. A slightly larger percentage of respondents (50%) received information about the conditions of transition from the status of a temporary employment agency to the status of an organization, which for many employees is an important aspect that increases the level of employment stability. If the organization is planning the activity of transferring temporary workers to the state of the organization at all, it is good to define and communicate the criteria that must be met (e.g. the level of absenteeism, the result of periodic evaluation).

The respondents, who confirmed receiving information about the terms and conditions of employment at the recruitment stage, were additionally asked whether what was declared to them was reflected in reality. Almost 80% of respondents confirmed this state of affairs. A good direction for the future may be to increase the number of people confirming this state of affairs, because it definitely affects the approach to work (employees perceive the user's employer as reliable) and, ultimately, the quality of the work performed. This credibility, which has been mentioned, also influences future potential candidates in the company's recruitment processes. It is necessary to avoid a situation where competent people will not apply to the organization due to negative opinions about the company, including its credibility.

The presented research results come from a preliminary pilot study hence the next stage may be to verify the conclusions in a study relevant to the logistics and warehouse industry and extend the study to the manufacturing industry. At the same time, in the author's opinion, other resource management processes, such as the onboarding process or the competence development process, may be subjected to further research. In this way, it is possible to get a full picture of the processes carried out, which have an impact on the quality of temporary work, and thus on the quality of manufactured products and services.

5. Summary

Temporary work, as one of the tools in ensuring flexibility of human resources in a company, is very popular in Poland. Companies in the logistics and warehouse industry or production organizations are examples of industries that benefit the most from this form of work. Temporary workers are a special group of employees for whom the rules of work are regulated in the Act on the Employment of Temporary Workers. As a rule, temporary agency workers receive similar basic conditions of employment (e.g. personal grade) as employees employed by the organisation, on the basis of an employment contract. However, there are a number of terms and conditions of employment that differentiate between the two groups, as well as the processes that these employees go through. Despite this, each employee is expected to be similarly committed to their work and meet the required quality of work, which is reflected in the quality of manufactured products and services.

On the basis of the research presented in the literature on the subject, it has been found that increasing the number of temporary workers in the employment structure of the organization affects the deterioration of the quality of manufactured products and services. Temporary workers go through a number of human resources management processes in an organization, where the first such process, considered by the author to be crucial, is the recruitment process. Therefore, in this publication an attempt was made to analyze and evaluate the process of recruitment of temporary workers and to indicate recommendations to be implemented in enterprises in order to improve the quality of work, and thus improve the level of quality of services provided. On the basis of a preliminary pilot study conducted on a group of 25 temporary workers from logistics and warehouse companies located in the Great Poland region, the following conclusions were prepared:

- Participation in the recruitment process both at the headquarters of the temporary employment agency and at the premises of the employer-user or only at the premises of the employer-user allows employees to obtain a wide range of information about what the agency itself and the employer-user offer. It seems that such a practice should be firmly rooted in the process of recruiting temporary workers.

- It is a good practice to allow candidates to see the user of the processes carried out at the employer's premises, which, according to the survey, influenced the decision to take up employment in over 65% of people. This is an important part of the recruitment process, and it is worth devoting resources to it on the part of the employer-user.
- At the recruitment stage, it is recommended that employer-users start or continue (depending on the current state of affairs) the practice of presenting job candidates with the tasks for a given position and quality requirements, which will certainly result in a better match between the temporary worker and the employer-user, which in turn will translate into ensuring the required level of quality.
- Based on the results of the survey, it can be concluded that there is room for improvement in terms of transparency regarding the presentation of working conditions (basic salary, bonus, non-wage benefits, conditions for transition to employment in the organization). It may be a good practice to create so-called cover letters, which would describe the main terms and conditions of employment (and other information useful to temporary workers). Standardizing communication in this area can help both the temporary employment agency and the employer-user to provide clear and consistent information (regardless of where the recruitment process is conducted).

The presented results of the initial pilot study may be subsequently verified in the actual study. At the same time other human resources management processes, in the field of temporary workers, may be subjected to additional study. On this basis, it is possible to build a full picture of the practices used in enterprises, affecting the quality of work by temporary workers, and to indicate the directions of changes in order to improve the achieved results in terms of quality.

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ASSESSMENT OF THE FINANCIAL SITUATION OF SELECTED COMPANIES OF THE POLISH SUGAR INDUSTRY 2016-2022

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Purpose: The main objective of the article is to analyze and evaluate the financial situation of selected companies operating in the sugar industry and belonging to the WIG Food index for the years 2016-2022. The secondary objective is to verify the relationship (correlation) between financial liquidity and company profitability and to try to indicate the direction of this relationship if it occurs.

Design/methodology/approach: The article uses a literature review, analysis of financial data from the financial reporting of companies using statistical methods. Four models of multidimensional discriminant analysis were applied (model D. Hadasik, model J. Gajdka and D. Stos, D. Wierzba and the 'Poznań' model). The analysis was extended to the calculation of three financial liquidity ratios and three profitability ratios of the company. Data from 2016-2022 were analysed in order to illustrate how the situation of the selected companies developed in the period before and after the COVID-19 pandemic.

Findings: All the analysed companies were in a good financial position during the analysed period. The most rigorous multivariate discriminant analysis models were those of J. Gajdka and D. Stos and D. Wierzba, which indicated deteriorating financial performance in selected years. Moreover, the analysed companies were characterised by high liquidity and profitability in 2016-2022. Only ZPC Otmuchów SA achieved negative values of profitability indicators in the analysed period, which was a result of negative net profit.

Practical implications: A practical application of the presented research could be to draw the attention of companies operating in the food industry to methods of assessing their financial health using appropriate tools and to verify the relationship between liquidity and profitability in these companies.

Originality/value: The article presents an analysis and evaluation of the financial condition of selected companies from the WIG Food index. Correlation analysis was used, and the reasons for the financial performance are indicated.

Keywords: Liquidity, profitability, discriminant analysis, confectionery industry, COVID-19 pandemic.

Category of the paper: research paper.

1. Introduction

The world sugar market is characterised by volatility caused by political events and economic cycles. Price increases in this market are closely linked to major historical political and economic events: the Great Depression of the 1920s, the Cuban missile crisis of 1962 or the energy crisis of the 1970s (The Sweet and Sour History of Sugar Prices, 2023). Since 2000, the world sugar market has been subject to cyclical fluctuations. From a research and economic analysis perspective, it is important to identify the strength of the impact of these fluctuations and the determinants that cause them. In addition, the literature lists factors that influence global sugar prices, such as rising diesel prices, weather conditions, global sugar consumption trends or market regulations (Rumánková, Smutka, 2013). Between 2016 and 2022, we had to deal with important events that could affect the operation of companies in the global and European market: the COVID-19 pandemic, Brexit and the military conflict in Ukraine.

Countries that are part of the European Union have brought sugar production under a common market organisation. It has many functions: it creates opportunities for cooperation between producer organisations and inter-branch organisations, sets minimum quality requirements for producers and secures agricultural markets. Very importantly, Member States provide voluntary production support to specific sectors in difficulty, such as sugar beet and cane production. The sugar market within the European Union is covered by two EU policies: market measures (e.g. private storage aid) and trade measures (e.g. international trade agreements as a whole) (Agriculture and rural development, 2023).

The Polish sugar sector has been dependent on the world market for many years. The production potential of the Polish sugar industry is greater than the demand on the domestic market, which means that the production surplus is exported (Szajner, 2019).

The scale of the agri-food industry in Poland has developed significantly in recent times, both in terms of subject, object and quality. Despite the fact that the industry in Poland is often classified as a so-called low-tech sector (e.g. in terms of innovation), it is an important part of the Polish economy. The confectionery industry in Poland is one of the most innovative branches of the food industry with a high growth potential. This is reflected in the fact that the consumption of chocolate and confectionery in Poland is almost three times higher than in Switzerland, Belgium or the UK (Kopyra, Firlej, Luty, 2020). The improved competitiveness of Polish agri-food companies is influenced by the fact that producers are rapidly adapting to changes in consumer behaviour and preferences in terms of the quality of products consumed and their growing awareness of food (Szczepaniak, 2016).

The COVID-19 pandemic had a greater or lesser impact on the agri-food industry in Poland, depending on the sector/industry concerned. The impact on the confectionery industry can be divided into two periods: short (up to 3 months) and long (more than 3 months). In the short term, the following factors can be distinguished: decrease in employment in the industry,

limited range of production and products, decrease in sales revenue due to restrictions (lockdown), e.g. in the entertainment sector, temporary closure of business premises (e.g. confectionery shops) or inability to fully compensate for lost revenue despite attempts to sell products via e-commerce. Longer term factors include: obstacles to exports and, in addition, a decline in domestic demand for premium products, a decline in sales associated with limited employment, the collapse of the most economically vulnerable businesses, particularly in the SME sector (Szczepaniak et al., 2020).

Companies in the sugar and confectionery industry most often organise their activities by combining the processes of raw material procurement, production, distribution and trading. Sugar and the products in which it is used are most often purchased by consumers in shopping centres, while the distribution of products through the e-commerce channel is developing.

Although Polish foreign trade in agri-food products faced many difficulties in 2016-2022 (e.g. COVID-19 pandemic, Brexit, military conflict in Ukraine), an increase in the value of food exports was still recorded. Restructuring and modernisation changes that took place in the Polish agri-food industry after Poland's accession to the European Union in 2004 positively influenced the growth of competitiveness of the Polish food industry and strengthened its competitive position on the international arena. A systematic increase in the value of Polish agri-food exports makes it possible to manage food surpluses, which is an important source of revenue for the Polish agri-food industry (Polski handel zagraniczny, 2023).

The value of exports, imports and the balance of Polish foreign trade in agri-food products increased between 2016 and 2022 (Figure 1). The dynamics of Polish foreign trade in agri-food products in 2016-2022 is as follows: exports - 196%, imports - 185%, balance - 221%.

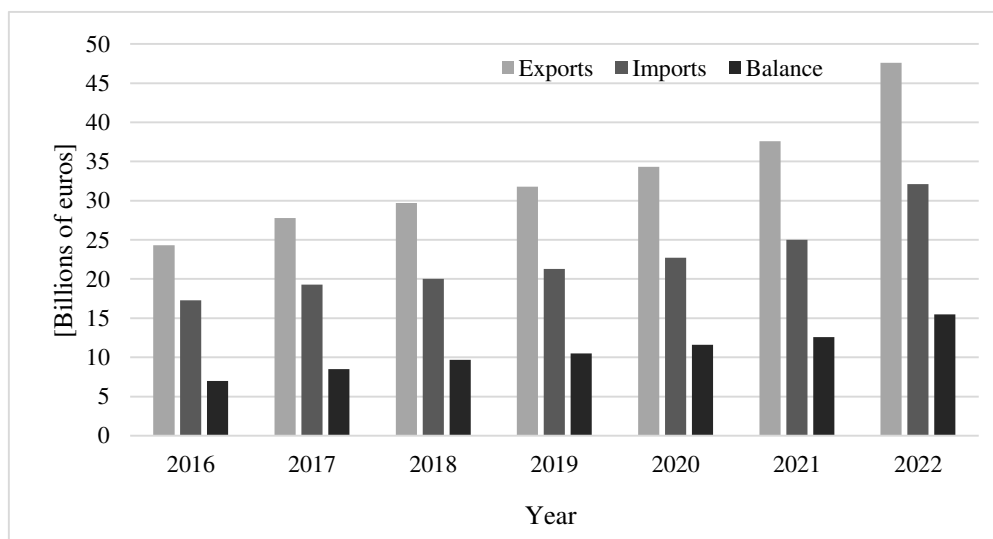


Figure 1. Value of Poland's foreign trade in agri-food products 2016-2022 (in EUR billion).

Source: own elaboration based on: Foreign trade in agri-food products. Retrieved from: <https://www.gov.pl/web/kowr/handel-zagraniczny-produktami-rolno-spozywczymi>, 12.08.2023.

The year 2022 turned out to be a record year in terms of Polish agri-food exports, the value of which amounted to EUR 47.6 billion (PLN 223 billion). This represented an increase of 26.7% compared to 2021 (EUR 37.4 billion [PLN 170.8 billion]). In 2016-2022, Germany remained Poland's main trade partner, to which exports of products in 2022 amounted to EUR 11.9 billion and were 25% higher than in 2021. The vast majority of Polish agri-food products are exported to EU countries (in 2022, the value of exports with these goods amounted to EUR 35.3 billion, which accounted for 74% of the value of total exports) (Wyniki polskiego handlu zagranicznego, 2023).

In the most turbulent period of the analysis carried out (2019-2021), 'sugar and confectionery' as a group of export commodities was invariably ranked fourth in terms of export value in the commodity structure of Polish agri-food exports. In 2022, the aforementioned product group dropped to fifth place reaching a value of EUR 3.2 billion which still represented an increase of 14% compared to 2021 and 7% of the total 2022 agri-food exports (EUR 47.6 billion) (Wyniki polskiego handlu zagranicznego, 2023).

The purpose of this paper is to assess the financial situation of selected companies operating in the sugar industry in Poland under the crisis conditions caused by the COVID-19 pandemic by means of discriminant analysis, and to analyse their liquidity and profitability. The paper focuses mainly on the COVID-19 pandemic period (2019-2021). In addition, the study attempts to establish links (correlations) between the liquidity and profitability of the analysed companies.

The article adopts a hypothesis (H1) stating that the selected models of multidimensional discriminant analysis are a valid tool for verifying and assessing the financial situation of the analysed sugar companies in Poland. In addition, a second hypothesis (H2) was formulated, which states that there is no statistically significant relationship between financial liquidity and financial profitability of the analysed companies.

2. Literature Review

Relationship between liquidity and profitability of the company

A company's liquidity and profitability are considered to be very important areas in terms of its assessment (e.g. financial health). The continuity of a company's operations and development is determined by the maintenance of liquidity. The company's profitability, on the other hand, is an essential source of asset and capital growth. Maintaining liquidity and profitability at an appropriate level is high on the hierarchy of corporate financial management objectives. Moreover, the relationship between a company's liquidity and profitability is a complex issue that requires an appropriate approach to reconcile these two conflicting

objectives - minimising liquidity risk and maximising value for owners (Kuciński, 2018). It is important to compare the values of individual financial ratios (e.g. the relationship between a company's liquidity and profitability) when assessing the financial position of companies (Lisek, Luty, Ziolo, 2019). The issue of a company's liquidity and profitability and the relationship between them has been addressed by many researchers. In the foreign literature, the issue of the relationship between a company's liquidity and its profitability has been analysed several times (Table 1).

Table 1.

Foreign studies analysing the relationship between liquidity and corporate profitability

Author (year)	Results of the analysis
K.V. Smith (1980)	Failure to maximise liquidity and profitability simultaneously. The analysis showed that the decision to increase profitability does not mean increasing the company's liquidity at the same time.
M.L. Jose, C. Lancaster, J.L. Stevens (1996)	Research in the US market has shown that the lower the liquidity, the higher the profitability of the company.
H. Shina, L.A. Soenena (2000)	Research conducted on a sample of 1000 companies, which showed a negative correlation between profitability and liquidity.
A. Blatt (2001)	Analysis of 1555 Japanese and 379 Taiwanese companies. The study found no relationship between liquidity and profitability as measured by the dynamic model.
Y.J. Wang (2002)	Research has shown that an excessive reduction in liquidity can contribute to a company's reduced profitability.
I. Lazaridis, D. Tryfonidis (2006)	The analysis was conducted on the Greek market (Athens Stock Exchange). The study used operating profit margin as a measure of profitability and cash conversion cycle as a measure of liquidity. A statistically significant relationship was found to exist between the two.
Q. Saleema, R.U. Rehmana (2011)	A study of Pakistani listed companies. A similar relationship to the analysis done by Y.J. Wang.
C.K. Ashraf (2012)	Analysis of 16 Indian companies. Research on the impact of working capital on profitability. Results identified a negative relationship between working capital and firm profitability.

Source: own study based on a literature search on the subject.

In the Polish context, the relationship between liquidity and profitability has also been addressed by many authors (Table 2).

Table 2.

Studies analysing the relationship between liquidity and profitability of companies in Poland

Author (year)	Results of the analysis
A. Bieniasz, D. Czerwińska-Kayzer, Z. Golaś (2007)	A study of 30 branches of food companies in Poland showed that the length of inventory and accounts payable cycles has a strong impact on profitability.
P. Szczepaniak (2009)	The analysis of non-financial sectors in Poland showed that there is a moderate linear relationship between profitability and liquidity for most sectors.

Cont. table 2.

M. Bolek, R. Wolski (2010)	The correlation analysis showed that as liquidity decreases, neither the return on capital nor the company's assets increase.
T. Pawlonka (2011)	Correlation analysis in the meat industry (purposive sample of 12 companies). The majority of companies (9 out of 12) showed a low, medium and high correlation between the indicators analysed. This correlation was defined as positive and parabolic.
M. Soliwoda (2011)	The correlation between liquidity and turnover profitability (or total costs per employee) was analysed. Small enterprises had the highest levels of gross turnover profitability and quick liquidity ratio. The research showed a significant correlation between gross turnover profitability and quick liquidity (small enterprises) and between total costs per employee and quick liquidity (medium enterprises).
D. Zawadzka, R. Ardan, E. Szafraniec-Siluta (2011)	Analysis of entities operating in agriculture. The research showed a link between an increase in asset profitability and an increase in the quick ratio.
M. Bolek, W. Wiliński (2012)	Research based on construction companies on the Warsaw Stock Exchange (WSE) has shown the negative impact of liquidity on profitability.
J. Pawlak, D. Paszko (2014)	Analysis of fruit and vegetable processing enterprises. Conclusions similar to those of D. Zawadzka, R. Ardan and E. Szafraniec-Siluta.
J. Jaworski, L. Czerwonka, M. Mądra-Sawicka (2018)	The analysis of indicators for food-producing enterprises (sample 1 046) did not show a statistically significant relationship between profitability and liquidity.
A. Kuciński (2018)	The analysis covered capital companies in the clothing and footwear sector (Warsaw Stock Exchange). The correlation coefficients between the indicators were not statistically significant.
E. Szymańska, X. Lukoszová (2021)	Purposeful selection of companies in the meat industry. The study showed a significant correlation between current and quick financial liquidity and profitability of assets and equity.

Source: own study based on a literature search on the subject.

The financial liquidity and profitability of an enterprise are important to both owners and investors. In areas of the economy with higher rates of return, greater financial liquidity may indicate a strong position for the company due to its ability to secure new contracts. Profitability is particularly important in traditional industries with stable relationships between the company, subcontractors, and customers. When evaluating companies in the Polish market, investors place greater importance on profitability than financial liquidity due to the prevalence of traditional enterprises (Szymańska, Lukoszová, 2021).

Discriminant analysis in scientific research

Further research is required to investigate the relationship between financial liquidity and company profitability, due to differences in the results of foreign and Polish researchers. Polish literature on the subject, specifically related to discriminant analysis and bankruptcy prediction of companies in the confectionery and sugar industry, clearly indicates the popularity of using multidimensional discriminant analysis models to assess their financial situation. The research analysed various entities over a specific period and used a diverse selection of discriminant analysis models (refer to Table 3).

Table 3.

Research using multidimensional discriminant analysis to evaluate enterprises in the confectionery (and sugar) industry in Poland

Author (year)	Analyzed entities	Models employed
Zdunek E. (2010)	WIG Food index companies (a.o. ASTARTA HOLDING N.V. and Wawel SA)	linear
Dąbrowski B.J., Boratyńska K. (2011)	Selected companies from the WIG Food index (a.o. Wawel SA)	Z6 INE PAN*; Z7 INE PAN; 'Poznań' model; Prusak B. Z _{BP1}
Firlej K., Bargieł A., Szymański M. (2014)	WIG Food index companies (a.o. ASTARTA HOLDING N.V., Wawel SA, ZPC Otmuchów SA)	Wierzba D.; Z7 INE PAN; 'Poznań' model; Przemysł NBP
Zielińska-Sitkiewicz M. (2016)	Selected companies from the WIG Food index (a.o. Wawel SA i ZPC Otmuchów SA)	'Poznań'; Prusak B. Z _{BP1} ; Z7 INE PAN
Kopczyński P. (2017)	Food industry enterprises (a.o. Wawel SA)	Zulkarnaina, Shamshera and Ali Mohammada (Malezja); Altmana; Lugovską (Rosja); Mączyńska; Hadasik; 'Poznań' model; Gajdka and Stos II; Prusak B.I.
Zdunek-Rosa E., Huterska A. (2018)	Confectionery industry enterprises (a.o. ASTARTA HOLDING N.V. and Wawel SA)	Hadasik
Olszewska K., Turek T. (2018)	Selected companies (a.o. Wawel SA)	Mączyńska; Hadasik; 'Poznań' model
Firlej Ch. (2022)	WIG Food index companies (a.o. ASTARTA HOLDING N.V., Wawel SA, ZPC Otmuchów SA)	Hadasik; Z6 INE PAN; Z7 INE PAN; 'Poznań' model

* INE PAN: Instytut Nauk Ekonomicznych PAN.

Source: own study based on a literature search on the subject.

The literature on multidimensional discriminant analysis does not yet provide answers to important questions, such as the universality of discriminatory models across sectors, the period of diagnostic reliability of a given model, and whether the number of variables used in the model affects the quality of the study. Similar observations can be found in foreign literature (Balcaen, Ooghe, 2006; Agarwal, Taffler, 2007).

3. Materials and Methods

The research process involved a literature search, analysis of financial data from the balance sheets of selected companies in the sugar industry between 2016 and 2022, and the use of selected statistical methods. The analysis covered companies listed on the Warsaw Stock Exchange (WSE) that belong to the WIG Grocery index from 2016 to 2022 ($t = 1, 2, \dots, 7$) and are assigned to the 'food products' sector. Three companies were selected: Astarta Holding N.V., Wawel SA, and Zakłady Przemysłu Cukierniczy Otmuchów SA. Although the number of employees increased only in Wawel SA (by 91 employees) between 2016 and 2022,

all examined entities continued to operate on the Warsaw Stock Exchange and remained in the indicated indices during the analyzed years (see Table 4).

Table 4.

Characteristics of the analyzed entities in 2016-2022

Analyzed entities	Country	Share in indexes on the Warsaw Stock Exchange*	Number of employees	
			year 2016	year 2022
Astarta Holding N.V.	Ukraine	WIG, WIG-CEE, WIG Food index, WIG Ukraine, sWIG80, sWIG80dvp, sWIG80TR, WIG140	9 602	6 591
Wawel SA	Poland	WIG, WIG Poland, WIG Food index, sWIG80, sWIG80dvp, sWIG80TR, WIG140	908	999
ZPC Otmuchów SA	Poland	WIG, WIG Poland, WIG Food index	502	482

* As of 11.12.2023.

Source: own study based on the financial statements of the analyzed entities in the years 2016-2022.

During the initial stage of assessing the financial condition of enterprises, various discriminatory models were employed, including those developed by D. Hadasik, J. Gajdka and D. Stos, D. Wierzba, and the 'Poznań' model. The entity was classified as having either a good or bad financial condition based on the value of the discriminant function Z.

The term 'financial situation' can be used interchangeably with 'financial standing', which refers to 'the company's competitive position, credibility, and economic strength' (Bień, 1999). The literature treats the company's financial situation as identical to the concept of its financial condition (Urbańczyk, 1998; Wypych, 1998; Smithson, Smith, Wilford, 2000). The financial condition is shaped by both internal (quantitative and qualitative) and external factors (Bombiak, 2010). Models of multidimensional discriminant analysis focus solely on the first group of quantitative factors, neglecting the crucial aspect of industry specificity. This oversight may have a negative impact on their effectiveness in certain economic sectors (Rusek, 2010; Wysocki, Kozera, 2012). It is worth noting that all models selected for analysis are highly regarded among researchers who have examined the financial situation of the entities they selected, as well as the probability of bankruptcy risk. Discriminatory models assess solvency and enable early recognition of insolvency risk, which may lead to bankruptcy (Antczak, 2023).

For the three selected models of multidimensional discriminant analysis, namely D. Hadasik's model, the 'Poznań' model, and D. Wierzba's model, the limit value is set to zero. This means that for the indicated models, a Z function value higher than zero indicates a good financial situation of the entity, while a value below zero indicates a difficult financial situation. The only exception is the model of J. Gajdka and D. Stos, where the limit value of the Z function is 0.494549 (Jagiello, 2013).

Table 5.*The build up of selected discriminatory models*

Model/ Function form/ interpretation
Hadasik: $Z_H = 2,36261 + 0,365425X_1 - 0,765526X_2 - 2,40435X_3 + 1,59079X_4 + 0,00230258X_5 - 0,0127826X_6$ X_1 = current assets/current liabilities X_2 = (current assets – inventories)/current liabilities X_3 = total liabilities/total assets X_4 = (current assets – short-term liabilities)/total liabilities X_5 = receivables/sales revenues X_6 = inventory/sales revenue $Z_H < 0$ difficult financial situation $Z_H > 0$ good financial situation
Gajdka and Stos: $Z_{GS} = 0,7732059 - 0,0856425X_1 + 0,0007747X_2 + 0,9220985X_3 + 0,6535995X_4 - 0,594687X_5$ X_1 = sales revenues/balance sheet total X_2 = liabilities x 365/manufacturing costs of products sold X_3 = net profit/balance sheet total X_4 = gross profit/sales revenues X_5 = total liabilities/assets $Z_{GS} < 0,45$ at risk of bankruptcy $Z_{GS} > 0,45$ good financial situation
Wierzba: $Z_W = 3,26 X_1 + 2,16 X_2 + 0,3X_3 + 0,69X_4$ X_1 = (operating profit – depreciation)/total assets X_2 = (operating profit – depreciation)/product sales X_3 = current assets/total liabilities X_4 = working capital/total assets $Z_W < 0$ difficult financial situation $Z_W > 0$ good financial situation
'Poznań' model: $Z_P = 3,562 X_1 + 1,588 X_2 + 4,288X_3 + 6,719X_4 - 2,368$ X_1 = net financial result/total assets, X_2 = current assets - inventories)/short-term liabilities, X_3 = constant capital/total assets, X_4 = financial result from sales/sales revenues $Z_P < 0$ difficult financial situation $Z_P > 0$ good financial situation

Source: own study based on: Gajdka, Stos, 1996a; 1996b; Hadasik, 1998; Wierzba, 2000; Hamrol, Czajka, Piechocki, 2004; Śnieżek, Wiatr, 2014.

During the second stage, we analysed selected liquidity and profitability indicators. We used dynamic measures to describe the time series and performed correlation analysis using Pearson's correlation coefficient.

The liquidity and profitability of a company are economic categories that largely assess its financial condition (Gołębiowski, Tłaczała, 2009; Bąk, Dawidowicz, 2023). To manage a company's financial liquidity, it is important to plan and control the level of current assets and liabilities.

The most important short-term financial liquidity indicators include: the first-degree financial liquidity ratio, also known as the cash payment ratio (Cash ratio); the second-degree financial liquidity ratio, also known as the quick liquidity ratio (Quick ratio); and the third-degree financial liquidity ratio, also known as the current liquidity ratio (Current ratio). Please refer to Table 6 for their characteristics. In the literature (Stickney, 2009; Bragg, 2002), there is no clear definition of the level of financial liquidity indicators that would be universal for individual industries and sectors of the economy (with a breakdown by type of company

activity). Therefore, Table 6 provides proposed values of the applied liquidity indicators based on a literature review.

Table 6.
Characteristics of selected financial liquidity indicators

Indicator name	Formula	Optimal value
Cash ratio (CC)	$\frac{\text{current assets} - \text{inventory} - \text{short-term interperiod settlements} - \text{short-term liabilities}}{\text{short-term obligations}}$	0,2
Quick ratio (QR)	$\frac{\text{current assets} - \text{inventory} - \text{short-term interim settlements}}{\text{short-term obligations}}$	1,0-1,2
Current ratio (CR)	$\frac{\text{current assets}}{\text{short-term obligations}}$	1,5-2,0

Source: Gabrusewicz, 2002; Dresler, Czekaj, 2008; Soliwoda, 2011.

A company's profitability, also known as earning power, is higher when the company has a greater ability to generate profits. At the same time, the use of equity capital should be as low as possible. A profitable company is one whose income exceeds its costs. One of the objectives of any business is to generate a surplus of income over costs (Waśniewski, Skoczylas, 2004). Maximising profitability is considered necessary due to the increasing competition between companies (Arulanandam, Glinkowska-Krauze, Tan, 2023). As already mentioned, the main area of company profitability concerns the analysis of the profitability of equity, assets and sales (Dresler, Czekaj, 2008; Sierpińska, Jachna, 1997). This makes it possible to analyse the financial effects achieved by the company in relation to the value of the capital employed by the owners of the business unit, the assets and the volume of sales (Walczak, 2007). In the course of further analysis, the company's own research was extended to include profitability ratios in the areas of return on equity (ROE), return on assets (ROA) and return on sales (ROS). The basic formulae used to calculate the profitability ratios are shown in Table 7.

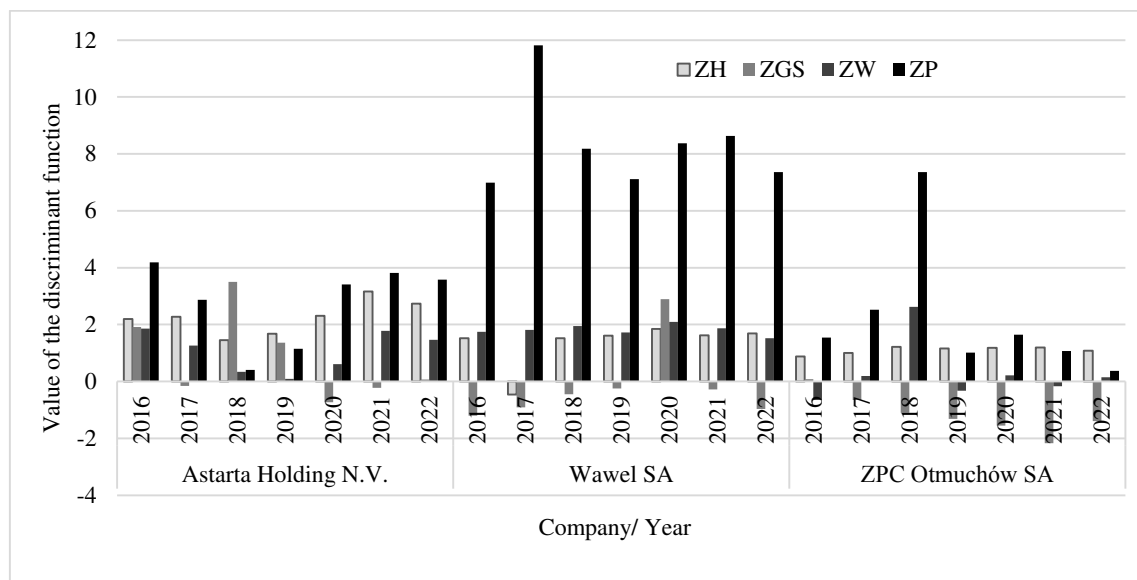
Table 7.
Characteristics of selected profitability indicators

The name of the indicator	Formula	Interpretation
Return on equity (ROE)	$\frac{\text{net profit}}{\text{equity capital}}$	return on equity employed
Return on assets (ROA)	$\frac{\text{net profit}}{\text{total assets}}$	asset management efficiency
Return on sales (ROS)	$\frac{\text{net profit}}{\text{net sales}}$	level depends on the industry

Source: Skoczylas, 2004; Witkowska, Witkowski, 2012; Misztal, 2015.

4. Results

Figure 2 shows the values of the individual discriminant analysis models used to analyse the three companies in the selected industries for the period 2016-2022.



ZH: model Hadasik; ZGS: model Gajdka and Stos; ZW: model Wierzba; ZP: 'Poznań' model.

Figure 2. Discriminant function values from 2016-2022.

Source: Own study based on analysis of financial statements of selected companies.

As can be seen in Figure 2, Dorota Hadasik's model did not indicate any companies that could be at risk of bankruptcy in the period 2016-2022. The exception is Wawel SA, which reached a value below the threshold of -0.46 in 2017. This was due, among other things, to a decline in sales revenues in 2016-2017. The model of J. Gajdka and D. Stos turned out to be the most stringent. This is due to the fact that the authors of the model set its limit at 0.45. Astarta Holding N.V. achieved a result above the threshold in 2016 and 2018-2019. In the remaining years of the analysis, the values for the models of J. Gajdka and D. Stos were below the threshold. Wawel SA only achieved a result above the threshold (2.89) in 2020, while ZPC Otmuchów SA did not achieve a result above the threshold throughout the analysis period. Astarta Holding N.V. and Wawel SA under the D. Wierzba model achieved Z(0) function values above the threshold. ZPC Otmuchów SA, on the other hand, achieved values below zero in 2016, 2019 and 2020. This was due to negative values of indicators X1 and X2 in the indicated years (negative values of "operating profit" in the case of both indicators). The 'Poznań' model turned out to be the least rigorous, as all the analysed companies achieved values above the model's threshold in the analysed period. Wawel SA achieved very high scores under the 'Poznań' model. This was the result of maintaining assets and revenues at a high level. It should be noted that, regardless of the results of the discriminant analysis models used, all the companies analysed were listed on the Warsaw Stock Exchange and were not removed from the WIG Food index. The achievement of negative values of individual models (in some

years of the analysis) is caused by a decrease in selected financial indicators, which is a consequence of the outbreak of the COVID-19 pandemic and the partial closure of the economy. The values of profitability and liquidity ratios for the analysed companies in 2016-2022 are presented in Figure 3.

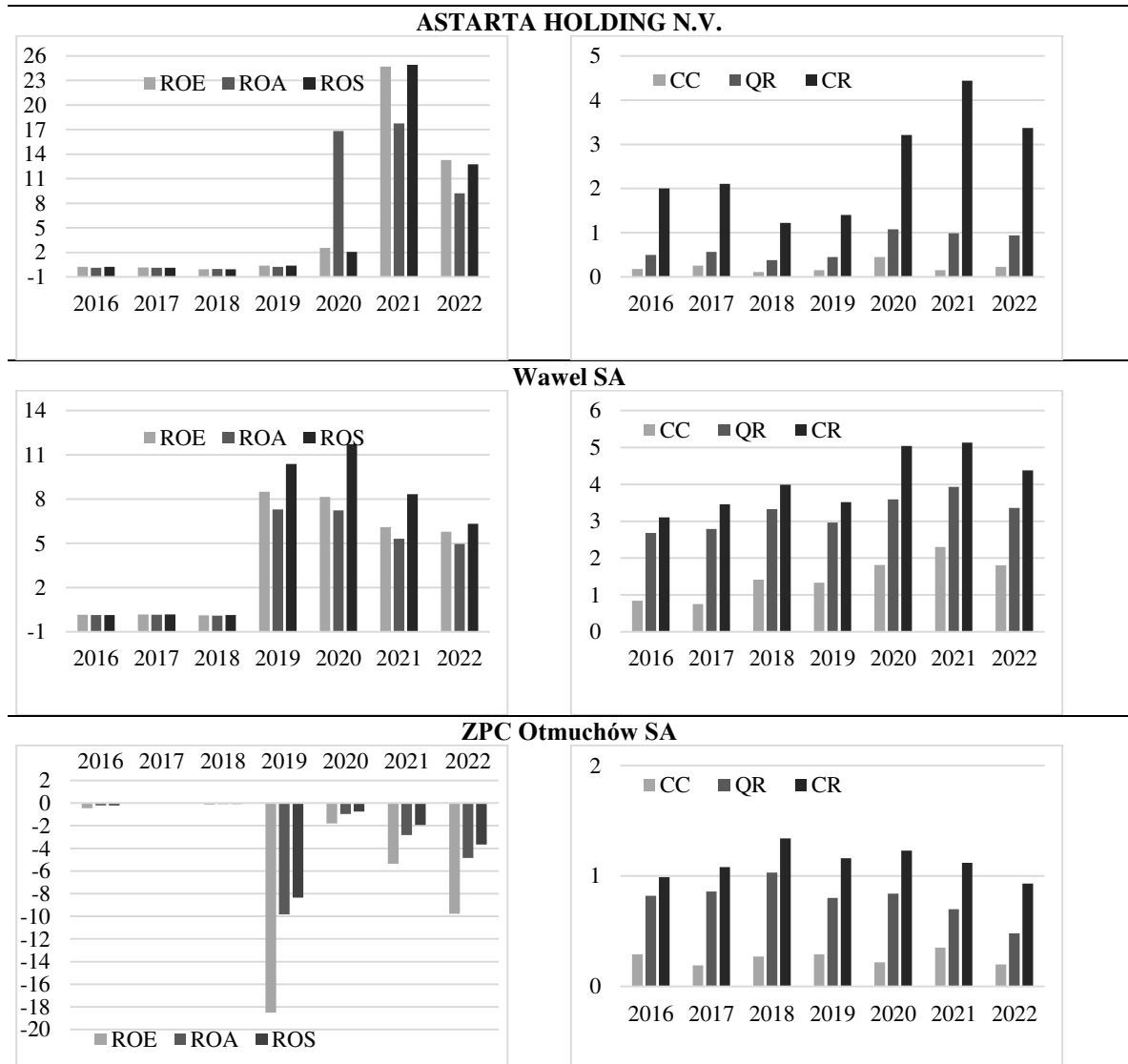


Figure 3. Values of liquidity and profitability ratios of companies in 2016-2022.

Source: Own study based on analysis of financial statements of selected companies.

The presented values of profitability indicators for Astarta Holding N.V. and Wawel SA in the years 2016-2022 indicate that their activities were profitable in terms of equity, assets and sales. Only in 2018 Astarta Holding N.V. reached negative values of all profitability ratios (ROE = -0.06; ROA = -0.03; ROS = -0.06), which was caused by negative net profit in the analysed year (-90777 thousand PLN). The situation is different for ZPC Otmuchów SA, which recorded negative values for all three profitability indicators throughout the period analysed. As in the case of Astarta Holding N.V. in 2018, the reason for this situation was the negative net profit in the analysed period. Analysing the profitability ratios, it can be concluded that in the case of Astarta Holding N.V. and Wawel SA, the profitability (REO, ROA, ROS)

has significantly improved in the years 2016-2022, while in the case of ZPC Otmuchów SA it has significantly deteriorated. The decrease in the profitability of sales of ZPC Otmuchów SA is clearly visible in 2022 (ROE = -0.44; ROA = -0.2; ROS = -0.21) compared to 2016 (ROE = -9.79; ROA = -4.84; ROS = -3.67). Based on the analysis of liquidity indicators, it can be concluded that the surveyed companies were characterised by high financial liquidity in the period under review. It should be noted that only ZPC Otmuchów SA achieved a current liquidity ratio (III degree liquidity) below 1 (in 2016 the value was 0.99 and in 2022 the value was 0.93). None of the examined companies reached the optimal value of the current liquidity ratio (1.5-2.0) in the analysed period. The achieved results were below or above this range. The optimal value of the quick liquidity ratio (2nd degree liquidity) was achieved by Astarta Holding N.V. (1.08 in 2020) and ZPC Otmuchów SA (1.03 in 2018). As for the cash liquidity ratio (liquidity level I), the companies reached the optimal value (up to 0.2) several times. Astarta Holding N.V. reached the optimal value in 2016 (0.18), 2018 (0.11), 2019 (0.15) and 2021 (0.15). Meanwhile, ZPC Otmuchów SA reached the optimum in 2017 (0.19) and 2022 (0.2). Only Wawel SA did not reach the optimal value of 1st degree liquidity in the analysed period. In most years of the period analysed, the net working capital was positive. This fact should be assessed positively, as the risk of losing financial liquidity was low.

In order to assess the degree of relationship between the values of financial liquidity and the profitability indicators of the companies selected for the study, the Pearson linear correlation coefficient was used. The research results make it difficult to establish whether there is a problem between the profitability and control of the analyzed enterprises (Table 8).

Table 8.
Pearson's linear correlation coefficients

Company/coefficient		Coefficient				
		ROE	ROA	ROS	CC	QR
ASTARTA HOLDING N.V.						
	ROA	0.728				
	ROS	1.000***	0.717			
	CC	-0.148	0.494	-0.168		
	QR	0.665	0.950**	0.648	0.628	
	CR	0.879**	0.909**	0.871*	0.322	0.916**
Wawel SA						
	ROE	0.735				
	ROA	0.733				
	ROS	0.701	0.990***	0.992***		
	CC	0.886**	0.663	0.666	0.680	
	QR	0.785*	0.517	0.525	0.563	0.961***
ZPC Otmuchów SA						
	ROA	0.999***				
	ROS	0.995***	0.997***			
	CC	-0.185	-0.200	-0.192		
	QR	0.459	0.433	0.380	0.123	
	CR	0.174	0.152	0.125	0.192	0.787*

Statistically significant respectively: *: p value < 0.05; **: p value < 0.01; ***: p value < 0.001.

Source: Own study based on designations as in figure 3.

As an entity within Astarta Holding N.V. it is important to consider the correlation between cash flow and the return on equity ratio, as well as the correlation between cash flow and sales profitability. In both cases, a negative correlation was observed, indicating that an increase/decrease in financial liquidity led to a decrease/increase in return on equity and sales profitability. A statistically significant correlation was found between the sales profitability ratio and the return on equity ratio (1.000) for Astarta Holding N.V. Other correlation relationships for different indicators were positive but statistically insignificant.

In the case of Wawel SA, a statistically significant correlation was found between the turnover profitability ratio and the asset profitability ratio (0.990), as well as the turnover profitability ratio (0.992). Furthermore, a statistically significant relationship was identified for the quick liquidity ratio (0.961). All other correlation relationships were positive, but not statistically significant.

At ZPC Otmuchów SA, there is a negative correlation in three cases: cash liquidity and return on equity (-0.185), cash flow and return on assets (-0.200), and cash flow and return on sales (-0.200). A statistically significant correlation was found within ZPC Otmuchów SA between the return on assets ratio and the return on equity ratio (0.999), as well as between the profitability ratio on sales and the return on equity ratio (0.995), and between the profitability ratio on sales and the return on assets ratio (0.997). The remaining correlation values were positive, but the strength of the relationship was weak and statistically insignificant.

5. Summary

The research on multidimensional discriminant analysis assesses the diagnostic reliability of the used discriminant models. It is important to note that the frequency of use of models does not equate to the ranking of their credibility and sufficiency. The research confirmed hypothesis H1, which states that multidimensional discriminant analysis models are useful for assessing the financial situation of surveyed enterprises in the Polish sugar industry. The selection of enterprises and analysis models was based on various factors. However, it is incorrect to attribute sectoral universality to discriminatory methods. The selected models accurately determined the financial situation of the surveyed enterprises from 2016 to 2022. It is important to note that this research only represents a fragment of reality, and further diagnostic tools should be employed to provide a more comprehensive analysis. This was partially implemented in the presented work. To enhance the analysis of a company's financial condition, it is crucial to consider the industry specificity criterion during the selection of multidimensional discriminant analysis models, particularly from a methodological perspective. The analysis and research presented here address a research gap by using

multidimensional discriminant analysis to verify the liquidity and profitability of selected entities in the food industry in Poland during the COVID-19 pandemic crisis from 2019 to 2022. The COVID-19 pandemic continues to affect the food industry in Poland, and ongoing analysis and research must incorporate new analytical methods. It is highly probable that subsequent analyses of this area will be comprehensive and in-depth, but this study already indicates some problems in selected areas caused by the COVID-19 pandemic.

The results of the research on the financial liquidity of the company, its profitability and the correlation between these areas provided certain grounds for confirming the second research hypothesis (H2), which states that there is no statistically significant relationship between the financial liquidity and the financial profitability of the analysed companies. The values of the Pearson's linear correlation coefficient between financial liquidity and the profitability of the companies analysed turned out to be largely statistically insignificant, therefore it cannot be clearly stated that such a relationship exists. The literature on the subject often indicates a negative correlation between financial liquidity and company profitability. The research results obtained did not allow to establish a clear direction and relationship between these two groups of financial indicators. The lack of reasons to reject the second hypothesis (H2) means that the direction of the relationship tested could not be determined or confirmed.

The relationship between financial liquidity and profitability is reflected in net working capital management strategies. The emerging positive relationship between liquidity and profitability may be the result of better exploitation of emerging business opportunities. A conservative strategy may mean maintaining a high level of financial liquidity, which results in lower profitability. The aggressive strategy is based on achieving high profitability with low financial liquidity. This results in maintaining negative working capital in the company. This means that the choice of an appropriate strategy (together with the nature of net working capital) determines the level of financial liquidity and the level of profitability achieved.

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AWARENESS OF SUSTAINABLE CONSUMPTION AMONG POLISH CONSUMERS OF GENERATION Z – A CASE STUDY

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Purpose: Progressive climate change requires the implementation of this idea not only in companies or manufacturing plants, but also in households. Therefore, this study attempts to: identify the awareness and type of attitudes of Generation Z consumers toward sustainable consumption, and assess the relationship between attitudes about sustainable consumption issues among Generation Z consumers and their behavior and stated intentions to behave toward sustainable consumption.

Design/methodology/approach: The survey was conducted among young consumers of Generation Z (n = 380). A non-probabilistic sampling technique known as convenience sampling was used to select respondents for the research sample. The research was carried out by indirect online survey measurement method (CAWI), using a survey questionnaire hosted on Google Form.

Findings: Issues of sustainable consumption are familiar to a group of Generation Z consumers. they are aware that excessive consumption and irrational use of resources can adversely affect the environment and climate change. However, the most important criterion in choosing products is price. A favorable aspect is that more and more young consumers are purchasing used products, which may be associated with their lower cost. However, they are more likely to purchase them through online services, which is more convenient. Despite awareness of the benefits of adhering to the principles of sustainable consumption, those surveyed are quite skeptical about supporting nonprofit organizations or participating in social campaigns.

Research limitations/implications: The research was carried out narrowly in terms of subjects, so it cannot be generalized to the entire segment of Generation Z consumers. The scope of the presented research is also limited. The results of the research should be considered as a pilot study.

Practical implications: Findings are relevant to actors along the entire chain of production and distribution of consumer goods, allowing the identification of consumer needs and behavior. State institutions and European Union bodies should continue their efforts leading to the development of the necessary legal and financial instruments that will encourage citizens to take socially and environmentally responsible actions.

Originality/value: This research underscores that sustainable consumption is increasingly important to young consumers and requires an interdisciplinary approach to pro-environmental research on their behavior.

Keywords: sustainable consumption, Generation Z, consumer awareness, pro-environmental attitudes.

Category of the paper: marketing research.

1. Introduction

The idea and practice of sustainable consumption is an important issue these days, as evidenced by its active promotion and support by various institutions, including the United Nations (UN), scientific research centers and non-governmental organizations around the world. International organizations such as the United Nations Environment Program (UNEP) and the Food and Agriculture Organization (FAO) are engaged in educational activities, public campaigns and the development of standards for sustainable consumption (Mammadli, 2023; Ribeiro et al., 2023; Halicka et al., 2019). Sustainable consumption is a complex and ambivalent concept consisting of two opposing terms - consumption and sustainability. However, existing definitions show that the main goal of sustainable consumption is to achieve harmony between meeting consumer needs and protecting the environment. It is a search for a balance between freedom of consumer choice and responsibility for others and the planet (Fanxi, 2022; Pilgrimienė et al., 2020). Nowadays, a significant part of society purchases products and consumes goods in excess of their actual needs. This phenomenon is due to various factors, and one of the main ones is the promotion of the ideology of consumerism, which promotes consumption as a means of experiencing positive emotions (Falke et al., 2022). Modern culture leads people to think that more material goods translate into greater satisfaction and fulfillment. Consumerism is often not only a lifestyle, but also a source of identity and social acceptance. However, more and more people are beginning to realize that unreflective accumulation and use of material goods does not bring long-term happiness. In addition, people, especially young people, are becoming increasingly aware of the negative impact of mass production and overconsumption on the environment, leading them to make more sustainable choices (Seyfi et al., 2023a; Seyfi et al., 2023b; Tarapata 2020).

An alternative to consumerism is the concept of sustainable consumption, which is well known in the field of economics. The concept of sustainable consumption is a key component of consumer utility theory. Due to the progressive growth of the global population and dwindling resources, the problem of long-term sustainability of consumption arises. It then becomes an important issue to maintain a balance between the current level of consumption and the needs of future generations, which is related to the limited amount of goods used in consumption processes. This is why sustainable consumption occupies such an important place in the circle of interest of economists these days (Confetto et al., 2023; Jasrotia et al., 2023).

The core of the definition of sustainability is sustainable consumption in the context of political economy, which implies maintaining the quality of life at the level available in the current civilization framework (Kramer, 2011). Sustainable consumption, ensuring a clean and healthy environment and improving the quality of life for current and future generations are integral parts of a sustainable development strategy, which is understood as a compromise between society's environmental, social and economic goals (Čapienė et al., 2021).

Improving living standards are resulting in increasingly rapid consumption of resources in industry, households and areas of personal consumption. Nowadays, the negative effects that unsustainable consumption patterns have on the environment are becoming increasingly vocal. For a long time, sustainability issues were mainly seen as the responsibility of producers, thus leaving consumers on the sidelines. However, this is not entirely true, as individual consumption behavior is a key factor currently driving unsustainable development and consumption (Pilgrimienė et al., 2020; Chatterjee et al., 2021; Casalegno et al., 2022).

Sustainable consumption harmonizes economic development, social equality and environmental protection. It is worth noting that currently one of the key challenges on a global scale is the problem of environmental pollution (Gavryshkiv, 2019). Pro-environmental and pro-social consumer involvement in sustainable consumption can lead to behavioral change, thus contributing to solving current global challenges (Čapienė et al., 2021). Developed public awareness is extremely important in shaping sustainable consumption (Niewielska, 2021). Sustainable consumption can be described as thoughtful, purposeful and conscious behavior resulting from deep reflection and related to the reevaluation of the human value system. The approach emphasizes moderation in consumption, aiming to rationalize it (Tarapata, 2020).

According to the Wuppertal Institute for Climate, Environment and Energy, pursuing the concept of sustainable consumption, consumers should minimize the amount of waste generated, avoid the use of goods that require high energy consumption during transportation, or purchase second-hand items, which contributes to reducing the production of new goods (Gavryshkiv, 2019).

In both the literature and the media, young people are referred to as Generation Z. Although this name has no formal justification, it is nevertheless widely used in research, scientific studies and in the media. Other terms are also used, such as Digital Natives, Selfie Generation, iGeneration, and Screeners. These terms indicate this generation's strong connection to new technologies. The timeframe of Generation Z has not been formally established. Precisely defining these boundaries is extremely difficult, especially due to the intermingling of generations. The scientific literature points to generations Y and Z as two distinct groups of young people. One of the most significant reasons for the separation of Generation Z in society is considered to be the advanced technological leap covering the years 1990-2000. This dynamic development included the expansion of the Internet and mobile telephony (Gabriellova, Buchko, 2021; Paczka, 2020). The younger generation of consumers is more likely to respond to new trends compared to older ones, resulting in faster adaptation to changing consumer behavior patterns (Kaminska, Krakowiak-Drzewiecka, 2023). Technological advances have a significant impact on the way young people function. They carry out the vast majority of their activities in a virtual environment. Actively using modern technologies, they are gaining more and more knowledge and developing awareness of the impact their choices can have on products, services, as well as the reputation of companies and brands. At some point in the development of this awareness, they acquire a willingness to take action

to promote sustainable consumption in their daily lives. Some of them begin to engage publicly, promoting posture in line with the idea of sustainable consumption. The resulting changes in habits and lifestyles are being implemented by a growing group of people (Faller, Gogek, 2019; Cochoy et al., 2020).

Determinants influencing the choice of sustainable consumption by Generation Z include concern for the environment. Awareness of the impact of human activities on the environment, resulting in pollution, loss of biodiversity or even climate change, among other things, motivates young people to take action to reduce negative impacts by choosing sustainable consumption. In order to improve the natural environment for future generations, it is necessary to reduce the amount of goods consumed. Another important factor is the values that guide young generations. People, guided by ethical values, can pursue sustainable consumption by supporting socially and environmentally responsible companies. At the same time, they try to avoid supporting companies that violate workers' rights or engage in unethical business practices (Wang et al., 2021; Wang, Rhemtulla, 2021). An important aspect that also drives the youngest generation of consumers toward sustainable consumption is concern for health. The concept of sustainable consumption in the context of health and food envisions an increased role for plant-based products, seasonal and local products, and products labeled with quality certificates and the fair-trade symbol in the daily diet. The drive to save money also encourages young people to make more conscious and thoughtful choices. Saving is becoming an integral part of lifestyles, which has an impact on consumer preferences and purchasing decisions. The introduction of sustainable consumption can lead to savings that become apparent in the long term. By reducing water and energy consumption and using items more efficiently, it is possible to generate savings that become noticeable over time (Ulla et al., 2021; Kiet et al., 2023).

Among the sustainable activities often undertaken by most people in their daily lives are first and foremost water and electricity efficiency. Segregating waste and reducing the quantity of products purchased and consumed in favor of quality are equally common practices. On a global scale, there is also growing consumer interest in organic food. The organic food market is currently the fastest growing area of food production. Demand for food products from "organic" crops has been steadily increasing for many years. Consumers are increasingly turning to foods described as "eco" because such products are produced without the use of genetically modified organisms (GMOs), artificial fertilizers and pesticides. In addition, in most cases they are free of additives such as preservatives, colors or sweeteners (Khanh et al., 2023; Kumar et al., 2023). Young people have a positive attitude toward acquiring used items, and by buying them they give them a second life. Particularly popular among young people have become online services or second-hand clothing stores, where it is possible to purchase so-called second-hand items or sell goods that will no longer be used. By buying used products, consumers contribute to reducing waste and consumption of natural resources, which supports the idea of recycling and reuse. In addition, this practice helps minimize the carbon emissions

associated with the production of new items, which is an important aspect of the fight against climate change (Huo et al., 2023; Shahjalal et al., 2023).

Putting sustainable consumption into practice requires specific transformations in both the demand and supply spheres. In the case of the former, it is a matter of changing consumption patterns, which are mainly based on the choice of ecologically sound products

and services, aiming to minimize negative environmental impacts at every stage of their life cycle. In the context of the supply side, modifications in production processes are important, aiming to reduce the consumption of natural resources by improving the ecological efficiency of the production of goods and services (Acampora et al., 2023).

There is a public perception that young people are often unaware of how advertising and brands influence their purchasing decisions and consumption patterns. The media use various strategies, both overt and covert, to manipulate young consumers. Particularly during adolescence, when there is an identity crisis, young people become an attractive group for advertising creators. The implications of this phenomenon for sustainable consumption can be negative, as it leads to increased consumption, which in turn harms the environment and society. Focusing on materialistic values can overshadow more important aspects of life, such as interpersonal relationships and personal development. Consequently, this attitude can contribute to social and environmental imbalances, as the pressure to consume, not always in line with the needs of the individual or society as a whole, increases. To promote sustainable consumption among young people, it is important to educate them about the mechanisms of advertising and encourage them to make informed and thoughtful purchasing decisions (Barwicka, 2018; Huo et al., 2023).

Nevertheless, interest in the idea of sustainable consumption among young people is growing, and their consumer behavior is conducive to promoting environmental and social actions. This trend could have a significant impact on the future of the world, as the young generation, being strong driving forces in society, can contribute to changing consumption standards to more sustainable ones. By preferring environmentally and community-friendly products and services, young consumers can influence the development of a more responsible consumption model, which can contribute to environmental protection and improved living conditions for local communities in the future (Tarapata, 2020).

In the context of the issues presented, this paper attempts to:

- identify the awareness and type of attitudes of Generation Z consumers toward sustainable consumption,
- to assess the relationship between attitudes on issues related to the phenomenon of sustainable consumption among Generation Z consumers and their behavior and stated intentions to behave towards sustainable consumption.

The article contributes the author's original research on sustainable consumption among Polish Generation Z consumers.

2. Subject and research methodology

The survey was conducted among young consumers of Generation Z ($n = 380$). A non-probabilistic sampling technique known as convenience sampling was used to select respondents for the research sample. The research was carried out by indirect online survey measurement method (CAWI), using a survey questionnaire hosted on Google Form. The questionnaire consisted of four thematic blocks. The first part dealt with assessing attitudes toward sustainable consumption issues (15 statements). The second part of the questionnaire consisted of questions to verify behavior towards sustainable consumption (12 statements). In the third part, consumers answered questions about their behavior when using products (11 statements). And the final, fourth part dealt with consumers' declarations of future intentions to support and promote sustainable consumption for the benefit of society (3 assertions). Respondents expressed their level of acceptance, in relation to the statements included in the questionnaire using a 7-point Likert scale, with strong disagreement with a given statement corresponding to a rating of 1 and its strong acceptance to a rating of 7. The collected empirical material obtained during the conducted research was subjected to statistical analysis using Statistica 13.3 software. Basic statistics such as mean values, standard deviations, median, mode, skewness and kurtosis were calculated. R-Pearson correlation analysis was used to determine the strength and significance of the relationships between attitude, behavior and intention.

3. Results and discussion

Table 1 includes statements that relate to attitudes (statements 1.1-1.15), behaviors (statements 2.1-2.12 and 3.1-3.11) and stated intentions regarding sustainable consumption of young consumers (statements 4.1-4.3).

Based on the research conducted and the results obtained, it was found that Generation Z consumers showed positive attitudes regarding the issue of sustainable consumption (Table 1). Respondents are more aware of the negative impact of production on the environment (mean score of 5.55, $M = 6$) than of excessive consumption (mean score of 4.95, $M = 5$). Nevertheless, they are aware of the adverse impact of over-consumption on climate change (mean score 5.25, $M = 6$). They also expressed concern about natural resources diminishing too quickly (mean score 5.56, $M = 6$). Surveyed consumers also felt that both businesses (mean score of 5.55, $M = 6$) and all citizens (mean score of 5.47, $M = 6$) should be more involved in activities to promote the idea and awareness of sustainable consumption among the public. Those who took part in the survey also expressed their concern about the presence in products available on the

market of too many ingredients that can negatively affect both the environment (mean score of 5.55, $M = 6$) and the human body (mean score of 5.93, $M = 6$). Considering purchasing behavior, the most important criterion turned out to be price (mean score of 6.15, $M = 6$) and information on the composition of products (mean score of 5.55, $M = 6$). Consumers also declared that they purchase second-hand products such as clothing, toys and durable goods, but they are much more likely to purchase them using online services (average score of 5.56, $M = 6$) than stationary stores (average score of 4.14, $M = 4$). It is definitely a favorable phenomenon among respondents that they do not purchase excessive amounts of food products (mean score 5.45, $M = 6$), but despite this and positive attitudes towards sustainable consumption, respondents do not pay much attention to the expiration date when making more food purchases (mean score 3.85, $M = 4$). When it comes to sustainable consumption usage behavior, using public transportation to reduce carbon emissions proved to be the most important factor (mean score of 6.11, $M = 6$), as well as taking care of one's own health by limiting consumption of highly processed products and those with a lot of additives (mean score of 5.87, $M = 6$), and regularly separating waste generated in the household (mean score of 5.61, $M = 6$). Although the majority of respondents do not buy groceries to "stock up", this phenomenon is quite common and ranks far lower in the hierarchy of factors. This may be due to the fact that points for free exchange of food between users are not always available. It is also a favorable phenomenon that respondents do not throw away durable, still usable products such as clothing or small household appliances, but resell such products on online services, less often giving them to people in need. This may be related to a desire to recoup some of the money invested in such products. Less important among respondents is reducing household electricity or water consumption. In the case of the results regarding intentions to behave towards sustainable consumption, it was shown that respondents have a neutral attitude regarding supporting nonprofit organizations or participating in campaigns for the benefit of society, as well as purchasing products whose part of the proceeds goes towards environmental protection.

Table 1.

Attitudes and behaviors of Generation Z consumers regarding sustainable consumption

Variables	X	SD	M	Mo	S	K
Consumer attitudes towards sustainable consumption						
1.1. I am aware of the negative impact of excessive consumption on the environment	4,95	1,50	5	6	-0,69	-0,16
1.2. I am aware of the negative impact of excessive production on the environment	5,55	1,53	6	5	-0,34	-0,55
1.3. I recognize the deepening problems concerning ecology and society	5,44	1,39	6	6	-1,01	0,91
1.4. I believe that waste is increasing alarmingly fast	5,43	1,48	6	7	-0,99	0,82
1.5. I am aware of the increasing pollution of the environment	5,55	1,35	6	6	-1,17	1,44
1.6. I am aware of the increasing pollution of water bodies and groundwater	5,45	1,50	6	7	-1,04	0,75
1.7. I believe that the world's sources of natural resources are diminishing too fast	5,56	1,61	6	6	-0,68	-0,24

Cont. table 1.

1.8. I believe that over-consumption is the cause of adverse climate change	5,25	1,47	6	6	-0,96	0,57
1.9. I believe that manufacturing companies should engage in activities to educate about sustainable consumption	5,55	1,26	6	6	-0,69	-0,16
1.10. I believe that every citizen should participate in campaigns and actions for the benefit of society	5,47	1,35	6	5	-0,34	-0,55
1.11. I believe that there are too few social campaigns on reducing consumption by the public	5,10	1,34	5	6	-1,01	0,91
1.12. I am sensitive to environmental issues	5,14	1,65	5	7	-0,99	0,82
1.13. I am convinced that I can improve the environment with my actions	4,93	1,46	5	6	-1,17	1,44
1.14. I believe that there are too many substances in products available on the market that adversely affect the environment	5,55	1,39	6	7	-1,04	0,75
1.15. I believe that there are too many substances in the products available on the market that adversely affect the human body	5,93	1,45	6	6	-0,92	0,62
Shopping behavior						
2.1. I try to choose environmentally friendly brands/products	4,56	1,25	5	5	-0,62	-0,04
2.2. I often make purchases of products packaged in an environmentally friendly way	4,79	1,46	5	6	-0,91	0,66
2.3. When going shopping, I carry a reusable bag with me	5,05	1,89	5	5	-0,68	-0,22
2.4. I don't buy groceries to "stock up"	5,45	1,75	6	5	-0,75	0,13
2.5. When buying more food products, I pay attention to the expiration date	3,85	1,98	4	5	-0,75	0,44
2.6. When buying products, I read their composition and pay attention to whether they contain ingredients that are harmful to the environment	4,95	1,56	5	5	-0,76	0,20
2.7. When buying products, I read their composition and pay attention to whether they contain ingredients unfavorable to health	5,55	1,43	6	4	-0,40	-0,06
2.8. When I have a choice between two products I buy the one that is less harmful to the environment	4,15	1,89	4	5	-0,27	-0,79
2.9. When I have a choice between two products I buy the one that is recycled	4,05	1,65	4	6	-1,09	1,12
2.10. When making a purchase, the most important thing for me is the price	6,15	1,45	6	6	-0,92	0,37
2.11. When making purchases of textile/everyday use products, I choose stores with used products	4,14	1,98	4	5	-0,79	0,01
2.12. When shopping for textile/everyday use products, I use online services that offer used products	5,56	1,75	6	5	-0,44	-0,36
Usage behavior						
3.1. I try to avoid consuming products that contain a lot of unhealthy ingredients and highly processed food	5,87	1,55	6	5	-0,49	-0,14
3.2. I take excess purchased or prepared products to an food sharing point	4,65	1,51	5	5	-0,68	0,40
3.3. I do not throw away food in the household	3,85	2,15	4	5	-0,94	0,53
3.4. I segregate garbage regularly	5,61	1,47	6	5	-0,22	-0,44
3.5. If I no longer use a durable product, but it is still functional/wearable I sell it on online services	5,55	1,25	6	5	-0,30	-0,49
3.6. If I no longer use a durable product but it is still serviceable/wearable I donate it to people in need	4,88	1,89	5	5	-0,89	0,81
3.7. I always turn off lights in rooms that no one is using	4,67	1,72	5	7	-1,82	4,40
3.8. I use energy-saving light sources	4,01	2,56	4	7	-2,59	9,13
3.9. I turn down the radiators during the heating season	4,55	1,98	5	6	-1,36	1,89
3.10. I save water when bathing, washing up	5,09	1,44	5	6	-1,58	2,75
3.11. I choose public transportation to reduce CO ₂ emissions	6,11	1,05	6	5	-0,73	-0,38

Cont. table 1.

Intentions to behave towards sustainable consumption						
4.1. I am willing to pay a higher price for goods whose producers are committed to environmental efforts	4,25	1,43	4	5	-1,45	2,08
4.2. I am ready to take part in a social campaign for sustainable consumption among the public	4,02	1,89	4	5	-1,28	1,84
4.3. I am ready to support charitable organizations that implement environmental activities	4,14	1,43	4	5	-0,85	0,22

X – arithmetic mean, SD – standard deviation, M – median, Mo – mode, S – skewness, K – kurtosis.

Source: own research.

Tables 2a, 2b and 2c present the determinants between Generation Z consumers' attitudes about sustainable consumption and their shopping and product use behavior and declared behavioral intentions. Based on the research conducted and the results obtained, it was shown that the correlations between almost all the analyzed variables were statistically significant ($p < 0.05$). The values of the coefficients ranged from 0.1 to 0.7. Coefficient values below 0.3 indicate low correlation of the analyzed variables, in the range of 0.3-0.5 - medium, while above 0.5 - strong. It was shown that people who perceive the deepening problems of ecology and society very often purchase environmentally friendly products/brands ($r = 0.60$) and packaged in an environmentally friendly way ($r = 0.70$). These people are also more likely to donate products they no longer use to people in need ($r = 0.63$). Although in the surveys conducted, the value of the correlation coefficient between attributes took on average values.

Table 2a.

Relationships between attitudes toward sustainable consumption of Generation Z consumers and behavioral attitudes and intentions

Variables	Variables														
	1.1.	1.2.	1.3.	1.4.	1.5.	1.6.	1.7.	1.8.	1.9.	1.10.	1.11.	1.12.	1.13.	1.14.	1.15.
1.1.	1,00														
1.2.	0,05	1,00													
1.3.	0,37	0,12	1,00												
1.4.	0,44	0,15	0,69	1,00											
1.5.	0,53	0,17	0,61	0,65	1,00										
1.6.	0,47	0,09	0,59	0,71	0,61	1,00									
1.7.	0,54	-0,01	0,46	0,49	0,47	0,45	1,00								
1.8.	0,57	-0,02	0,42	0,38	0,44	0,40	0,53	1,00							
1.9.	0,68	0,05	0,37	0,44	0,53	0,47	0,54	0,57	1,00						
1.10.	0,05	0,69	0,12	0,15	0,17	0,09	-0,01	-0,02	0,05	1,00					
1.11.	0,37	0,12	0,57	0,69	0,61	0,59	0,46	0,42	0,37	0,12	1,00				
1.12.	0,44	0,15	0,59	0,65	0,65	0,51	0,49	0,38	0,44	0,15	0,69	1,00			
1.13.	0,53	0,17	0,61	0,65	0,69	0,51	0,47	0,44	0,53	0,17	0,61	0,65	1,00		
1.14.	0,47	0,09	0,59	0,51	0,61	0,51	0,45	0,40	0,47	0,09	0,59	0,71	0,61	1,00	
1.15.	0,52	0,14	0,58	0,66	0,59	0,67	0,53	0,43	0,52	0,14	0,58	0,66	0,59	0,67	1,00
2.1.	0,40	0,00	0,60	0,55	0,52	0,58	0,50	0,42	0,40	0,00	0,60	0,55	0,52	0,58	0,54
2.2.	0,43	0,07	0,70	0,66	0,60	0,61	0,47	0,41	0,43	0,07	0,70	0,66	0,60	0,61	0,60
2.3.	0,38	0,09	0,54	0,60	0,46	0,50	0,47	0,35	0,38	0,09	0,54	0,60	0,46	0,50	0,49
2.4.	0,38	0,03	0,53	0,57	0,46	0,50	0,44	0,38	0,38	0,03	0,53	0,57	0,46	0,50	0,49
2.5.	0,37	0,08	0,55	0,56	0,51	0,48	0,47	0,31	0,37	0,08	0,55	0,56	0,51	0,48	0,47
2.6.	0,35	0,00	0,50	0,53	0,45	0,54	0,48	0,45	0,35	0,00	0,50	0,53	0,45	0,54	0,48
2.7.	0,35	-0,01	0,47	0,48	0,43	0,47	0,41	0,39	0,35	-0,01	0,47	0,48	0,43	0,47	0,45
2.8.	0,35	-0,02	0,52	0,50	0,47	0,48	0,37	0,36	0,35	-0,02	0,52	0,50	0,47	0,48	0,46

Cont. table 2a.

2.9.	0,54	0,09	0,49	0,53	0,59	0,57	0,56	0,51	0,54	0,09	0,49	0,53	0,59	0,57	0,56
2.10.	0,37	0,07	0,47	0,49	0,46	0,48	0,41	0,34	0,37	0,07	0,47	0,49	0,46	0,48	0,48
2.11.	0,45	0,10	0,57	0,60	0,56	0,51	0,51	0,39	0,45	0,10	0,57	0,60	0,56	0,51	0,52
2.12.	0,37	0,06	0,50	0,57	0,48	0,48	0,47	0,29	0,37	0,06	0,50	0,57	0,48	0,48	0,42
3.1.	0,36	0,09	0,53	0,56	0,57	0,53	0,44	0,36	0,36	0,09	0,53	0,56	0,57	0,53	0,49
3.2.	0,49	0,05	0,59	0,62	0,60	0,62	0,48	0,44	0,49	0,05	0,59	0,62	0,60	0,62	0,55
3.3.	0,35	0,05	0,63	0,62	0,56	0,58	0,45	0,37	0,35	0,05	0,63	0,62	0,56	0,58	0,52
3.4.	0,40	0,03	0,47	0,55	0,45	0,49	0,42	0,34	0,40	0,03	0,47	0,55	0,45	0,49	0,50
3.5.	0,30	0,06	0,52	0,53	0,43	0,43	0,43	0,30	0,30	0,06	0,52	0,53	0,43	0,43	0,46
3.6.	0,45	0,09	0,63	0,67	0,59	0,68	0,45	0,41	0,45	0,09	0,63	0,67	0,59	0,68	0,60
3.7.	0,12	0,18	0,19	0,19	0,20	0,17	0,13	0,08	0,12	0,18	0,19	0,19	0,20	0,17	0,20
3.8.	0,28	0,09	0,30	0,33	0,32	0,25	0,30	0,24	0,28	0,09	0,30	0,33	0,32	0,25	0,31
3.9.	0,11	0,06	0,19	0,16	0,19	0,15	0,15	0,03	0,11	0,06	0,19	0,16	0,19	0,15	0,13
3.10.	0,17	0,11	0,13	0,16	0,21	0,14	0,17	0,08	0,17	0,11	0,13	0,16	0,21	0,14	0,19
3.11.	0,09	-0,10	0,06	0,10	0,09	0,09	0,20	0,10	0,09	-0,10	0,06	0,10	0,09	0,09	0,12
4.1.	0,05	0,09	0,17	0,25	0,19	0,17	0,08	0,05	0,05	0,09	0,17	0,25	0,19	0,17	0,18
4.2.	0,24	0,01	0,42	0,45	0,34	0,37	0,40	0,17	0,24	0,01	0,42	0,45	0,34	0,37	0,35
4.3.	0,23	-0,01	0,35	0,35	0,27	0,35	0,28	0,13	0,23	-0,01	0,35	0,35	0,27	0,35	0,33

Source: own research.

Consumers who perceive the problem of increasing waste are also concerned about the increasing pollution of water bodies ($r = 0.69$), when shopping for products such as clothing they are more likely to choose second-hand stores ($r = 0.60$), do not throw away excess food products at households ($r = 0.62$) and are more likely to refer them to an eatery ($r = 0.62$). In addition, those who believe they can improve the environment with their actions always turn off lights in unused rooms ($r = 0.32$) and say they are willing to participate in a social campaign for sustainable consumption ($r = 0.34$). The study also found that consumers who are aware of the too-fast diminishing natural resources negatively view too many food additives ($r = 0.53$) and are more likely to choose environmentally friendly ones when making purchases ($r = 0.50$). These individuals are also more likely to take advantage of second-hand stores' offerings ($r = 0.51$). It was also found that those shopping for products in non-environmentally hazardous packaging often take their own bag with them ($r = 0.54$), do not waste food products ($r = 0.69$), as well as regularly segregate household trash ($r = 0.51$). These consumers also report participating in social campaigns ($r = 0.44$) and helping nonprofit organizations ($r = 0.44$).

Table 2b.

Relationships between attitudes toward sustainable consumption of Generation Z consumers and behavioral attitudes and intentions

Variables	Variables											
	2.1.	2.2.	2.3.	2.4.	2.5.	2.6.	2.7.	2.8.	2.9.	2.10.	2.11.	2.12.
2.1.	1,00											
2.2.	0,67	1,00										
2.3.	0,57	0,54	1,00									
2.4.	0,59	0,51	0,64	1,00								
2.5.	0,56	0,56	0,64	0,53	1,00							
2.6.	0,60	0,52	0,54	0,54	0,59	1,00						
2.7.	0,55	0,49	0,48	0,52	0,48	0,58	1,00					
2.8.	0,59	0,55	0,52	0,53	0,51	0,49	0,53	1,00				
2.9.	0,49	0,54	0,46	0,46	0,52	0,46	0,44	0,50	1,00			

Cont. table 2b.

2.10.	0,46	0,45	0,43	0,44	0,54	0,47	0,47	0,42	0,49	1,00		
2.11.	0,60	0,53	0,66	0,61	0,68	0,62	0,60	0,58	0,53	0,53	1,00	
2.12.	0,55	0,49	0,62	0,53	0,65	0,58	0,53	0,53	0,50	0,46	0,70	1,00
3.1.	0,53	0,50	0,49	0,52	0,56	0,51	0,55	0,57	0,56	0,51	0,64	0,60
3.2.	0,66	0,61	0,55	0,60	0,58	0,59	0,56	0,57	0,59	0,52	0,64	0,59
3.3.	0,66	0,63	0,53	0,56	0,60	0,57	0,52	0,51	0,43	0,44	0,59	0,52
3.4.	0,56	0,51	0,51	0,56	0,55	0,52	0,51	0,56	0,47	0,47	0,57	0,54
3.5.	0,60	0,55	0,56	0,53	0,57	0,56	0,54	0,58	0,39	0,43	0,62	0,55
3.6.	0,61	0,66	0,49	0,56	0,53	0,55	0,51	0,49	0,60	0,47	0,53	0,51
3.7.	0,03	0,18	0,08	0,06	0,08	0,08	0,08	-0,02	0,11	0,14	0,08	0,11
3.8.	0,16	0,29	0,23	0,23	0,21	0,21	0,23	0,19	0,30	0,25	0,29	0,22
3.9.	0,18	0,20	0,20	0,15	0,26	0,17	0,20	0,24	0,21	0,16	0,22	0,28
3.10.	0,11	0,22	0,10	0,20	0,12	0,08	0,18	0,11	0,20	0,19	0,10	0,10
3.11.	0,18	0,12	0,24	0,19	0,31	0,15	0,20	0,29	0,19	0,22	0,23	0,26
4.1.	0,06	0,18	0,06	0,13	0,04	0,12	0,12	0,02	0,12	0,18	0,04	0,08
4.2.	0,47	0,47	0,52	0,47	0,55	0,47	0,46	0,44	0,38	0,39	0,57	0,58
4.3.	0,41	0,44	0,34	0,38	0,39	0,39	0,39	0,37	0,26	0,26	0,38	0,44

Source: own research.

Table 2c.

Relationships between attitudes toward sustainable consumption of Generation Z consumers and behavioral attitudes and intentions

Variables	Variables													
	3.1.	3.2.	3.3.	3.4.	3.5.	3.6.	3.7.	3.8.	3.9.	3.10.	3.11.	4.1.	4.2.	4.3.
3.1.	1,00													
3.2.	0,60	1,00												
3.3.	0,51	0,58	1,00											
3.4.	0,60	0,62	0,49	1,00										
3.5.	0,54	0,57	0,59	0,73	1,00									
3.6.	0,61	0,67	0,61	0,53	0,50	1,00								
3.7.	0,05	0,10	0,10	-0,06	-0,05	0,14	1,00							
3.8.	0,22	0,31	0,20	0,16	0,13	0,30	0,47	1,00						
3.9.	0,14	0,25	0,18	0,19	0,19	0,19	0,26	0,28	1,00					
3.10.	0,18	0,18	0,19	0,19	0,10	0,16	0,19	0,36	0,39	1,00				
3.11.	0,23	0,22	0,12	0,25	0,20	0,11	0,09	0,20	0,33	0,30	1,00			
4.1.	0,11	0,15	0,13	0,03	0,03	0,18	0,55	0,34	0,18	0,26	0,16	1,00		
4.2.	0,40	0,48	0,48	0,47	0,49	0,39	0,23	0,38	0,45	0,32	0,47	0,29	1,00	
4.3.	0,37	0,42	0,40	0,42	0,40	0,37	0,18	0,25	0,39	0,36	0,45	0,23	0,70	1,00

Source: own research.

Based on the survey, it can be concluded that issues of sustainable consumption are familiar to a group of Generation Z consumers. They are aware that over-consumption and irrational use of resources can adversely affect the environment and climate change. However, the most important criterion in choosing products is price. A favorable aspect is that more and more young consumers are purchasing used products, which may be associated with their lower cost. However, they are more likely to purchase them through online services, which is undoubtedly more convenient. Despite awareness of the benefits of adhering to the principles of sustainable consumption, those surveyed are quite skeptical about supporting nonprofit organizations or participating in social campaigns.

Tarapata (2020) in his research indicates that a trend of sustainable consumption can be observed among young consumers due to their environmental knowledge. They are individuals, aware of both the increasing environmental problems and the positive effects of their own actions that can affect them (Tarapata, 2020). In a study conducted by Byrd et al., (2023) among young consumers, it was shown that almost 70% (69.1%) expressed concern about wasting natural resources, and 60.3% of respondents revised their shopping habits in relation to environmental protection (Byrd et al., 2023). According to Chen and Mandi (2023), China's Generation Z is showing a growing trend toward consumption that is environmentally friendly. According to the authors, the public's awareness of concern for both their health and the environment increased significantly during the pandemic, which was also significantly influenced by social media (Chen, Mandi, 2023). According to a study by Dragolea et al., (2023) there is a strong correlation between the sustainable consumption of Generation Z consumers and the satisfaction they feel with environmental activities. However, these authors found no correlation between the sustainable behaviors of young consumers and information on sustainable practices of companies, conveyed through marketing tools (Dragolea et al., 2023).

A study conducted by Gomes et al., (2023) among young Portuguese consumers showed that environmental concerns, anticipation of a green future and perceived green quality are the most likely drivers for Generation Z to purchase green products, and they are able to pay a higher amount for such products. According to the authors, the study provides the first evidence of how environmental concerns, future green vision, perceived quality and green benefits by young Portuguese consumers of Generation Z can influence their willingness to pay more for green products (Gomes et al., 2023). According to Wei et al., (2018) Generation Z consumers are increasingly aware of the importance of environmental protection and are willing to contribute to solving environmental problems.

According to a study by Jasek et al., (2022), young consumers pursuing the tenets of sustainable consumption most often indicated segregating waste, saving water, and giving up traveling short distances in vehicles in favor of walking. On the other hand, factors such as buying food products that contain the Fair Trade mark and clothes that are certified organic were rated lowest. According to the authors, these two low-rated factors may be due to the fact that products with such labels are more expensive than their commercial substitutes (Jaska et al., 2023).

As shown in a study by Milfont and Schultz (2016), environmental, social and economic risks are perceived by an increasing number of consumers, and they are therefore ready to take action to reduce this by implementing sustainable consumption principles. Concari et al. (2020) pointed out the need for an interdisciplinary approach to pro-environmental research on consumer behavior and listed such areas as engineering, chemistry, ecology, economics, marketing, law, business management, sociology and psychology. Today's consumer, thanks to easier access to multiple sources of information, has a wider range of knowledge and expects

manufacturers to make products that meet their needs. Oriented toward sustainable consumption, consumers expect production technologies that are environmentally friendly and distribution channels, but also to fit into the new economic model of a circular economy (Concari et al., 2020; Musova et al., 2021).

Conclusions

Surveys conducted have shown that young Generation Z consumers are aware of sustainable consumption. They express concern about the state of the environment or dwindling natural resources. According to the respondents, manufacturing companies and governmental and non-governmental organizations should engage in social campaigns to communicate information on sustainable consumption to the public. Nevertheless, almost half of the total number of consumers said they were reluctant to pay more for purchasing goods that are less harmful to the environment, but they pay more attention to whether these products have a negative impact on their health. It was shown that second-hand products are becoming increasingly popular and are more likely to be purchased from online services than from stationary stores. It has been shown that environmental concerns are less important during household use. It is worrying that more than half of the respondents throw away unused food products, which may be due to the fact that they do not pay attention to the expiration date of such products or do not have the opportunity to donate them to free food exchange points. Unfortunately, consumers also pay little attention to the rational use of energy, water or heating in households. It has also been shown that concern for the environment is less important in the hierarchy of factors than the price of the good being purchased. Consumers are also quite skeptical about participating in public advocacy campaigns aimed at promoting awareness of sustainable consumption. The results obtained are of great importance for actors along the entire chain of production and distribution of consumer goods, making it possible to identify consumer needs and behavior. State institutions and European Union bodies should continue their efforts leading to the development of the necessary legal and financial instruments to encourage citizens to take socially and environmentally responsible actions.

The results obtained cannot be unambiguously applied to the entire segment of Generation Z consumers, as the research was carried out within a limited subject range. The scope of the results presented is also limited. Further research is needed to determine the profile of the consumer who realizes the tenets of sustainable consumption, along with their characteristics based on social structure and individual psychographic conditions.

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THE PROCESS OF IMPLEMENTING SUSTAINABLE DEVELOPMENT IN POLAND

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Purpose: The purpose of this paper is to show the implementation progress of Agenda 2030 in Poland as the basic document related to making the sustainable development concept a reality.

Design/methodology/approach: This article describes and characterizes selected indicators monitoring the national priorities of the 2030 Agenda, divided into three aspects: economic, social and environmental. The analysis was carried out based on two reports: Report 2020, Report 2022, Poland on the path to sustainable development.

Findings: The article shows that the implementation of the provisions of the 2030 Agenda in Poland is at a good level, but indicators monitoring social and economic issues show that changes in these areas are more favorable than in the environmental area.

Research implication: Considerations regarding the implementation of the assumptions of the 2030 Agenda may be continued in the future in relation to the subsequent years of operation of this document in relation to both Poland and other countries for comparative purposes.

Originality/value: The study covers all three aspects of sustainable development: economic, social and environmental, and presents an analysis of the latest data related to the implementation of the assumptions of the 2030 Agenda in Poland.

Keywords: sustainable development, Agenda 2030, SDGs.

Category of the paper: technical paper.

1. Introduction

Created in the 1980s, sustainable development is one of today's key concepts of economic development. It is strictly related to reports of the Club of Rome, especially the "Limits to growth" which proposes zero economic growth if this is the only way to stop the degradation of the natural environment. That concept focuses on social goals and believes that attaining them provides a foundation for economic development of societies (Buszko, 2012).

Unlike neoclassical economics which disregarded the links between the economy and the natural and social environment, the sustainable development concept takes account of finite stocks of resources, of the poor condition of the natural environment and of how important is social development to economic development.

In 2010, there were ca. 6.9 billion people living on the earth; in 2050, the world's population will grow to approximately 9.1 billion. The growing population means greater demand for food, services and industrial products but also for water, clean air and other natural goods that allow the human kind to survive. Also, it translates into faster economic growth caused by an increase in GDP. In turn, a higher GDP means greater production volumes which require water, energy, natural raw materials and generate undesired byproducts. Hence, growth in production and consumption contributes more than ever to environmental degradation. Rogall (2010) warns that harmful emissions and the extraction of resources will double every 28 years. Moreover, the bad condition of the environment has an effect on social problems. In an effort to address these issues, the economic growth paradigm was replaced by the sustainable development concept.

The creation of the sustainable development concept is related to adopting a perspective on the global problem related to the condition of the natural environment which goes beyond national borders and is life-threatening for future generations. It is generally believed that the dissemination of the sustainable development concept—adopted as the overarching goal of the economic, social development and environmental policies—started with the 1987 Brundtland Report. It contributed to shifting away from the promise of development and to initiating the discussion on global management (Ziai, 2016). Sustainable development is the greatest opportunity for improving the relationships between humans and the environment and overcoming ideological barriers. Also, it is necessary to promote a policy that makes the citizens an integral part of change (D'Adamo, Gastaldi, Morone, 2022). The first concepts of sustainable development started to emerge after the 1972 UN conference held in Stockholm which declared the overarching role of environmental requirements which cannot be perturbed by human or economic development (Kośmicki, 2010). The final principle of durable and sustainable growth was formulated at the Earth Summit held in Rio de Janeiro in 1992. It established an inextricable link between preserving natural resources for future generations and the need for improving the standards of living, which also includes economic development. At the 1983 UN conference, the Brundtland Report defined sustainable development in a way that integrates economics and ecology into one system (Hadryjańska, 2005). It is generally believed that the dissemination of the sustainable development concept—adopted as the overarching goal of the economic, social development and environmental policies—started with that very report. It involves measures taken to mitigate the adverse effects of atmospheric warming, which is of particular importance to developing countries facing a number of challenges related to socioeconomic changes. In the conditions brought by the changing climate, the transfer of low-carbon technologies is

the best way for developing countries to align with (or even find new paths towards) sustainable development (Karakosta, Askounis, 2010).

The definition of durable and sustainable development provides for three fundamental goals (Borys, 1999; Śleszyński, 2000; Burzyńska, Fila, 2007; Kośmicki, 2010; Grabowska, 2001; Nazarko, Dobrzyński, 2006; Zubalewicz, Zabrocka, 2004; Dobrzańska, Dobrzański, Kielczewski, 2008; Rogall, 2010; Golusin, Munitlak-Ivanović, 2009):

1. The environmental goal: maintaining the natural resource capital and the productivity of utility systems in the long term; maintaining the stability, resilience and integrity of ecological processes; protecting the earth's atmosphere; maintaining the diversity of species and landscapes; making a sustainable use of renewable and non-renewable resources; ensuring healthy living conditions; restricting environmental degradation; eliminating environmental threats; and making a more productive use of resources in production and consumption processes.
2. The economic goal: maintaining the national economy and the whole economic system in a stable condition; full employment at an acceptable level of labor quality; making businesses more competitive through an economic management of resources; the need to pursue economic growth with the use of environmentally-friendly techniques and technologies in a way to ensure real improvements in prosperity while maintaining the limits of natural space; internalization of all major external costs; supporting equality; improving the availability of useful goods and services; price stability; balanced state budget.
3. The social goal: eradicating poverty; social security; overcoming demographic problems; fair life chances and social integration; internal and external security; resolving conflicts without violence; health protection; improving the quality of life by ensuring good living conditions and modifying the social values; maintaining cultural diversity; ensuring access to socially desired goods; social participation; reducing the debt of the poorest countries of the world; ensuring human rights and self-fulfillment to everyone; providing everyone with the ability to access social benefits and to contribute to social wellbeing against a fair remuneration; meeting human needs to the fullest possible extent; ensuring social and political stability; and improving the standards of living.

OECD established a system of short-term indicators of sustainable development which enable a holistic description of the environmental protection policy and lay down a standard for international benchmarking. The system's foundation is the causality principle which states that human activity is the factor that puts the greatest pressure on the environment by triggering adverse changes in natural resources. The society responds to these changes through an environmental protection policy, i.e. by establishing a feedback loop to reduce the pressure on the environment. The system uses Pressure, State and Response (PSR) indicators which can provide a starting point for sustainable development programming and for defining the

minimum criteria for environmental management at any scale: at a global, continental, national, regional and local level (Śleszyński, 2000; Jeżowski, 2007; Kobyłko, 2007; Baum, 2011; Madej, 2002).

Sustainable development indicators should deliver reliable, legible and accurate information on the progress in implementing that concept in the territory concerned. They should comprehensively address the problem which involves economic, environmental protection and social development issues (Heldak, Raszka, 2013).

On September 25, 2015, the UN General Assembly adopted the Resolution “Transforming our world: the 2030 Agenda for Sustainable Development” (Agenda 2030), an action program with unprecedented scope and importance which defines the sustainable development model at the global level. Its framework extends far beyond the previously implemented Millennium Development Goals (MDGs) set in 2000. While the latter focused mostly on national average figures, SDGs address the most marginalized and vulnerable groups and rely on disaggregated data (de Jong, Vijge, 2021). According to Agenda 2030, key modernization efforts should be undertaken to eradicate poverty in all its forms while pursuing a number of economic, social and environmental goals. Sustainable Development Goals (SDGs) differ from MDGs in their objectives, concepts and policies. Sustainable Development Goals provided for in the Agenda 2030 address several key deficiencies of the Millennium Development Goals and span over a broader, more transformation-oriented program which better reflects the complex challenges of the 21st century and the need for structural reforms to the global economy (Fukuda-Parr, 2016).

Agenda 2030 is consistent with the commitment to establish a social model based on respect for human rights (Arts, 2017).

It includes the definition of 17 goals composed of 169 targets (Unic Warsaw) which are a follow-up to the Millennium Development Goals set out in the UN Millennium Declaration. The strict interrelation between the 17 targets suggests that the pursuit of any of them inevitably affects other ones. Therefore, any non-integrated development efforts which separately address each of the targets and neglect the interactions between them could lead to a failure in implementing the requirements of the Agenda 2030 (Biglaria, Beiglaryb, Arthanaric, 2022).

The goals and related targets, as defined in the Agenda 2030, stimulate activities in the domains of utmost importance: people, planet, prosperity, world peace and partnership (Unic Warsaw):

- People: to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfill their potential in dignity and equality and in a healthy environment.
- Planet: to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.

- Prosperity: to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature.
- Peace: to foster peaceful, just and inclusive societies which are free from fear and violence.
- Partnership: to mobilize the means required to implement this Agenda through a revitalized Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people.

Having in mind that the Agenda 2030 is a universal plan of global development, it must every time be aligned with national realities, and therefore the states play a key role in implementing it. The complexity of and interrelations between SDGs require broad involvement and responsible collaboration. In this context, it is important that global goals be translated into national, regional and local targets, and to make people realize their importance to everyone. Article 21 of the Agenda makes every state responsible for implementing it at national, regional and global level, taking into account different national realities, capacities and levels of development and respecting national policies and priorities.

The purpose of this paper is to present the sustainable development concept in the context of implementing the goals set out in Agenda 2030 (the Resolution “Transforming our world: the 2030 Agenda for Sustainable Development”) in Poland. It was adopted on September 25, 2015 by the United Nations General Assembly, and was signed by 193 states. The Agenda 2030 lays down 17 sustainable development goals (SDGs) and 169 associated targets. It is a follow-up to the Agenda 21 which outlined the 21 Millennium Development Goals formulated at the UN conference held in 1992 in Rio de Janeiro and subsequently included in the UN Millennium Declaration of 2000. Agenda 2030 is planned to be implemented over another 15-year period (ending in 2030); it spans over all countries and their internal socioeconomic policies, and is supposed to address the implementation of the global Paris Agreement on counteracting climate change.

This paper will outline and describe the selected indicators used in monitoring the national priorities of Agenda 2030, split into three aspects: economy, society and environment.

The authors will attempt to answer the question whether Poland has made any progress in implementing the SDGs over the last decade and, if so, what is the area that witnessed the greatest advancements.

2. Results

This study was prepared using two reports: Report 2020 and 2022, Poland on the path to sustainable development. The latest figures for some indicators come from 2019, which is

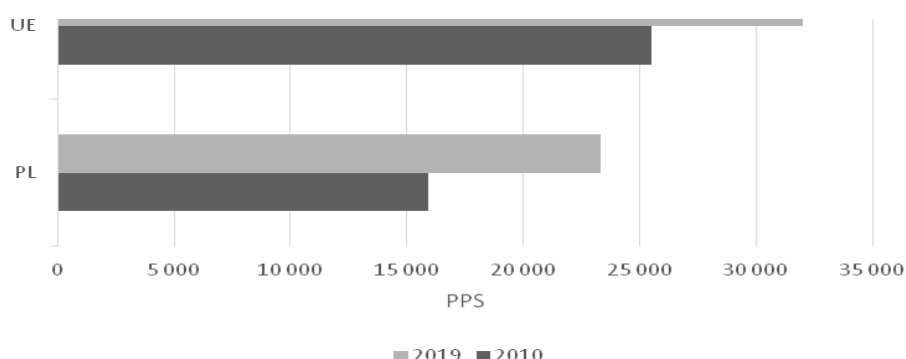
probably due to the frequency of measurements and monitoring. This study analyzed the data on selected goals of the Agenda 2030 in order to present the degree to which sustainable development principles are implemented in Poland. A reference was made to data from 10 years ago so as to show the changes taking place over the recent years and to draw conclusions on the objective of this paper. The data was arranged in a way to reflect the three main aspects of the sustainable development concept: the economic, social and environmental areas. Priorities are assigned to each of the 17 goals, and their implementation progress is measured with specific indicators. Due to its limited nature, the description below will only take account of selected goals and some of their priorities.

2.1. Economic aspect

Economic matters are covered by goal 8 which is about promoting stable, sustainable and inclusive economic growth, full and productive employment, and decent work for everyone.

Since 2005, the global economy has grown by 45% in real terms, at a relatively stable pace from one year to another, except for the years 2008-2009. At that time, the economic crisis hit most regions around the world; as a consequence, in 2009, the global GDP declined at an annual rate of 1.3%. In Europe, the GDP per capita is more than 2.5 times the global average.

Poland is among the countries which gradually bridge the gap between them and the wealthiest EU economies. Since 2010, the Polish gross domestic product has increased by 38% in real terms vs. barely 15% in the whole EU. The Polish GDP per capita (in PPS) continues to be much below the regional average level and is at 72% of the EU average (Figure 1). However, the gap is much smaller than in 2010 where the GDP per capita was 62% of the average Union level. Another favorable trend in Poland is the increase in labor productivity which has grown by 29% in real terms since 2010 (vs. an average rate of 7% in the EU) and represents 80% of the average regional level in nominal terms (vs. 70% at the beginning of the decade).



*PPS, the common conventional currency used in the EU for the purposes of international benchmarking, allows to eliminate the differences in prices between the countries.

Figure 1. GDP per capita in Poland in 2010 and 2019 (PPS*).

Source: (GUS: <https://raportsdg.stat.gov.pl/2020/cel8.html>).

The first indicator of the priority related to the search for new competitive advantages is the share of high-tech exports in total exports. In 2010-2020, it followed an upward trend, with 6% at the beginning and 9% at the end.

Another indicator of this priority is the one showing the expenses on innovative activities in enterprises in relation to GDP. That ratio was calculated as total expenditure on innovative activities incurred by industrial and service enterprises with no less than 10 employees in relation to GDP. In the period concerned, it did not follow a stable trend, with intermittent growth and decline. In 2010, it was at 2.39% and amounted to 1.72% in 2018.

The third indicator of that priority is the Global Competitiveness Index (GCI) presented as a ranking. In 2010-2019, Poland's average rank was around 40; initially, Poland was ranked 39th, then moved to 43rd in 2014 and 37th at the end of that period (https://sdg.gov.pl/statistics_nat/8-1-c/).

The indicator of the priority related to enterprise development is the ease of doing business (presented as a Doing Business ranking). The higher the country's ranking, the simpler the regulations for running an enterprise and the stronger the legal protection of ownership. In 2012, Poland was ranked 55th and went down over the next 4 years (being ranked 24th in 2014); in 2020, it was ranked 40th (https://sdg.gov.pl/statistics_nat/8-2-a/).

An important priority of goal 8 is the increase in the employment ratio which, in accordance with the LFS (Labor Force Survey) method, was ca. 50% for people aged over 15 in the study period.

The promotion of stable forms of employment is of crucial importance for the attainment of goal 8. The indicator of that priority is the number of people employed under an employment contract in relation to the total number of people working in the national economy. Between 2010 and 2020, it was ca. 73-74% in Poland.

The economic activation of young people, women, persons aged 50+, long-term unemployed and disabled is an extremely important priority for goal 8; its basic indicator (the economic activity index) varied between 55.3% and 56.1% (Figure 2).

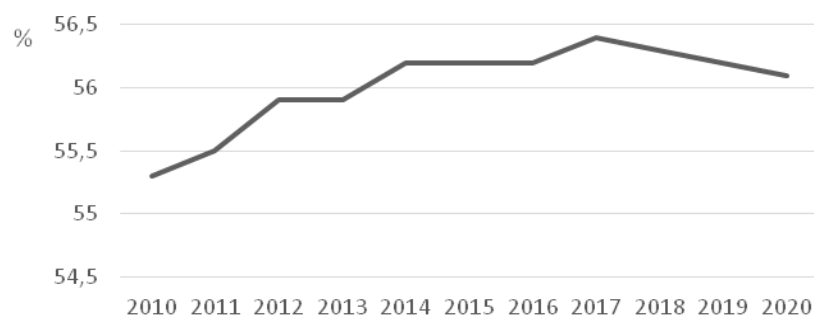


Figure 2. Economic activity index in Poland between 2010 and 2019.

Source: (GUS: https://sdg.gov.pl/statistics_nat/8-7-a/).

Just as most Union countries, Poland saw a decline in the share of economically inactive people: currently, 25% of persons aged 20-64 neither have nor seek an occupation (the EU average rate being 21%) vs. almost 29% in 2010. There was a slight change in the main reasons for being inactive. In most cases, these are caregiving and family duties (31% of cases in Poland vs. 22% in the EU), followed by retirement (28% and 18%, respectively) (Figure 3). However, at the beginning of the decade, the above reasons were cited in the reverse order.

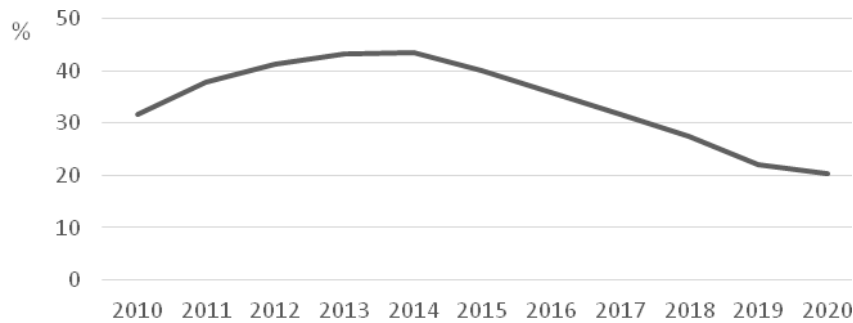


Figure 3. Share of long-term unemployed in total unemployed (aged 20-64) in Poland between 2010 and 2020.

Source: (GUS: https://sdg.gov.pl/statistics_nat/8-7-b/).

The next goal related to economic matters is goal 9 which means building a stable infrastructure, promoting sustainable industrialization and supporting innovativeness.

The first Polish priority under goal 9 is to improve the legal and institutional environment that encourages the undertaking of risky innovative activities, measured with the Global Innovation Index. The GII includes 80 indicators which take account of aspects such as patent applications, education, business environment, infrastructure and maturity of the economy in the context of innovativeness. Poland reached its best GII ranking (38th) in 2020 and 2022, and the worst (49th) in 2013.

As regards the priority related to the development of knowledge-intensive industries and services, the first indicator is expressed as the relationship between gross domestic R&D expenditure and GDP. Since the beginning of the decade, Poland has witnessed gradual growth in research and development expenses, with ca. EUR 6 billion being spent in 2021 (more than twice the amount recorded in 2010). Funds allocated to current expenditure grew faster than investment resources. Although the intensity of R&D activities increased from 0.72% of GDP in 2010 to 1.44% of GDP, it remains below the EU average level (which grew from 1.92% to 2.12% of GDP over that period). Also, a large gap persists between Poland and European leaders of innovativeness (including Sweden, Austria, Germany and Denmark) where the intensity of research and development activities is nearly three times greater (GUS: <https://raportsdg.stat.gov.pl/2022/cel9.html>).

Compared to 2010, there are changes in the structure of financing and running R&D activities. Currently, more than half of R&D funds (53%) come from the enterprise sector and a smaller part (35%) is provided by the government, whereas the proportion recorded in 2010 was reversed (with 24% and 61%, respectively). Also, the enterprise sector increased its contribution to the implementation of research and development activities. Today, just like in the EU, it accounts for ca. two thirds of funds spent on that area (in addition to its own funds, it also uses a part of funds originating from the government sector and some foreign resources). The higher education sector continues to demonstrate a relatively high share (of over 30%) in the structure of R&D expenses grouped by implementing sectors. Conversely, there was a drop in the government's contribution to the implementation of R&D projects. The next indicator covered by that priority is the R&D expenditure of the enterprise sector in relation to the GDP. Between 2010 and 2020, it grew consistently from 0.19 to 0.88, testifying to an increased interest from enterprises in research and innovative activities. Unfortunately, it is not reflected in the share of net income from the sale of new or improved products in total net sales income of industrial enterprises. Over the study period, that ratio declined from 11.3% to 9.3%. The above means that interest in research and enterprise development does not directly translate into increased income from selling innovative products.

2.2. Social aspect

Of the 17 goals under the Agenda 2030, the largest group relates to social issues, including goal 1 which addresses the need to eliminate poverty in all its forms all around the world. The key indicator of that goal is the real poverty rate, expressed as the percentage of people living in households below the relative poverty line, defined as 50% of the average spending of all households.

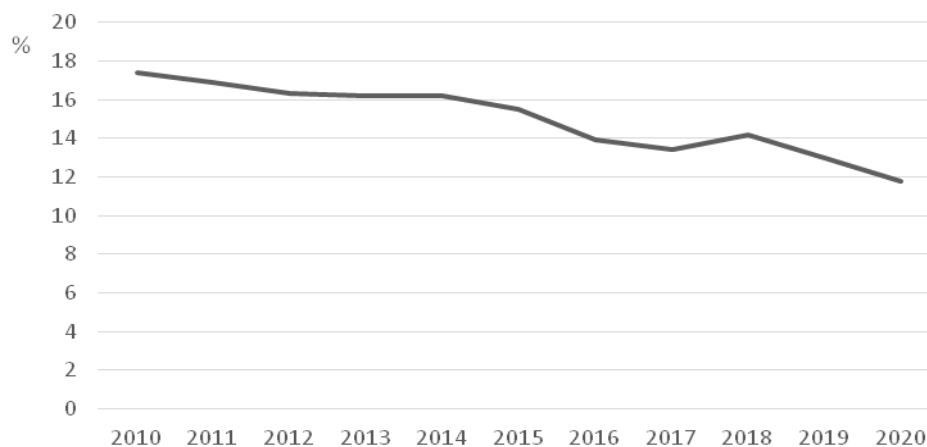


Figure 4. Real poverty rate in Poland between 2010 and 2020 (%).

Source: (GUS: https://sdg.gov.pl/statistics_nat/1-1-a/).

In Poland, just like throughout Europe, extreme poverty is relatively rare but many households do not earn enough to enjoy a peaceful life. However, this is less frequently the case than at the beginning of the decade; conversely, the problem becomes more widespread in the EU. The percentage of the Polish population at risk of poverty (taking account of social transfers as part of their income) decreased to 15% from nearly 18%, the level recorded in 2010 (Figure 4). Currently, it is below the EU average (which increased to 17%) although it was the opposite only a couple of years ago. The at-risk-of-poverty rate for rural residents (21% vs. 24% in 2010) is twice that for big city dwellers (10% vs. 11%).

The next indicator for goal 1 is the households' real disposable income per capita, with 2008 as the base year. In Poland, it grew by more than 40% over the last decade. The financial situation of Polish households is clearly better than in 2010. At that time, nearly 15% of households suffered from severe material deprivation, i.e. struggled to finance at least 4 out of 9 needs considered as basic in the European realities. Today, these problems are faced by barely 4% of Polish households which, unlike at the beginning of the decade, is less than the average rate recorded in the EU (6%). Just like a couple of years ago, the financial situation is the usual reason why households cannot afford a one-week holiday away from home once a year or meet unexpected expenditure. These difficulties are indicated by 30% of households, which is much less than in 2010 when it was the case for more than half of them.

An important indicator of the population's quality of living is the one which presents the housing resources of a territorial unit (Figure 5). Low values mean a shortage of dwellings which can result in social problems, e.g. making it difficult for young people to become self-empowered. In turn, high levels mean excessive housing resources which may lead to economic difficulties, e.g. in maintaining the unused part of it. The value of this ratio is also impacted by cultural and demographic factors, such as the average number of children per family, average age and a culture of multigenerational cohabitation.

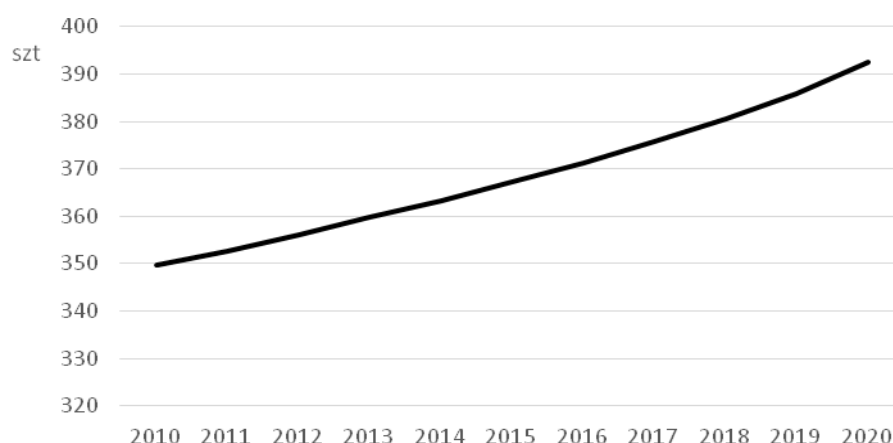


Figure 5. Number of dwellings per 1000 population in Poland between 2010 and 2020.

Source: (GUS: https://sdg.gov.pl/statistics_nat/1-4-a/).

Another goal with a social dimension is goal 2 which means eliminating famine, attaining food security and better nutrition, and promoting sustainable farming.

Two target indicators were defined as part of the priority related to increasing the share of agricultural produce (including high-quality food) in Polish exports: the value of agri-food exports per capita and the share of agri-food products in total Polish exports. Both of them follow an upward trend, and the former more than doubled between 2010 and 2021, going from over PLN 1400 to PLN 4500.

Goal 3, also related to social aspects, is about ensuring a healthy life to everyone at any age and promoting wellbeing.

One of its priorities is to narrow the gap in access to healthcare, and is measured as the number of doctors per 10,000 population and the number of nurses and midwives per 10,000 population. These indicators increased between 2009 and 2020, with the number of nurses being twice that of doctors (62.6).

According to subjective views of the Polish population, the health condition of the society has improved since the beginning of the decade. Most people (60%) consider their health status to be good or very good; this is slightly more than in 2010 (58%). At the same time, there is a decline in the percentage of persons reporting to be in a bad or very bad health condition (to 13% from 15% in 2010). The Poles rate their health status below the total EU level. In the EU, 69% of people view their health condition as good or very good and 8% as bad or very bad, on average. Both in Poland and in the whole EU, most good and very good ratings are given by men. Conversely, women more frequently than men declare to have a medium (neither good nor bad) health status and to be in a bad or very bad health condition.

Another goal relating to social issues is goal 4 which calls for providing everyone with high-quality education and promoting lifelong learning.

One of the priorities under goal 4 is to improve the quality and attractiveness of vocational education and to better align the vocational training and education with labor market needs. It is measured with the unemployment rate among graduates of vocational schools (as per the LFS). Between 2010 and 2020, it went down from 36% to 22%, but it needs to be noted that total unemployment in Poland followed a downward trend over that period (Figure 6).

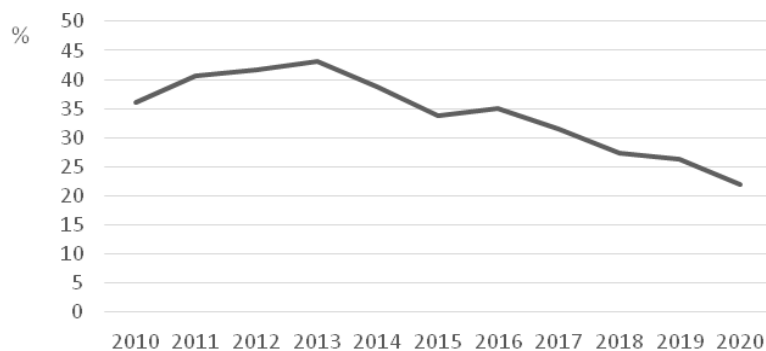


Figure 6. Unemployment rate for graduates of vocational schools (in accordance with the LFS).

Source: (GUS: https://sdg.gov.pl/statistics_nat/4-1-a/).

Goal 4, i.e. improving the quality of education, also involves the quality of tertiary education. Due to demographic and socioeconomic changes, the number of students at Polish universities gradually declines, but still many young residents decide to enroll in a tertiary program: in academic year 2018/2019, the gross enrolment rate (which only takes account of first- and second-cycle studies and long-cycle master's degree programs, excluding foreigners, in relation to population aged 19-24) for this level of education was 46% (vs. 54% in academic year 2010/2011). More and more Poles have a tertiary education: almost 47% of people aged 30-34 hold a university diploma (vs. 40% in the entire EU), compared to 30% at the beginning of the decade (Figure 7).

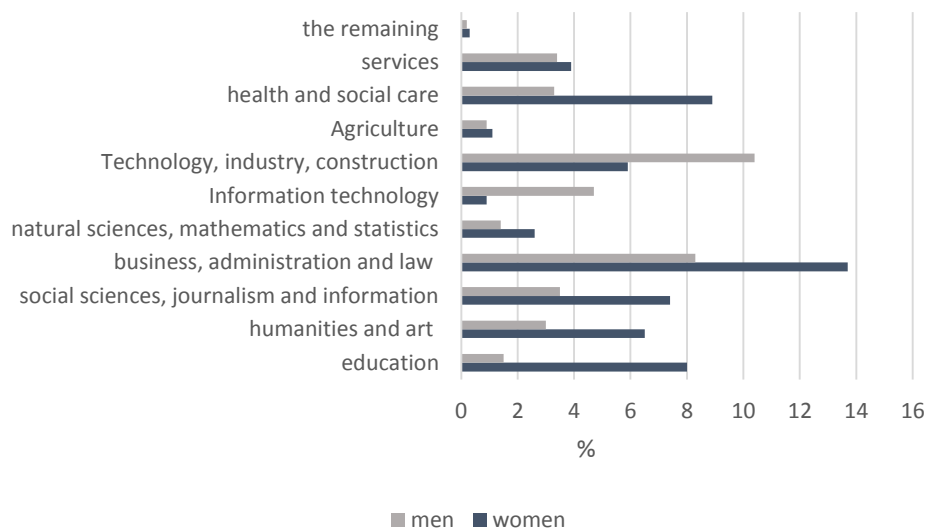


Figure 7. Polish students grouped by fields of education in 2018 (%).

Source: (GUS: <https://raportsdg.stat.gov.pl/2020/cel4.html>).

Goal 5 is related to attaining gender equality and empowering women and girls. In Poland, just like in other EU countries, gender inequality is noticeable in a number of ways, including in the labor market, despite women being more educated. Indeed, they quit education at an early stage less frequently than men; 3.6% of women aged 18-24 ended their schooling at the junior secondary level (vs. 6.7% of men). Also, women are more inclined to continue into university. More than a half of women aged 30-34 have a tertiary education (vs. barely 40% for men). However, women opt for different fields of study. They enroll in pedagogy, humanities and social courses three times more frequently than men (22% of female vs. 8% of male students), and twice less frequently in natural and technical sciences programs (9% of female vs. 17% of male students).

The fact of women being more educated does not translate into equal employment opportunities. The situation of women in the labor market has evolved in line with the general improvement in economic conditions, and is now better than at the beginning of the decade. However, in the working-age population, the employment rate is smaller for women than for men (70% vs. 79%) and the unemployment rate is higher for women than for men (4% vs. 3%).

The percentage of Polish women which are economically inactive due to caregiving duties is among the highest in the EU and follows an upward trend.

Another indicator of goal 5 relating to the priority of implementing gender equality is the difference in earnings between women and men, expressed as the pay gap (Fig. 13). It is calculated as the difference in the gross average hourly rate between men and women, presented as the percentage of the gross average hourly rate of men. The data relates to enterprises with 10 or more employees in accordance with the 2007 Polish Classification of Economic Activity (sections from B to S). In 2010-2019, that indicator varied in the range of 4.9% to 4.8% with significant growth in 2018 (8,8%), which reflects a widening pay gap to the detriment of women.

2.3. Environmental aspect

The environmental aspect is addressed under goal 6 which relates to ensuring access to water and good sanitary conditions to everyone through sustainable management of water resources.

One of the priorities of that goal is to establish legal and financial mechanisms that promote a reasonable use of water resources, to implement water-saving technologies and to build and upgrade sewage treatment plants. Its indicators include the percentage of the population served by treatment plants which follows an upward trend (Figure 8).

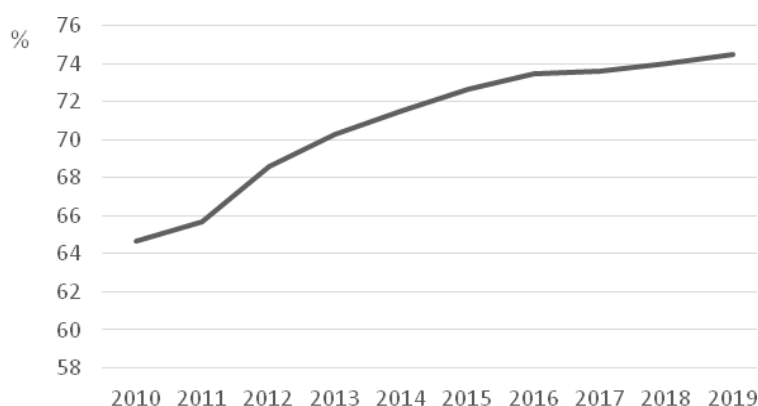


Figure 8. Percentage of the Polish population served by treatment plants in 2010-2019.

Source: (GUS: https://sdg.gov.pl/statistics_nat/6-2-a/).

Another goal related to environmental matters is goal 13 which involves counteracting climate change and its consequences. The key indicator of the first priority under goal 13 is the change in carbon emissions (and, generally, in greenhouse gas emissions) against 2010. In 2020, CO₂ and GHG emissions dropped by ca. 5 and 6 percentage points, respectively. The annual amount of greenhouse gas emissions from the national economy per capita is 11 tons, slightly more than the average EU level of 9 tons which is below that recorded at the beginning of the decade (10 tons). In the context of most member states reducing their

emissions, Poland became the 7th largest emitter of greenhouse gases per capita in the EU, moving from the 11th rank it held in 2010 (GUS: raportsdg.stat.gov.pl/2022/cel13.html).

The reduction in the volume of greenhouse gases released to the atmosphere is driven by a number of measures, including the shift to low-emission energies, especially renewables.

The introduction of innovative technologies for tapping into available sources of energy is the second priority under goal 13. Its indicators include the share of renewable energies in gross final consumption of energy which usually followed an upward trend with 9.3% in 2010 and 16.1% in 2020 (in the EU, it increased from 13% to 18%). As a consequence, with the gradual reduction in the use of fossil fuels, the consumption of one joule of energy results in generating 5% less greenhouse gases than in 2010. In the EU, it declined on average by 8%, and the leaders include Finland, Denmark and Sweden (a drop by 26-23%) which use renewables on a relatively large scale.

Goal 15 is about protecting, restoring and promoting the sustainable use of terrestrial ecosystems; managing forests in a sustainable way; combating desertification; preventing and reversing the soil degradation process; and halting the loss of biodiversity.

In Poland, 10 million ha (i.e. 33% of the national territory) are legally protected areas. A large part of them are covered by the European Ecological Network Natura 2000 (Figure 9) established by the EU as a follow-up to the UN Global Convention on Biological Diversity (referred to as the Rio Convention). The purpose of Natura 2000 is to maintain valuable natural habitats and protect rare or endangered plant and animal species on the EU territory.

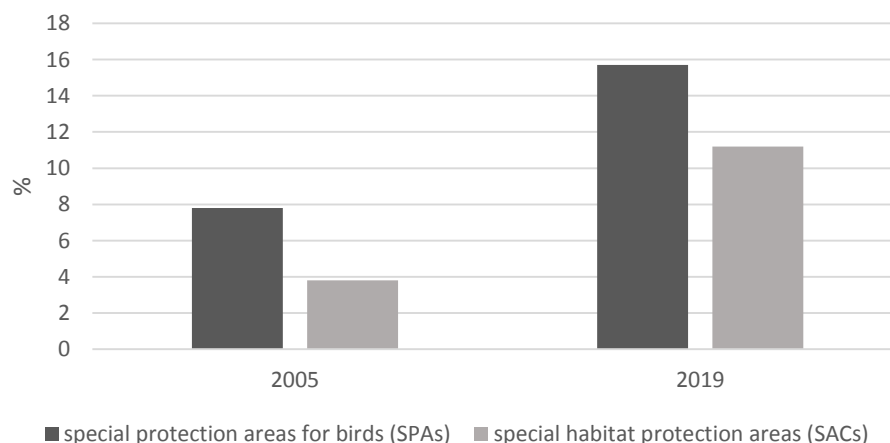


Figure 9. Share of terrestrial Natura 2000 areas in Poland's land area in 2005 and 2019 (%).

Source: (GUS: <https://raportsdg.stat.gov.pl/2020/cel15.html>).

Another indicator of that goal is the share of forestry land in land area. Over the years, an increasingly smaller part of the national territory is subject to afforestation (23,000 ha in 2000 vs. 1000 ha in 2018). This is the consequence of several factors, including the changes to the criteria of eligibility of private agricultural land for afforestation under the 2007-2013 Rural Development Program. Between 2000 and 2018, the share of forestry area in the EU increased from 36.5% to 38.2%. In Poland, that ratio also followed an upward trend over that period, but reached a lower level of ca. 30%.

3. Summary

In view of the set of indicators used in monitoring the pursuit of Sustainable Development Goals, Poland has made considerable progress in reducing poverty over the recent years. There is a clear improvement in the financial situation of households, measured as gross real disposable income per capita. The situation in the labor market also continues to improve. In 2020, despite the pandemic, the average unemployment rate recorded in Poland was 5.9% (compared to 10.4% in 2015). As confirmed by the outcomes of PISA tests, high-quality education can also be observed to follow a positive trend. The percentage of children aged 3-5 enrolled in preschool is on the rise, too. Furthermore, there is growth in Polish agri-food exports per capita, and the general share of agri-food products in Polish exports remains at a similar level of ca. 13% which is highly important from the perspective of ensuring food security.

The pace of economic growth in Poland over the recent years compares favorably with what is witnessed in the European Union as a whole. There is consistent growth in gross domestic expenditure on research and development (R&D), with a year-over-year rate of 18.1% in 2021. Note however that in 2019 the R&D intensity rate reached a relatively low level of 1.44%. The share of renewable energies in gross final consumption of energy grew to more than 12% in 2019; there is increased exploitation of geothermal energy. However, just like most European countries, Poland continues to face challenges related to counteracting climate change. The implementation of SDGs requires adopting an interdisciplinary approach, being open to changes in today's world, raising awareness through education from an early age, promoting attitudes that take environmental and climate challenges into account, encouraging participation in development processes and promoting active citizenship.

Although Poland keeps improving its performance with respect to environmental aspects of sustainable development, the above analysis proves these changes are not dynamic enough. It also needs to be emphasized that the quality of atmospheric air—an issue of vital importance to all citizens—has not improved despite an increased use of renewables. Furthermore, even though the indicators related to terrestrial life follow a positive trend, the changes are too slow.

There seems to be satisfactory progress in implementing Agenda 2030 arrangements in Poland. However, the indicators used in monitoring the social and economic aspects show that changes in these two areas are more beneficial than those taking place in the environmental dimension.

The outcomes of the above analyses also highlighted some methodological gaps in the national sustainable development concept, because the set of national indicators does not address waste management and does not include detailed indexes for water pollution and protection of water resources (Hadryjańska, Wysokińska-Senkus, Stańczyk 2021).

The pursuit of the initial assumptions behind the Agenda 2030 and its 17 Sustainable Development Goals faces new challenges related to the outbreak of the COVID-19 pandemic in early 2020 (with its adverse consequences to many economies and societies) and to the war in Ukraine in 2022. The crises show that a flexible approach needs to be adopted to implementing the sustainable development goals whose basic assumptions must, however, remain a stable foundation.

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ATTITUDES OF POLISH CONSUMERS TOWARD SUSTAINABLE LOGISTICS – PILOT STUDIES

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Purpose: The main objective of this article is to identify and analyze the attitudes of Polish consumers toward practices related to sustainable logistics.

Design/methodology/approach: The results will be based on empirical research concerning attitudes toward practices related to sustainable logistics in a research sample of 130 consumers. The research was conducted in November 2023 and covered the entire area of Poland.

Findings: The vast majority of respondents are positive when assessing their ecological attitude. Therefore, they have specific preferences in the field of urban transportation. Most often they use electric bicycles or scooters. In addition, they prefer goods to be delivered to parcel machines. They appreciate when shipments are combined into one delivery or the switching of paper transport documents into electronic ones. Priority solutions in sustainable logistics include, in the opinions of consumers, organizing intelligent and ecological warehouses and modernizing the transport fleet. In addition, almost half of the respondents assessed that they are aware of greenwashing in the logistics industry and in their opinion the phenomenon is mainly manifested by the abuse of not insignificant formations in the field of sustainable development.

Research limitations/implications: Among the limitations of the research are the small sample size of the empirical study, as well as the limited nature of the survey questionnaire.

Practical implications: This research has provided a lot of practical information that can be used in the business environment. Firstly, companies knowing consumer preferences can better adjust their marketing strategies to meet expectations, as well as develop more attractive product offerings. In addition, the research points to the need for public campaigns to educate consumers about sustainable logistics, as well as greenwashing.

Social implications: This research can be a systemic shift toward more environmentally and socially responsible practices in both the private and public sectors. By influencing public attitudes, corporate behavior, policy development, and quality of life, it can contribute to building a more sustainable and resilient society for future generations.

Originality/value: Up-to-date knowledge of consumer attitudes toward sustainable logistics activities is particularly important for both the business and government communities.

Keywords: sustainability, consumer attitudes, greenwashing.

Category of paper: Research paper.

1. Introduction

Sustainable development is a concept involving a harmonious balance between social, economic development and environmental protection. It involves ensuring that current and future generations can fulfill their needs and aspirations without destroying the environment or limiting the ability of future generations to use it. It should be noted that the realization of the goals of sustainable development requires the cooperation of all market participants, including government agencies, the private sector, NGOs, civil society and scientific research institutions. It is worth noting that the concept of sustainable development has special relevance to logistics, which plays a key role in ensuring sustainable development on many levels. Sustainable logistics aims to reduce the carbon footprint, waste and pollution at all stages of the supply chain from production, storage, transportation to the distribution of products to final customers (Jayarathna, Agdas, Dawes, 2023).

Sustainable logistics is a topic that is frequently discussed in contemporary literature on the subject (e.g., Ren et al., 2020; Zowada, 2020). Also, consumer attitudes toward various new technologies, products or practices of companies in the market are an important and repeatedly addressed topic in scientific research (e.g., Gârdan et al., 2023; Reddy et al., 2023). However, there is a lack of research related to Polish consumers' overall perception of sustainable logistics. Previous work has been related to Poles' attitudes toward environmental issues (e.g., Wachowiak, 2022; SW Research, 2023) and their awareness of these issues (e.g. Moroz et al., 2021; Stefaniuk, 2021). Much research has also been devoted to topics related to urban sustainability and consumer attitudes toward selected forms of low-carbon urban transportation. Special attention has been paid to e-bicycles, e-scooters and electric cars (e.g. Fyhri, Sundfør, 2020; Tupe, Kishore, Johnvieira, 2020; Sendek-Matysiak, 2020; Wu, Liao, Wang, 2020; Kopplin, Brand, Reichenberger, 2021; Popova, Zagulova, 2022). There is also a great deal of interest in studies related to consumer attitudes toward environmentally friendly delivery of the products they purchase (e.g. Ingat, Chankov, 2020; Caspersen, Navrud, 2021; Mobile Institute, 2021) and the most frequently chosen form of delivery (Lemantowicz, Sitarska, 2022; Geminus, 2022). In connection with the rapid development of technologies enabling more environmentally friendly packaging of goods, answers are being sought to questions related to consumer attitudes toward different types of packaging (Nguyen et al., 2020; Mobile Institute, 2021). No less attention has also been paid to the phenomenon of greenwashing, where the main focus has been on discussing the phenomenon and ways to reduce it (e.g. de Freitas Netto et al., 2020; Pimonenko et al., 2020).

In view of the above, the topic of Polish consumers' attitudes toward sustainable logistics is important, topical and involves both academic researchers from various fields of science and practitioners.

The main objective of this paper is to analyze the attitudes of Polish consumers toward sustainable logistics. The specific objectives are to learn about Polish consumers' preferences toward various forms of sustainable urban transportation and environmentally friendly forms of delivery, to identify the most important pro-environmental activities of companies related to the shipment of goods, as well as the priority sustainable logistics solutions in the opinion of the respondents. In addition, an important goal of the survey is also to learn about respondents' awareness of green goods delivery and greenwashing.

2. Research methodology

The main objective of the study was to determine the attitudes of Polish consumers toward sustainable logistics. The method used in the research process was a diagnostic survey using a questionnaire technique. The survey used the technique of CAWI (Computer Assisted Web Interview) – a computer-assisted interview through survio.pl. For the purposes of the pilot study, a survey questionnaire was developed, consisting of a main part containing eight questions and a metric to characterize respondents (Table 1).

Table 1.
Characteristics of the research sample

Variable	Characteristics
Gender	Women – 62.3%, men – 36.2%, non-binary – 1.5%
Age	18-24 years – 31.5%, 25-34 years – 20.8%, 35-44 years – 25.4%, 45-54 years – 15.4 %, 60-64 years – 3.8%, >65 years – 3.1%
Residence	City – 63.8%, rural – 36.2%
Education	Higher – 59.2%, secondary – 36.2%, vocational – 4.6%
Assessment of income situation	Very good – 16.9%, good – 45.4%, average – 33.8%, bad – 2.3%, very bad – 1.5%

Source: Own elaboration.

3. Results and discussion

Respondents were asked to rate their own environmental attitude (Figure 1). The vast majority declared that they rated it rather well (66.2%), almost one-fifth rated it definitely well and only 6.2% rated it rather badly or definitely badly. This is also confirmed by a study conducted by SW Research (2023) on Poles' attitudes toward ecological issues, according to which the percentage of eco enthusiasts is growing year by year, indicating that ecology is

becoming increasingly important in the public discourse. Also, a survey of students at Podlasie Universities found that despite not having extensive environmental knowledge, they are characterized by high environmental awareness (Moroz et al., 2021). Moreover, environmental protection is increasingly perceived by consumers as one of the most important problems facing Poland (Stefaniuk, 2021).

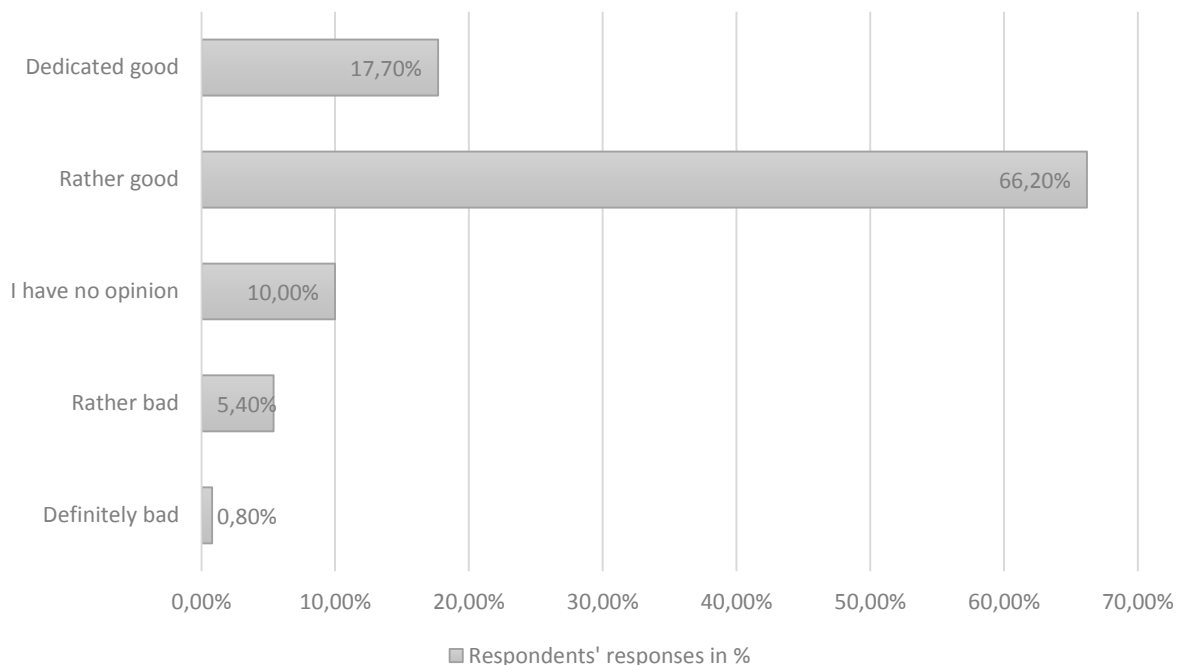


Figure 1. Respondents' assessment of their own environmental attitudes.

Source: Own elaboration based on the conducted surveys.

A special role in the pursuit of sustainable development has been attributed to cities for years (Popova, Zagulova, 2022), so one of the important manifestations of consumers' green attitudes is their decisions related to the form of urban transportation.

In this study, respondents were asked to indicate their preferences in this regard (Table 2). It was revealed that more than one-quarter of the respondents opt for their own electric bicycle or other means of transportation other than those indicated in the survey. Public electric bicycles are used by 21.5%. Sharing a private car with others going in the same direction is preferred by 19.2%. Nearly 18% of respondents choose a publicly available electric scooter to travel around the city, while just over 13% use their own. Their own electric car is used by 14.6% of respondents, and their own electric scooter by 8.5%. The lowest percentage of respondents use an electric car for minutes (3.8%). The above results are reflected in the opinions of students at the Warsaw University of Life Sciences, who, among the ways to sustainably manage household resources, mentioned changing modes of transportation to greener ones (Wachowiak, 2022). Also, research by Fyhri and Sundfør (2020) confirms that electric bicycles are becoming an increasingly important part of the urban transportation system and can be an important contribution to reducing the negative environmental impact of urban

transportation. In turn, the high popularity of electric scooters among consumers is confirmed by studies conducted by Kopplin, Brand and Reichenberger (2021) or Popova and Zagulova (2022). It is worth noting, however, that Germans, for example, perceive electric scooters as a source of entertainment rather than a meaningful way to get around town and are seen as less safe than other modes of transportation (Kopplin, Brand, Reichenberger, 2021). As evidenced by studies by Tupe, Kishore, Johnvieira (2020), Wu, Liao and Wang (2020) and Sendek-Matysiak (2020), among others, an important obstacle influencing the less frequent choice of electric cars for urban travel is the country's poor infrastructure and the price of these vehicles, which may confirm the low consumer interest in this mode of urban travel in this study.

Table 2.

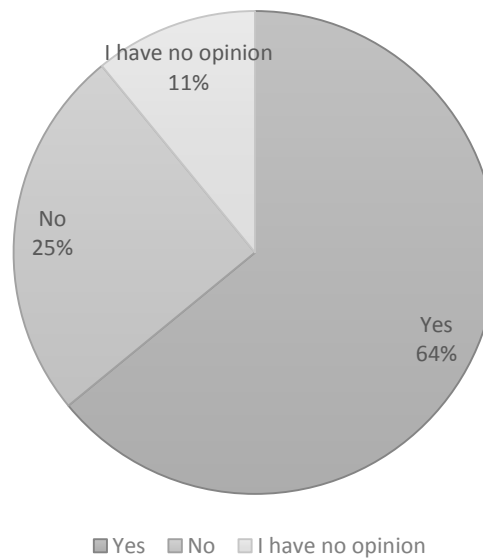
Preferences for green forms of urban transportation

Forms of urban transportation	Responses	Share %
Electric car for minutes (carsharing)	5	3.8%
Own electric car	19	14.6%
Sharing a private car with others going in the same direction (carpooling)	25	19.2%
Publicly available electric scooter	23	17.7%
All-access electric bicycle	28	21.5%
Own electric scooter	18	13.8%
Own electric bicycle	34	26.2%
Own electric motor scooter	11	8.5%
Other forms of urban transportation	34	26.2%

Source: Own elaboration based on the conducted surveys.

Figure 2 shows the respondents' environmental awareness in the context of product delivery. To the question "do you pay attention to the pro-environmental aspects of the delivery of the products you buy?" as many as 64% said "yes". Only 25% said they do not take this aspect into account when shopping, and 11% have no opinion. These results are in line with a number of surveys conducted in various countries, where consumers also declare their pro-environmental attitude toward delivery (e.g. Inyat, Chankov, 2020; Caspersen, Navrud, 2021). It is worth noting that consumers declare the possibility of waiting longer for a shipment when the supplier sends all purchased products in one package in order to reduce the carbon footprint (Mobile Institute, 2021).

Respondents' responses in %

**Figure 2.** Environmental awareness in the context of product delivery.

Source: Own compilation based on the conducted surveys.

Respondents consider parcel machine delivery to be the most eco-friendly form of delivery (63.8% of responses). It is worth noting that parcel machine delivery is the most frequently chosen form of delivery among Poles (Lemantowicz, Sitarska, 2022; Geminus, 2022). Nearly one-quarter perceive personal pick-up at a store branch and delivery by a courier using an electric or hybrid car (23.1%) as the most environmentally friendly deliveries. Many respondents also pointed to the delivery of products by a courier using an electric bicycle (18.5%) or delivery to pick-up points (13.8%). The least environmentally friendly, in the opinion of consumers, are deliveries by a courier directly to home or work (8.5%) and traditional deliveries by the post office (0.8%). Detailed results are presented in Table 3.

Table 3.

Respondents' opinions on environmentally friendly forms of delivery

Forms of delivery	Responses	Share %
Delivery to parcel machines	83	63.8%
Delivery by courier to pick-up points (e.g., Żabka, Polish Post Office, gas station)	18	13.8%
Delivery by courier directly to home/work	11	8.5%
Traditional delivery by post office	1	0.8%
Personal pick-up at a branch of the store	31	23.8%
Delivery by courier using an electric bicycle	24	18.5%
Delivery by courier using an electric or hybrid car	30	23.1%
Other	2	1.5%

Source: Own elaboration based on the conducted surveys.

Companies take many measures to reduce their negative impact on the environment. Respondents were asked to rate the importance of selected pro-environmental aspects of companies' supplies and activities (see evaluation in Table 4). It can be seen that respondents gave the highest ratings to activities related to combining shipments in a single delivery

(on a scale of 1 to 5 ,where 1 means - not important in general, and 5 - very important, 87.7% of respondents assigned a rating of 4 or 5) and to replacing paper shipping documents with electronic ones, as well as to appropriately sized packaging for the product (83.8% of responses each). Reducing the use of plastic in product packaging (e.g., using paper tape) was equally highly rated, with as many as 83.1% indicating this. Among other pro-environmental activities of companies related to the delivery of goods, 76.1% of respondents highly rated the delivery of parcels to parcel machines or other pick-up points. Eco-friendly packaging (76.2%) and eco-friendly fillers (73.1%) also proved to be very important. The possibility of returning reusable packaging is appreciated by 68.4% of respondents, while delivering goods by electric or hybrid car is appreciated by only 43.8% of respondents. These activities are at the same time the least appreciated, with about 10% of people in both cases indicating they are the least important.

Research by other authors also confirms that consumers are attaching increasing importance to the type of packaging of the products they buy. They require, above all, that it be eco-friendly and recyclable packaging (e.g. Nguyen et al., 2020; Mobile Institute, 2021).

Table 4.

Assessment of the importance of selected environmentally friendly aspects of companies' supplies and operations (scale from 1 to 5, where 1 means - not important in general, and 5 - very important)

Pro-environmental aspects of company supplies and operations	1	2	3	4	5
Eco-friendly packaging	2 (1.5%)	4 (3.1%)	25 (19.2%)	33 (25.4%)	66 (50.8%)
Eco-friendly fillers	4 (3.1%)	6 (4.6%)	25 (19.2%)	29 (22.3%)	66 (50.8%)
Properly sized packaging for the product	1 (0.8%)	4 (3.1%)	16 (12.3%)	28 (21.5%)	81 (62.3%)
Limiting the use of plastic in packaging (e.g., paper tape)	2 (1.5%)	4 (3.1%)	16 (12.3%)	27 (20.8%)	81 (62.3%)
Ability to return reusable packaging (e.g., using a parcel machine)	11 (8.5%)	9 (6.9%)	21 (16.2%)	22 (16.9%)	67 (51.5%)
Delivery of goods by electric or hybrid car	19 (14.6%)	14 (10.8%)	40 (30.8%)	25 (19.2%)	32 (24.6%)
Delivering shipments to parcel machines or other pick-up points	5 (3.8%)	5 (3.8%)	21 (16.2%)	38 (29.2%)	61 (46.9%)
Combining shipments in a single delivery	3 (2.3%)	2 (1.5%)	11 (8.5%)	26 (20.0%)	88 (67.7%)
Converting paper shipping documents into electronic ones	4 (3.1%)	4 (3.1%)	13 (10.0%)	22 (16.9%)	87 (66.9%)

Source: Own elaboration based on the conducted surveys.

Taking into account environmental legislation, current trends and consumer expectations, companies in the logistics industry are taking many measures to reduce their harmful impact on the environment (e.g. Zowada, 2020; Kołodziejczak, Kowalska, Misztal, 2022). In the conducted surveys, respondents were asked to identify future logistics solutions that they believe are a priority to implement. As can be seen in Table 5, the highest percentage of respondents believe that the organization of smart and green warehouses, equipped, for example, with photovoltaic panels, smart lighting, rainwater recovery or recycling, is by far

the most important measure in the current times. Also highly rated were upgrading the transportation fleet to a more environmentally friendly one (44.6%), optimization of the routes traveled, and a packaging recirculation system for e-stores (37.7% each). Slightly more than 32.3% of respondents identified the creation of central warehouses for logistical handling of re-commerce platforms as a pro-environmental measure of priority. About 20% of respondents believe that companies should focus on the introduction of eco-friendly parcel vending machines or the use of shared micro-hubs in city centers that allow delivery and courier companies to make the last leg of deliveries using bicycles. Measures related to the introduction of autonomous cars appeared to be the least important (10.8%).

Table 5.

Priorities for the introduction of forward-looking green logistics solutions according to respondents

Examples of solutions	Responses	Share %
Use of shared micro-hubs for city centers that allow delivery and courier companies to make the last leg of deliveries using bicycles	28	21.5%
Creating central warehouses for logistical handling of re-commerce platforms (selling used products after they have been inspected, refreshed, repaired, labeled, etc.).	42	32.3%
Smart and eco-friendly warehouses, equipped with, for example, photovoltaic panels, smart lighting, rainwater recovery, recycling, etc.	67	51.5%
Upgrading the transportation fleet to a more environmentally friendly one	58	44.6%
Optimization of routes traveled (choosing the fastest and best route to the destination)	49	37.7%
Introducing eco-friendly parcel vending machines (e.g., One Box, powered by electricity)	31	23.8%
Re-circulating packaging system for e-stores (reusable packaging, return of cardboard boxes via parcel machines)	49	37.7%
Autonomous city buses	27	20.8%
Autonomous cars	14	10.8%
Other	4	3.1%

Source: Own elaboration based on the conducted research.

With the significant increase in social and economic interest in sustainability and environmental protection, the phenomenon of greenwashing, a marketing practice in which organizations mislead consumers about the real impact of their actions on the environment, has also increased (de Freitas Netto et al., 2020; Pimonenko et al., 2020). Many market participants, suspicious of pro-environmental promises, are becoming increasingly aware of a reliable assessment of companies' actions in the context of sustainability. The survey was conducted to find out the awareness of greenwashing in the logistics industry and the most common symptoms of this practice according to respondents. It was shown that almost half of the respondents are aware of greenwashing (49.2%), as many as 36.9% do not know, and 13.8% are not aware (Figure 3).

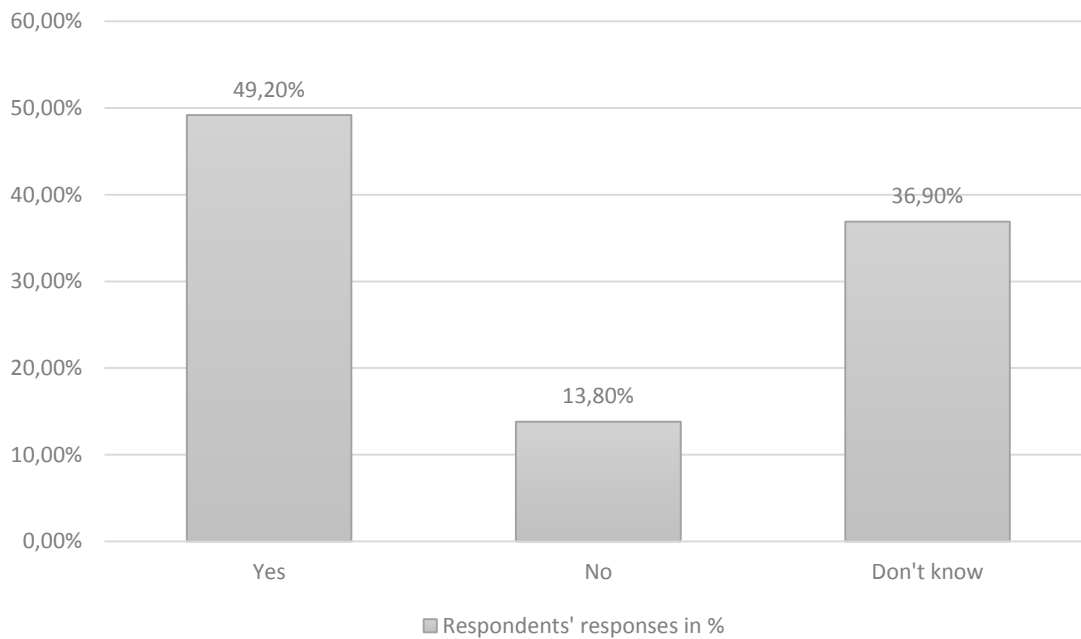


Figure 3. Awareness of greenwashing in the logistics industry.

Source: Own compilation based on the conducted surveys.

As can be seen in Table 6, the largest number of respondents, that is, 46.9%, indicated that the most common practice of this phenomenon is the misuse of meaningless phrases (e.g., “eco-friendly,” “sustainable supply”), without explaining what the environmentally friendly nature of the service consists of. About one-third of respondents pointed to promoting a business as green without certifying this fact, such as with an appropriate certificate, as a symptom of greenwashing. In turn, about one-quarter of respondents pointed to providing selective data to certify green operations, omitting inconvenient data from information about the company. Slightly more than 20% believe that the use of overly exaggerated, suggestive advertisements for services implying green values are the most common actions associated with the green lying phenomenon in question. About 16% of respondents also considered that the use of scientific jargon, incomprehensible to the average consumer, and the exaggeration of the scope of the company’s green solutions can be considered a greenwashing phenomenon in these organizations. It is worth noting that 17.7% do not notice this phenomenon in the activities of companies in the logistics industry.

Table 6.

Symptoms of greenwashing in the activities of the logistics industry in the opinion of respondents

Activities	Responses	Share %
I do not notice that the phenomenon occurs in the activities of companies in the logistics industry	23	17.7%
Misuse of meaningless phrases (e.g., “eco-friendly”, “sustainable supply” without explaining what the environmental friendliness of the service consists of)	61	46.9%
Promoting a business as eco-friendly without any proof of the eco-friendliness of its services in the form of certificates	46	35.4%
Omitting inconvenient information from details about the company	32	24.6%

Cont. table 6.

Using scientific jargon that is incomprehensible to the ordinary consumer	21	16.2%
Using overly exaggerated, suggestive advertisements for services that suggest green values	30	23.1%
Exaggerating the scope of a company's green solutions (publicizing individual green solutions)	22	16.9%
Providing selective data to certify environmental performance	34	26.2%
Other actions	5	3.8%

Source: own elaboration based on the conducted surveys.

4. Summary

The main objective of this study was to analyze Polish consumers attitudes toward sustainable logistics. The specific objectives were to learn Polish consumers' preferences toward various forms of sustainable urban transportation and environmentally friendly forms of delivery, to identify the most important pro-environmental activities of companies related to the shipment of goods, as well as the priority solutions for sustainable logistics in the opinion of the respondents. In addition, an important goal of the study was also to find out respondents' awareness of green goods delivery and greenwashing.

It was shown that respondents overwhelmingly rated their green attitude well. The most frequently chosen sustainable means of transportation around the city is the electric bicycle or electric scooter. Respondents were characterized by high environmental awareness in the context of product delivery. According to them, the greenest form of delivery is parcel machine delivery. They also attributed high pro-ecologic importance to companies' activities related to combining shipments in a single delivery, replacing paper shipping documents with electronic ones, and properly sized packaging for the product. Among the priority solutions for sustainable logistics, the organization of smart and green warehouses and the modernization of the transport fleet were singled out above all. It is worth noting that almost half of the respondents assessed that they were aware of greenwashing in the logistics industry, and in their opinion the phenomenon manifests itself mainly in the misuse of meaningless sustainability phrases.

This research provided a lot of practical information that can be used in the business environment. Firstly, by knowing consumers' preferences, companies can better adapt their marketing strategies to expectations, as well as developing more attractive product offerings. In addition, the research points to the need for social campaigns to educate consumers about sustainable logistics, as well as greenwashing.

Further research should focus on consumer characteristics that consider their socioeconomic profile, which will enable the development of more tailored marketing strategies to promote sustainable practices. In addition, it is worth looking for ways to engage consumers in companies' pro-environmental activities by exploring their opinions on a variety of presumption-related activities. Among the limitations of the research are the small sample size of the empirical study, as well as the limited nature of the survey questionnaire.

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SUSTAINABLE USE OF METHANE GLOBALLY. SELECTED SOCIAL AND ENVIRONMENTAL ASPECTS

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Human history is becoming more and more a race
between education and disaster¹.

H.G. Wells

Purpose: in the cognitive space, the article focuses on the issue of sustainable methane emissions, which can be seen as an approach aimed at controlling and reducing methane emissions into the atmosphere in a way that takes into account the balance between the emission and removal of this gas, in order to reduce its impact on climate change.

Methodology: the theses presented in the article were verified using the following methods: literature review, critical analysis of literature, analysis and comparison of documents and an example of good practices.

Result: in recent years, issues related to sustainable development and environmental protection have become central topics in the international arena. One of the key elements of this debate is the role of methane as a greenhouse gas and the question of whether its use can contribute to sustainable development or pose a potential threat to the environment.

Originality: the key task is to develop a strategy that will allow for the effective use of methane while minimizing negative effects on the environment. Innovative technologies, stringent regulations and international cooperation are the key to achieving this goal and turning the use of methane into an opportunity for sustainable global development.

Keywords: environment, methane, society, sustainable development.

¹ See: Wells, H.G. (1983). *World History*. Wrocław: Ossolineum National Library, Series II.

1. Introduction

As environmental concerns and the need to reduce greenhouse gas emissions become more pressing issues, methane, which is one of the most powerful of these gases, is becoming a subject of increasing concern. According to experts' estimates, the Environmental Protection Agency - the US federal agency working to protect human health and the natural environment EPA (Environmental Protection Agency) - China, the United States, Russia, India, Brazil, Indonesia, Nigeria and Mexico are responsible for almost half of all anthropogenic methane emissions. The main sources of methane emissions in these countries are very diverse. For example, a key source of methane emissions in China is coal production, while Russia emits most of its methane from its natural gas and oil systems. The largest sources of methane emissions from human activities in the United States are oil and gas systems, enteric fermentation of livestock, and landfills (<https://www.epa.gov/gmi>). Methane, which is both a by-product of natural processes and human waste, can also be a source of valuable renewable energy resources (Azar, García, Johansson, Sterner, 2023). In this light, the important question becomes how to use methane in a sustainable manner on a global scale to the benefit of society and the environment?

2. Definition and properties of methane

The history of the discovery of methane is associated with many researchers and discoverers who gradually learned about its existence and properties. As evidenced by numerous sources, one of the first to encounter methane was Antoine Lavoisier, known as the father of modern chemistry². In 1783, Lavoisier noticed that the gas released by the decomposition of organic plant and animal materials was unusual and, in fact, different from other gases such as oxygen or hydrogen. This gas was called "flammable gas", but at the time of Lavoisier's work its exact composition was not understood. However, in the history of discoveries, the first person to successfully identify methane as the main component of "flammable gas" was Alessandro Volta, an Italian physicist and chemist - this took place in 1778. Then Alessandro Volta conducted thorough experiments that became the source of determining the chemical

² Antoine Lavoisier, in full version Antoine-Laurent Lavoisier (born August 26, 1743 in Paris, France - died May 8, 1794 in Paris), distinguished French chemist and leading figure of the 18th-century chemical revolution, who developed an experimentally based theory of chemical reactivity oxygen and co-author of a modern system for naming chemical substances. He also served as a leading financier and public administrator before the French Revolution, and was executed along with other financiers during the Terror. See: <https://www.britannica.com/biography/Antoine-Lavoisier>, October 25, 2023.

composition of this gas as a compound of carbon and hydrogen, i.e., methane³. Over the following years, researchers continued to study the properties and uses of methane, which led to an understanding of its role as an important fuel and chemical feedstock.

Semantically, the term "methane" comes from the Greek word *methano*, which means behind or beyond and rot or putrefaction (Favre, Powell, 2013). The name refers to the way methane is often created in nature, through the processes of bacterial decomposition of organic matter under anaerobic conditions, such as swamps, lakes and other areas with limited access to oxygen. In fact, methane is a by-product of the metabolism of anaerobic bacteria that break down organic substances such as plant residues, carbon, and organic material present in swamps and swamps. This process is a natural source of methane in nature. Water accompanied by methane in the process of decomposition of organic matter, is known as "mud water", and this process is called "mud fermentation." Methane is an organic chemical compound with the formula CH₄, consisting of one carbon atom and four hydrogen atoms. It is one of the most important and simplest alkane hydrocarbons. As a gas, methane is not only one of the main components of natural gas, but is also important in both scientific and practical contexts (Hassa et al., 2004).

The history of the discovery of methane and the origin of the term "methane" illustrate the evolution of our knowledge of this important chemical compound. Methane, although simple in structure, has a significant impact on our everyday lives as an energy source and chemical raw material. Moreover, its role in ecological cycles highlights the importance of understanding and monitoring methane emissions in the context of climate change and the natural environment (Nosalewicz, Brzezińska, Pasztelan, Supryn, 2011, pp. 355-373). Methane has many practical applications in various fields. Some of the most important uses are methane as a fuel that can be used to produce heat and electricity in thermal and cogeneration plants. It is also used as a fuel for natural gas vehicles. In the chemical industry, methane is used as a raw material for the production of many chemical products, such as ammonia, methanol, and many other organic compounds. Methane is used in transport as a fuel in vehicles, especially in buses and trucks, in the form of compressed gas (CNG) or liquefied gas (LNG). Equally often, methane - which is present in crude oil and natural gas deposits - can be used as a raw material or fuel in the oil industry.

³ Born into a noble family but in rather difficult financial circumstances, on February 18, 1745 in Como, Italy, Alessandro Volta would come to electrify the world with his intellect and achievements. His father would die in debt, leaving the family in poverty - which later led Volta to conclude: "I was actually poorer than poor". His intellectual abilities were initially suspect, and he was mute until the age of four, when he vigorously said "NO" to express his dissenting opinion on a planned family activity. His household quickly realized that they had a real intellectual gem among them. From this most inauspicious origin, Volta was already considered "one of the greatest leaders" during his lifetime. thinks not only in electricity, but in all branches of physics. From: Willis Hurst J., Bruce Fye, W., Volta, A. (2002). Atlanta, Georgia, USA: Emory University School of Medicine.

To sum up, methane is an important chemical compound that can be described in both theoretical and practical terms. As a simple hydrocarbon, it is of key importance in many areas, including - as has already been noted - as an energy source, a raw material in the chemical industry and as a fuel for vehicles. However, due to its properties as a greenhouse gas, its role in climate change and global warming is also important, which requires attention and actions to ensure its sustainable use in a social and environmental context - as a result, reducing its emissions into the atmosphere (Shivanna, 2022, pp. 160-171).

3. Methane and its sustainable use

In the space described above, sustainable methane emissions can be viewed as an approach that aims to control and reduce methane emissions into the atmosphere in a way that takes into account the balance between emission and removal of this gas, with the aim of reducing its impact on climate change (Mar, Unger, Walderdorff, Butler, Beyond, 2022, pp. 127-136). Methane (CH₄) is a powerful greenhouse gas that has a much greater capacity to absorb heat than carbon dioxide (CO₂), although it is present in the atmosphere in smaller quantities. So, a clear and explicit focus on sustainable methane emissions is very important, because methane, as already noted, has a major impact on global warming. Sustainable methane emissions include several key elements such as:

- monitoring and controlling methane emissions,
- methane removal and recovery,
- investments in renewable energy sources,
- education and social awareness,
- increasing economic efficiency and balance,
- protection of the environment and human health,
- resilience to climate change.

Achieving efficient and sustainable methane emissions based on the above actions will play an increasingly important role in global efforts to combat climate change. This requires international cooperation, investment in technologies and practices that reduce methane emissions, and the involvement of both the public and private economic sectors. This seems to be a key element of the transformation towards a more sustainable and fair economy that takes into account the protection of the environment and the lives of future generations.

In this perspective, it is worth noting that the sustainable use of methane is of great importance from an economic, social and environmental point of view. As noted by researchers dealing with the economic costs of methane emissions, traditionally climate change mitigation has focused mainly on reducing CO₂ emissions, because this gas is a key factor responsible for past and expected future global warming (Masson-Delmotte, 2021). However, some studies

indicate that rapid and sustained reductions in anthropogenic methane emissions are both cost-effective and necessary to limit global warming to 1.5 to 2°C above pre-industrial levels (Program Narodów Zjednoczonych...). Taking into account this undeniable fact, it should be emphasized that in social space, the emission and use of methane affect people's lives and the condition of ecosystems. Methane recovery and its use as an energy source can bring benefits to local communities. In areas where natural gas or coal mining occurs, controlling methane emissions is crucial to the safety of residents, both in terms of health and explosion risk. Methane recovery reduces these threats and can improve the quality of life in these regions. In the environmental context, controlling methane emissions is crucial to preventing climate change and preserving biodiversity. Methane emissions from mines, power plants and industrial installations affect air, soil and water quality. Reducing these emissions impacts ecosystem health, biodiversity and the quality of life of people, especially those living near these emission sources.

We cannot ignore the fact that the sustainable use of methane, especially in the production of renewable energy, contributes to the reduction of its emissions into the atmosphere, which is of key importance in the fight against climate change. Methane can be used to produce biogas, which is a valuable and ecological source of renewable energy. This in turn reduces dependence on fossil fuels and contributes to a more sustainable energy system. The sustainable use of methane creates new business opportunities, creating jobs and generating income from the production and sale of biogas. This contributes to the development of local communities and economies. Finally, the use of methane as a renewable energy source increases energy independence and security of energy supply, which is important in the context of changing conditions on the fossil fuel market (Sobczak, Chomać-Pierzecka, Kokiel, Różycka, Stasiak, Soboń, 2022). An example to confirm the above thesis is the war in Ukraine, as a result of which gas prices on the stock exchange increased to over EUR 100 per megawatt hour (Wpływ wojny na Ukrainie..., 2023).

In conclusion, designing and implementing sustainable methane actions can improve public acceptance of these initiatives. The sustainable use of methane is a key aspect of combating climate change, ensuring sustainable development, creating jobs and improving the quality of life, which makes - as already noted - an important issue from an economic, social and environmental perspective. As estimated by Høglund-Isaksson, global emissions could reach 414 Mt of methane in 2030. The technical mitigation potential is estimated at 195 Mt of methane in 2030, of which approximately 80% can be achieved at a marginal cost of less than 20euro t⁻¹ CO₂ equivalent using a social planner's cost perspective. From a private investor's cost perspective, the relevant fraction is only 30 percent. In this light, methane emission and use constitute both an opportunity and a threat to social development (Høglund-Isaksson, 2012). The key in this area is appropriate management and regulations that allow for the control of methane emissions while using it as an energy source. In the context of sustainable economic development, there is the potential to turn this challenge into an opportunity, improving people's

quality of life and protecting the natural environment (Pathway to a Cleaner Energy Future, 2021).

4. Methane and its sustainable use on a global scale

The issue of the use of methane in the global policies of the world's largest economies is extremely important in the perspective of climate change and the promotion of sustainable development. Methane (CH₄) is a powerful greenhouse gas that has much greater potential to trap heat in the atmosphere than carbon dioxide (CO₂). Therefore, focusing on reducing methane emissions is crucial to achieving greenhouse gas reduction goals. One of the key determinants of the indicated concentration is greenhouse gas emissions resulting mainly from the combustion of fossil fuels (coal, oil and natural gas) for automotive and industrial purposes, which causes carbon dioxide emissions during their extraction and consumption. The amount of CO₂ in the atmosphere before the industrial revolution was approximately 280 ppm, and has now increased to 412 ppm (as of 2019). An increase in atmospheric temperature also causes an increase in ocean temperature. Oceans play an important role in the global carbon cycle and remove approximately 25% of carbon dioxide emitted by human activities. In addition, some CO₂ dissolves in ocean water, releasing carbonic acid, which increases the acidity of seawater. Rising ocean temperatures and acidification not only reduce their capacity to act as carbon sinks, but also impact ecosystems (Global Methane Tracker, 2022). In this perspective - as emphasized in the introduction to the expert opinion - the world's largest economies, such as the United States, China, the European Union, India and others, play a significant role in the global use of methane (Table 1).

Table 1.

Methane emissions from coal mines by largest emissions and countries. Status at the end of 2023 and proposal for the future level of methane emissions.

Country	Operating Mines Methane (CH ₄)			Proposed Projects Methane (CH ₄)		
	Annual CH ₄ Emissions (MCM)	Annual CH ₄ Emissions (Mt CO ₂ e 20 years)	Annual CH ₄ Emissions (Mt CO ₂ e 100 years)	Annual CH ₄ Emissions (MCM)	Annual CH ₄ Emissions (Mt CO ₂ e 20 years)	Annual CH ₄ Emissions (Mt CO ₂ 100 years)
Australia	3,443	190	69	1,270	70	25
China	70,050	3,872	1,399	12,420	687	248
Czech Republic	105	6	2	5	0	0
Germany	352	19	7	0	0	0
India	1,528	84	31	1,320	73	26
Indonesia	1,306	72	26	85	5	2
Kazakhstan	587	32	12	45	2	1
Mongolia	162	9	3	64	4	1
North Korea	441	24	9	0	0	0

Cont. table 1.

Poland	1,213	67	24	60	3	1
Russia	3,788	209	76	1,397	77	28
South Africa	1,648	93	34	556	31	11
Thailand	119	7	2	0	0	0
Turkey	158	9	3	52	3	1
United States	4,286	237	86	56	3	1
Vietnam	409	23	8	0	0	0

Units of measurement: million cubic meters (MCM), million tonnes (Mt), CO₂ equivalent (CO₂e).

Source: Global Coal Mine Tracker.

An analysis of the role of each of these economies in the context of sustainable use of methane indicates the following regularities. The United States is one of the largest producers and consumers of energy in the world. Therefore, their role in reducing methane emissions is important. Recent years have seen increasing commitment by the federal government and many states to reduce methane emissions from the oil and gas industry, as well as the transportation sector. In this light, it is necessary to further increase efforts to regulate, monitor and modernize infrastructure to reduce methane leaks and its sustainable use. An example of such activities is the plan to reduce methane emissions through remediation in the space of closed coal mines, which are a significant source of methane emissions, the volume of which is estimated at 5.9 MMT CO₂ on an annual basis. In this plan, President Biden proposed an aggressive program to remediate disused coal mines as a key part of his Build Back Better program (The Build Back Better Framework, 2021). The program was financed by the US Congress in the amount of \$11.3 billion under the Infrastructure Investment and Jobs Act, of which a significant item was the Mine Land Abandoned (AML) grant, which allowed for the remediation of most of the currently known AML landfills in the area. USA, creating jobs and helping to reduce methane emissions from underclaimed, abandoned mines - stimulating economic development (<https://www.epa.gov/superfund...>, 2023). In turn, China is the world's largest producer and consumer of hydrocarbons, which makes it a key player in methane emissions. There is a need in this country to increase control over methane emissions, both in the energy sector and in agriculture. China is making efforts to modernize its industry by promoting low-emission technologies, such as technologies that reduce methane leaks in oil and gas extraction and production processes. As noted by the authors of the research published in the article entitled "Changes in methane emissions observed in China linked to factors influencing policy" increased control determines active reduction of methane emissions in China. A comprehensive assessment of the current situation can provide a benchmark for tracking the country's future progress. Using satellite and surface observations, methane emissions in China were quantified from 2010 to 2017. Incorporating newly available terrestrial grid data across China has significantly improved the ability to reduce emissions at sub-national and sectoral levels. Author's research shows that recent changes in methane emissions in China are related to energy, agricultural and environmental policies. In this light, contrasting trends in methane emissions across regions attributable to coal mining are found, reflecting region-

specific responses to China's energy policy of closure of small coal mines (decreases in the southwest) and consolidation of large coal mines (increases in the north). Coordinated methane production from coal and coal seams in southern Shanxi effectively reduces methane emissions despite increased coal production there. This perspective identifies the policy drivers of recent changes in methane emissions in China, providing inputs for formulating methane policies to achieve the climate goal (Zhang, Peng, 2022). Another large shareholder in methane emissions is the European Union. It is also taking an active role in promoting the sustainable use of methane as part of its strategy to combat climate change. To this end, it implements stringent methane emission standards in the energy sector and seeks to increase energy efficiency to reduce methane emissions. The European Union also supports environmentally friendly agriculture by promoting practices that reduce methane emissions. Authors of the work entitled "Reducing methane emissions - an important step in strengthening the sustainable development dimension in network activities" emphasize the importance of the following activities and goals (Olczak, Piebalgs, 2020):

- gas value chains should be more oriented towards sustainable development, and the network of methane emitting companies should mainly strive to reduce methane emissions,
- a regulation should be introduced limiting methane emissions from the gas sector at European level,
- solid and transparent monitoring of methane emissions should be created, encouraging the network of companies emitting methane to undertake and implement ambitious action plans in the area of establishing a European Methane Emissions Observatory, which could be an effective tool for significant methane reduction. The observatory would undertake data analysis based on grassroots reporting by a network of methane emitting companies, aerial surveys and satellite measurements, ensuring the necessary transparency of the results obtained,
- National Regulatory Authority (NRA) should recognize effectively incurred costs by regulated entities. A form of incentive-based regulation aimed at minimizing network losses based on the experience of the electricity sector could be a promising approach in the space of sustainable methane use.

As a result of their decision - and this should be particularly emphasized - the development of regulations on methane emissions in Europe will require the European Commission to make difficult choices; to strike the right balance between the stringency of the MRV (Monitoring Reporting and Verification) framework and the costs incurred by regulated entities, as well as creating a framework that takes into account technological developments while being sustainable.

The last economy discussed and a large emitter of methane is India. As a developing market with high potential for economic growth, this country is struggling with challenges related to controlling methane emissions. It addresses challenges related to methane emissions in the agricultural and coal mining sectors. In this perspective, India needs to invest in modern technologies and practices that will help reduce methane emissions and accelerate sustainable development. As noted in the report entitled *A brief profile on coal. India (Country Profiles. The Carbon..., 2023)*. This is a particularly important process and challenge because India is the second largest consumer of coal in the world after China, overtaking the United States in 2015. Moreover, China's coal consumption has stabilized, meaning India can largely determine the fuel's global trajectory. Many analysts expect India's rapid growth to drive global demand growth over the next few years - although it is expected to remain below peak in 2014. Coal has fueled rapid growth in electricity consumption in India, and the size of the country's coal fleet has more than tripled since 2000. In 2017, coal generated 76% of India's electricity. As of January 2019, India has 221 gigawatts (GW) of coal-fired power plants in operation. According to Global Coal Plant Tracker, it is the third largest fleet in the world, with 11% of global capacity. Another 36 GW is under construction and another 58 GW is in earlier stages of development. As has already been noted, India is the second largest producer and importer of coal after China. Coal India, a national coal mining company and the world's largest coal producer, produces about 84% of the country's output. India has proven coal reserves of approximately 98 billion tones, or 9.5% of the world's reserves, again second only to China.

To conclude, a common challenge for the economies described above is the need to cooperate and coordinate activities for the sustainable use of methane. As indicated by numerous sources, there is a need to exchange technologies, experiences and knowledge in order to effectively reduce methane emissions on a global scale. Furthermore, international initiatives such as the Paris Agreement play a key role in achieving global harmonization. As the authors of the report note: *Methane Abatement (Bredariol the Oliveira, McGlade'a, 2023)*. there is a huge opportunity to reduce methane emissions from the energy sector. We estimate that approximately 70% of methane emissions from fossil fuel activities can be reduced with existing technology. In the oil and gas sector, emissions can be reduced by more than 75% by implementing well-known measures such as leak detection and repair programs and retrofitting leaking equipment. In the coal sector, more than half of methane emissions can be reduced by maximizing the use of methane from mines or by flaring or oxidation technologies when energy recovery is not cost-effective.

In this space, it appears that the roles of economies such as the United States, China, the European Union and India are crucial in the global use of methane. Their actions and commitment to controlling methane emissions will have a significant impact on the future of our planet and the fight against climate change. However, achieving methane emission reduction goals requires international cooperation and long-term actions for its sustainable use.

The facts described above determine - as has already been emphasized - the need for joint action on a global scale in order to identify and reduce the sources of methane emissions and its sustainable use. The global methane commitment plays a huge role in this space, in particular the global declaration announced during COP26 in November 2021 to accelerate actions aimed at reducing methane emissions (The Global Methane Pledge).

Countries joining The Global Methane Pledge commit to a common goal of reducing global methane emissions by at least 30% by 2030 relative to 2020 levels and striving to use the best available inventory methods to quantify methane emissions. By joining the commitment, the countries declare to take comprehensive actions to "achieve reductions in the energy and waste sectors and strive to reduce emissions from agriculture through technological innovations, as well as incentives and partnerships with farmers." This initiative, led by the United States and the European Union, currently brings together 111 participants from countries that together are responsible for 45% of global man-made methane emissions (<https://www.ccacoalition.org/en/resources...>). Among these activities, it is worth noting initiatives related to fossil fuels. The indicated sources are responsible for over one third of methane emissions caused by humans. These emissions represent one of the best short-term options for climate action because the ways to reduce them are known and understood (Rogelj, Geden, Cowie, Reisinger, 2021). The identified goals in the area of fossil fuels focus on precisely defined activities, which are:

- the need to build a broad coalition whose goal will be to bring methane emissions resulting from fossil fuel activities onto a net zero emissions path (Net Zero Strategy..., 2021),
- using proven technologies and principles to reduce methane emissions (Report ESG Respect Energy, 2022),
- thanks to well-known existing technologies, over 40% reduction in oil and gas emissions at no net cost (Wang, Li, Jon, Li, Liu, Zhang, 2023),
- widespread adoption of proven policies that would halve global emissions from oil and gas activities (Technologies and perspectives for achieving carbon (Wang, 2021),
- introducing institutional support that could lead to significant reductions in oil and gas traded internationally (Krueger, 2023),
- the construction of early warning systems to locate leaks could facilitate timely action and a significant reduction in methane emissions (Methane Report, 2022),
- creating conditions for shaping voluntary initiatives that can play a key role in ensuring timely methane reductions (A direct result of surveys detecting methane..., 2022),

In the area of the indicated activities - which should be particularly emphasized - avoiding methane emissions from coal is a serious challenge. Solving this problem, it is important to emphasize, is more challenging than in the case of oil and gas activities, but there are opportunities to mitigate these emissions. Existing technologies may play a significant role in

this process in the near term. In the IEA's (International Energy Agency) Net Zero Emissions by 2050 scenario, coal consumption will fall by 55% from 2020 to 2030 and by almost 90% by 2050. This decline would significantly reduce methane emissions from coal mines as well as CO₂ and other air pollutants; emissions reductions would be even greater if the focus was on the worst-performing coal assets. For example, removing the worst-performing quartile would remove approximately 25 Mt of methane, while removing the best-performing quartile would only remove approximately 4 Mt (Zerowe emisje netto do 2050 r., 2022),

In the indicated perspective and indicated guidelines - numerous expert opinions emphasize - that policies and measures are still necessary to reduce methane leaks from coal plants on a global scale (Launay-Smirnov, 2023). Technology and innovation are a particularly important area in this field. In the light of the above thesis, it is worth emphasizing again that today is an era of dynamic technological development, and one of the key challenges we face is protecting our environment against harmful greenhouse gas emissions. Methane, a powerful greenhouse gas, plays a particularly important role in climate change processes. Therefore, contemporary development and implementation of new technologies are crucial to reducing methane leaks and protecting our planet. One of the measures to reduce methane leaks on a global scale is to monitor the sources of these emissions. Modern monitoring technologies, such as satellites, sensors, drones and telemetry systems, enable precise tracking of leak sources at various stages of the production process, from the extraction of natural raw materials to their processing and transport. This allows for quick identification of problems and more effective corrective actions. In practice, this means the possibility of minimizing methane emissions at the stage of extraction of natural resources, which is crucial for limiting the impact of this gas on climate change (Emran, Tannant, Najjaran, 2017). Along with monitoring, it is important to isolate methane sources and technological innovations enable the recovery and utilization of methane and its transformation into energy sources, instead of leaving it in the wind. This not only determines the reduction of emissions, but also creates additional energy sources. The above-mentioned goals are indeed found in hard coal mining, which has long been an important sector of the economy, providing the fuel necessary for energy production around the world. In recent years - and it should be particularly emphasized - in the global mining industry, experts have been focusing more and more attention on the need for technological innovations in the recovery, utilization and transformation of methane.

5. Summary

As has been noted several times in recent years, issues related to sustainable development and environmental protection have become central topics in the international arena. One of the key elements of this debate is the role of methane as a greenhouse gas and the

question of whether its use can contribute to sustainable development or pose a potential threat to the environment. In this perspective, methane, which is the main component of natural gas, plays a key role in the energy balance of the global economy. Its extraction and use are integral elements of modern society, providing energy for the production of electricity, heating homes and driving vehicles. However, methane is also a greenhouse gas, contributing to global warming. In view of the above regularities, it seems that the key global challenge is the need to construct an economic model that will allow for the sustainable use of methane (Brauers, 2022). One of the approaches to this goal is to develop technologies that allow for the effective capture and use of methane in energy processes. Equally important - and this should not be forgotten - are the potential threats related to the extraction and use of methane. Leaks in gas infrastructure, uncontrolled emissions and operational processes can lead to the release of methane into the atmosphere, which significantly accelerates the global warming process. Therefore, it is necessary to focus on improving technologies and industry practices to minimize the potential negative effects of methane emissions into the environment (Questions and answers..., 2020). From a global perspective, international cooperation is a key element in the effective management of methane emissions. Countries should strive to establish uniform standards for the extraction, transport and use of methane to avoid a situation where one country makes efforts towards sustainable use while others ignore the problem. Therefore, it seems correct to say that the sustainable use of methane in a global context is both a challenge and a threat. The key task is to develop a strategy that will allow for the effective use of this energy resource while minimizing negative effects on the environment. Innovative technologies, stringent regulations and international cooperation are the key to achieving this goal and turning the use of methane into an opportunity for sustainable global development.

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DIMENSIONS OF THE DIGITAL ECONOMY BASED ON THE ANALYSIS OF ARTICLES PUBLISHED IN SELECTED SCIENTIFIC DATABASES

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Purpose: The aim of the article was to identify scientific articles dealing with specific dimensions of the digital economy and to characterize them based on an analysis of the abstracts of the identified scientific articles.

Design/methodology/approach: The objectives were achieved by using the method of a literature review, through which scientific articles addressing specific areas/dimensions of the digital economy were identified and analyzed. The analysis was based on scientific articles downloaded from the Web of Science (WoS) and Scopus databases. An in-depth analysis of the articles was used to prepare an overview of the dimensions of the digital economy.

Results: The research shows a rather scarce number of publications on the digital economy and the multifaceted nature of the issues addressed, which are difficult to categorize into specific dimensions of the digital economy. The analysis of keywords and abstracts shows that some dimensions of the digital economy are more frequent and others less studied by the authors.

Research implications: In the future, it would be interesting to fill the gaps in the definition and dimensions of the digital economy, and extend the analysis to include more qualitative aspects.

Originality/value: This article presents the results of a literature review on the dimensions of the digital economy, a new and relatively under-researched topic. The strategy of searching for articles in selected databases represents the author's proposal of a set of dimensions of the digital economy, which is a combination of the dimensions described in the literature and recent trends in the digital economy.

Keywords: dimensions of the digital economy, research dimensions, scientific databases, scientific articles.

Category of the paper: literature review.

1. Introduction

At a time of rapid ICT development and socio-economic change, the digital economy is becoming an increasingly important factor shaping modern societies and global markets. The digital economy is not only a new area of economic activity, but also a broad and diverse area of research, requiring interest from researchers and business representatives. To fully understand this new reality, it is necessary to break it down into smaller areas, or dimensions, and to identify key indicators to measure these dimensions.

The digital economy is still a new research area, which is reflected, among other things, in the fact that there are no clearly established methods for conceptualizing and operationalizing this phenomenon. Ongoing research and published works in this area refer only to selected areas of the digital economy. Attempts are made to measure selected areas of the digital economy, as exemplified by indicators such as DESI (Digital Economy and Society Index) or those proposed by the OECD. The variety of definitions and research approaches to what should be analyzed in this area makes it difficult to understand and study the phenomenon of the digital economy. In addition, the lack of clearly delineated dimensions of this phenomenon and a set of indicators and yardsticks makes it impossible to realize measurements and comparisons of the degree of digitalization of economies on a geographical basis.

The need to undertake research into the digital economy and its dimensions stems from a number of important factors that influence today's society and economy. Among these, the most relevant are the dynamic development of information and communication technologies, the transformation of business processes, the emergence of new business models or new consumption trends. The digital economy is becoming an important factor shaping production processes, consumption processes and social interactions.

In the context of considering the digital economy, it becomes important to understand the transformation processes that are taking place in the structure of the economy as a result of technological development and digitalization. It is therefore cognitively interesting to carry out an analysis of scientific articles published in selected scientific databases on different dimensions of the digital economy. The quantitative and qualitative analysis of these publications allows us to learn and understand the different research approaches and key issues undertaken in scientific work in the area of the digital economy. The analysis of the various dimensions of the digital economy will allow us to understand the mechanisms shaping modern economies and to identify potential challenges and opportunities for development facing the digital sector.

The aim of this article is to identify the issues addressed by researchers on the different dimensions of the digital economy between 2013 and 2023. Presenting the state of knowledge on the dimensions of the digital economy will enable us to understand the complexity of this phenomenon and identify gaps in research relevant to different aspects of socio-economic life and in need of further exploration (e.g. in terms of subject, entity or space).

The objectives were achieved by using the method of a literature review, through which scientific articles addressing specific areas/dimensions of the digital economy were identified and analyzed. The analysis was based on scientific articles downloaded from the Web of Science (WoS) and Scopus databases. An in-depth analysis of the articles was used to prepare an overview of the dimensions of the digital economy.

2. Dimensions of the digital economy - a literature review

The digital economy is a new and complex object of research. It encompasses a broad spectrum of economic, social and cultural activities supported by the internet and related information and communication technologies (Radomska, 2019).

After reviewing the most important publications on the subject, it can be said that there is no clear definition of the digital economy. In the most general sense, this term refers to ICT-based economic activity (Chen, 2020), and in a narrower sense, it means the conduct of economic activity through online and web-based markets (Kupenova et al., 2020). A well-known approach to considering digital transformation is to divide the digital economy into areas such as market 4.0, production 4.0, consumption 4.0, work 4.0, state 4.0 and globalization (Śledziwska, Włoch, 2020).

Some of the key features of the digital economy include increased flexibility, innovation and efficiency of organizations, reduced response time to changing needs of customers, employees, partners, and the creation and use of new digital business models. The digital economy is characterized by knowledge, globalization, digital business models, speed of change, supporting infrastructure and autonomous integration (Kruljac, 2021).

In this article, the digital economy is treated as a system i.e. "an ordered arrangement of elements consisting of economic subjects, resources, as well as adopted ways of solving problems of production, distribution, exchange and consumption" (Kryczka, 2018, p. 545). It also emphasizes the existence of a new paradigm of functioning economic subjects called a "network paradigm" which means that everything in the economy is interrelated (Kołodko, Koźminski, 2017). This system mentions three elements of the digital economy: the networked of the society, the digital transformation and the economy based on the data (Skowronek-Mielczarek, 2021).

Analyzing content and publications on the digital economy, it was found that this phenomenon is defined and analyzed differently in different research scopes. The most frequently researched areas of the digital economy between 2010 and 2021 are the growth and structure of the digital economy, digital strategy and market, business activity of enterprises, ICT and education (Hoffmann-Burdzińska, Stolecka-Makowska, 2022).

Elements enabling the digital economy such as, for example, fast and reliable internet access, developed ICT infrastructure, innovative technological, legal and institutional solutions are recognized as the basic foundations of the digital economy. Hence, the following can be considered as manifestations (symptoms) of the digital economy: popularization of the internet, digitisation of data, consumer networking, the internet of things, business innovation (Platforma Przemysłu Przyszłości, 2020), among others. The dimensions of the digital economy, on the other hand, can be understood as a scope considered in terms of its length, breadth and height or depth.

The topic of dimensions of the digital economy is complex, covering many different aspects, which are most often measured by indicators such as the DESI (Digital Economy and Society Index) and the model developed by the OECD. The aforementioned indicators are tools used to analyze different aspects of the digital economy and society and differ in their thematic scope, geographical scale, methodology and dimensions measured (table 1).

Table 1.
DESI and OECD metrics - basic characteristics

Specification	DESI	OECD
Scope	<ul style="list-style-type: none"> ● focusing mainly on assessing progress in the digitization of society and the economy ● measuring aspects such as Internet access, use of digital technologies by citizens and businesses, digital competencies, integration of digital technologies in the public sector 	<ul style="list-style-type: none"> ● covers a wide range of topics, including economy, society, environment, innovation, labor markets, etc.
Spatial scale	Used mainly for analysis of European Union member countries and some non-EU countries (developed by European institutions)	are used to compare data for OECD member countries and other partner countries
Methodology	Use of a specific methodology and a set of indicators specifically designed to assess the digitization of society and the economy	Use of diverse methods and indicators, depending on the specific research needs or analysis conducted by the OECD
Dimensions	<ul style="list-style-type: none"> ● human capital ● connectivity (digital infrastructure) ● integration of digital technologies ● Internet use digital public services (e-government) 	<ul style="list-style-type: none"> ● nature of the transaction (environment) - "how" ● digital product - "what" ● producers "who" ● users "who"
Application	<ul style="list-style-type: none"> ● to compare selected economic and socioeconomic aspects of different countries, ● enable evaluation of progress identification of areas requiring further action ● are used in research, serve as recommendations for member countries 	

Source: Own elaboration (European Commission, 2022; Fritsch, Lichtblau, 2020; OECD, 2020).

As a measure of the degree of digitization, the DESI helps to assess and monitor the level and progress of digitization and track the digital competitiveness of EU countries. It was created to measure the degree of implementation of the Digital Single Market (DSM) strategy and identify areas for further action (European Commission, 2022).

The DESI consists of five main dimensions and 24 sub-indicators measuring various aspects of digitization. Its main components are: 1. human capital (skills of internet users and advanced digital skills); 2. connectivity (digital infrastructure i.e. availability of fixed and mobile broadband and the cost of these connections); 3. digital integration (digital intensity, digital

technologies for business, e-commerce); 4. internet usage (various online activities performed by citizens); 5. digital public services (e-government) (European Commission, 2022, p. 4).

The OECD model, on the other hand, as an analytical tool, is used to compare primarily OECD member countries. It consists of a set of different indicators covering a wide range of topics related to economy, society, environment and other aspects of development. Among them are measures to measure selected elements of the digital economy. The defined and analyzed dimensions of the digital economy, which have a broad and multidimensional scope, include: the nature of the transaction - "how" (digitally ordered, platform enabled, digitally delivered), the digital product - "what" (goods, services, information/data) and the partners involved - "who" including: producers and users (corporations, households, government, non-profit institutions serving households, rest of the world). Also included is a category of "enablers" understood as "complementary factors of digital transformation". The additional category of "enablers" (infrastructure and investment) has a significant impact on the digital economy (Fritsch, Lichtblau, 2020; OECD, 2020). Another OECD indicator that does not refer to dimensions of the digital economy only to trade in digital services is DSTRI (Digital Service Trade Restrictiveness). It measures across the board the barriers that limit companies from providing digital services and includes five measures: 1. infrastructure and connectivity, 2. electronic transactions, 3. electronic payment systems, 4. intellectual property rights, 5. other barriers to trade in digital services (OECD Going Digital Toolkit, 2022).

Also indicated are general levels of the digital economy relating to: business activities of enterprises (including producers of ICT and information goods and services, as well as companies dependent on digital resources), digital society and digitized interactions (e.g., use of digital platforms, social-media), digital transactions (ordered and purchased digital products and services) (Kontolaimo, Skintzi, 2018).

After reviewing the literature on the dimensions of the digital economy, the authors assumed certain keywords as a starting point for redefining the dimensions of the digital economy. Further detailed analyses of scientific articles have already addressed selected dimensions of the digital economy.

3. Research approach

The research aims for this article were: (1) to identify scientific articles dealing with specific dimensions of the digital economy and (2) to characterize them based on an analysis of the abstracts of the identified scientific articles

The method used for this article is a literature review, through which scientific articles addressing specific areas/dimensions of the digital economy were identified and analyzed.

The research investigation proceeded in four stages.

The first was to decide on article databases in which to search for publications for further analysis. Considering the existing possibilities, the authors decided on Scopus and Web of Science databases, which are the leading electronic sources (Jež et al., 2018).

The second stage of the work involved defining articles' search strategy. The search phrase consisted of two phrases, the first referring to a specific dimension of the digital economy and the second to the digital economy: "name of the dimension of the digital economy" + "digital economy". All phrases were searched first in article titles and then in titles and abstracts. The selected dimensions of the digital economy were: "market" (market issues), "human capital" (labour), "government" (public administration), "business" (companies), "consumers" (consumers, households), "banking system" (banks), "international" (international environment), "digital technologies" (digital technologies), "green" (environment) and "metaverse". The choice of dimensions resulted from a review of the literature on the subject and basic assumptions about the economy as a system in which certain groups of actors, such as businesses, consumers, the state, banks, participate in the processes of production, distribution, exchange and consumption of goods and services. The time period of the searches was assumed to be the years from 2013 to 2023. The reason for such timeframes is the finding of the bibliographic analysis of the digital economy conducted by the authors in 2021. It shows that the digital economy phenomenon was defined in 2013. An increase in the number of published articles on the digital economy has also been observed since that year (Hoffmann-Burdzińska, Stolecka-Makowska, 2022).

The third stage consisted of the preparation of tables of search results and the analysis of the number of papers and citation measures.

The last stage in the research procedure consisted of reading the abstracts of the retrieved articles and identifying the research problems taken up in them and the territorial scope of the research.

4. Research results and analysis

The results of the article search according to the method described in the previous section of the article are presented in Tables 2 and 3.

Table 2 shows the number of articles identified in the search for each phrase. From the data presented in the table, it can be seen that the most popular dimensions on which various authors write are "green", i.e. topics related to the so-called "green economy" and ecological issues (about 45% of the total results at the search level in titles and abstracts in both databases). A relatively large number of results in article titles and abstracts resulted from searches on the "business" dimension (approx. 20% of publications in the WoS database and 14% in the Scopus database).

Table 2.

Digital economy articles 2013-2023- search phrase "digital economy" in title, abstract, title and abstract (in numbers)*

Specification	The number of papers searched in scientific databases					
	Web of Science the phrase in:			Scopus the phrase in:		
	title	abstract	title and abstract	title	abstract	title and abstract
Total	286	3716	214	348	4687	241
"market" + "digital economy"	44	773	25	42	716	28
"human capital" + "digital economy"	20	174	18	16	132	12
"government" + "digital economy"	17	488	12	15	496	14
"business" + "digital economy"	59	936	42	47	807	34
"consumer/s" + "digital economy"	17	194	9	17	288	10
"banking system" + "digital economy"	2	13	1	3	9	3
"international" + "digital economy"	20	361	10	73	649	28
"digital technologies" + "digital economy"	0	484	0	9	1191	5
"green" + "digital economy"	107	283	97	126	376	107
"metaverse" + "digital economy"	0	10	0	0	23	0

Source: Own elaboration.

Analysis of the citation statistics (table 3) shows a similar trend in terms of the dominant dimension. The highest number of citations (about 70% in WoS and about 57% in Scopus) was for the "green" dimension. The highest citation averages in the WoS database were for the "green" (14,28) and "government" (10,27) dimensions. In the Scopus database, the highest averages pertained to the same dimensions, except that the average number of citations per article was higher for the "government" dimension (19,21 - the highest average compared to the others presented in Table 2), followed by "green" (14,73 - a level of average similar to the WoS database). The H-index per dimension in both databases was highest for the "green" dimension (18 in WoS and 19 in Scopus).

Table 3.

Citations for articles on the digital economy 2013-2023 - search for the phrase: "specific dimension" + "digital economy" in the title and abstract of an article

Specification	Citations in:					
	Web of Science			Scopus		
	Total	Average per item	H-index	Total	Average per item	H-index
Total	1981	-	-	2656	-	-
"market" + "digital economy"	156	6,24	5	280	10	8
"human capital" + "digital economy"	28	1,56	3	65	5,42	5
"government" + "digital economy"	113	10,27	4	269	19,21	6
"business" + "digital economy"	190	4,52	5	325	9,56	9
"consumers" + "digital economy"	66	7,33	3	122	12,2	4
"banking system" + "digital economy"	3	3	1	3	1	1
"international" + "digital economy"	40	4	3	78	4,59	4

Cont. table 3.

“digital technologies” + “digital economy”	-	-	-	12	2,4	1
“green” + “digital economy”	1385	14,28	18	1502	14,73	19
“metaverse” + “digital economy”	-	-	-	-	-	-

Source: Own elaboration.

The quantitative data presented in both tables show trends in the coverage of the various dimensions of the digital economy by different authors. In addition to the leading directions, i.e. the dimensions "green", "business", as well as the most frequently cited dimensions "green" and "government", it is worth noting the dimensions that are written about and/or cited the least from their respective scopes. Based on the data in both tables, it can be seen that the dimension of the digital economy that is least addressed is 'metaverse' (the small number of publications whose abstracts address this issue). The results in terms of the number of citations for this dimension indicate a lack of citations over the time period studied. The second dimension very little addressed by the authors is “digital technologies”. Given the fact that the digital economy is intrinsically linked to this dimension, the sporadic uptake of this topic by the authors is an interesting result for further research to explain the reason for this. The “banking system” dimension is also relatively rarely addressed.

After identifying the key quantitative metrics for articles on each dimension of the digital economy, the authors conducted a qualitative analysis of the content of the abstracts to identify the detailed research focus of the articles and their territorial scope. As a first approximation to this, the authors combined the search results obtained in both databases at the level of a given dimension and reduced the sum of articles by repeated items. Table 4 presents the results of the qualitative content analysis of the abstracts of the articles identified in each dimension of the digital economy.

Table 4.

Topics and themes of digital economy dimensions on the basis of the review of articles' abstracts (2013-2023) - Search for the phrase "digital economy" in the title and abstract of an article in the Web of Science and Scopus databases

Specification	Research subject and/or problem	Territorial scope of the research
banking system + digital economy (N = 4)	<ul style="list-style-type: none"> ○ digital transformation, transformation of a banking system (4) ○ commercial banks (3) ○ organization of the cybersecurity system, hacker attacks (2) ○ financial technologies ○ financial innovations ○ application of mobile system to the banking services ○ developing banking system 	Russia (2) Uzbekistan (2)

Cont. table 4.

technology + digital economy (N = 5)	<ul style="list-style-type: none"> ○ economic growth (2) ○ transformation of labour market ○ supply chain ○ logistics system ○ production ○ blockchain system ○ the ecosystem ○ e-government ○ social adaptation 	Russia (3) Turkey Thailand
green + digital economy (N = 113)	<ul style="list-style-type: none"> ○ innovation e.g. eco-innovation, green innovation, GI efficiency/quality, green technology innovation, green science innovation, green technological innovation (54) ○ industry, manufacturing p.ex. manufacturing industry, industrial agglomeration, industrial green development, industrial green innovation, industrial green total factor productivity, industrial green transformation, industrial structure – optimization/rationalization/upgrading, industry convergence, textile (40) ○ productivity, green productivity, green total factor productivity – GTFP (32) ○ spatial spillover, p.ex. spatial: autocorrelation, characteristics, externality, heterogeneity, measurement, regression, effects (32) ○ green development, sustainable development (31) ○ technology e.g. technical progress, technology innovation, communication technology, by-production technology (30) ○ internet, internet of Things - IoT (26) ○ energy, clean energy, energy conservation/efficiency/transition, renewable energy, green total factor energy efficiency – GTFEE (20) ○ environment, e.g. environment friendly, environmental quality/regulation, environmental sustainability, ecological, eco-efficiency, ecological efficiency (18) ○ investment e.g. educational investment, green investment, long-term investment (17) ○ carbon e.g. carbon credit, carbon emission intensity/reduction, green low-carbon development, low-carbon green total factor productivity (16) ○ model e.g. chain serial mediation model, coupling and coordination models, difference-in-differences model, dynamic threshold model, gravity model, dynamic panel model; Hidden Markov chain modeling SBM-GML, model Spatial Durbin model (SDM), time-varying DID model, Tobit model (16) ○ information e.g. feedback, coupling coordination, performance (15) ○ finance e.g. green finance, digital finance, financial development, financial agglomeration (14) ○ pollution e.g. air pollution, CO2 emissions, environmental pollution, heavy-polluting enterprises (12) ○ urbanization e.g. urban green development efficiency, urban green transformation, urban level, urban agglomeration, promoting urban green development enterprises (10) ○ agriculture e.g. agricultural green total factor productivity, agricultural supply chain, agricultural technology innovation, green agricultural development (10) ○ electricity consumption, energy consumption, energy use (9) ○ big data, data mining, machine learning (9) ○ ecosystem e.g. cooperation ecosystem, green economy (7) ○ government, taxes, regulation (7) ○ agglomeration e.g. city, economic agglomeration (6) ○ business e.g. enterprise, entrepreneurship (6) ○ green transformation (5) ○ green economic efficiency (GEE) (3) 	China (111)

Cont. table 4.

consumer + digital economy (N = 17)	<ul style="list-style-type: none"> ○ law p.ex. competition law, consumer data protection law, EU consumer law, data protection law (7) ○ information and communications technology, Information needs, media exposure, smart Contracts (4) ○ purchases e.g. digital consumption, online purchasing decision-making, online shopping (3) ○ marketing, digital marketing, marketing studies (3) ○ consumer behaviour (2) ○ consumer protection (2) ○ competition (2) ○ consumer psychology, psychological state (2) ○ service business, commercial practices (2) ○ artificial Intelligence (AI) ○ canopy clustering algorithm ○ omnichannel consumer ○ consumer awareness ○ consumer welfare ○ consumer engagement ○ consumer experience ○ online consumer skills ○ index of consumer prices ○ household production ○ digital infrastructure ○ experience economy ○ online platforms ○ predictive model design ○ privacy paradox ○ sustainable development 	Russia (3) Thailand China Malaysia Germany Italy
market + digital economy (N = 25)	<ul style="list-style-type: none"> ○ labour market (14) ○ measurement (12) ○ technology (AI, big data, IoT, platforms, online games) (7) ○ transformation (4) ○ d.e. basics (3) ○ sustainable development (3) ○ innovation (3) ○ market competition (2) ○ business model (2) ○ legislation (2) ○ telecommunications sector (2) ○ strategic dimension of markets (2) ○ ambidexterity ○ working time ○ factors influencing the labour market ○ e-commerce, e-marketing ○ carbon emissions ○ energy intensity ○ digital industrialization ○ information ○ quality in the food market ○ market capitalization of the d.e. ○ digital competence ○ consumers (privacy) ○ convergence ○ engineering marketing ○ workforce optimization ○ online payments ○ law ○ factor productivity 	China (6) Russia (4) Turkey Chile Romania OECD countries BRICS countries USA Germany Republic of Korea Sweden EU USA

	<ul style="list-style-type: none"> ○ promotion of tourism companies ○ technology-based regulation ○ education market ○ financial market ○ healthcare market ○ market society ○ innovation risk ○ mobile, internet, software, IT services sector ○ insurance for digital workers ○ internationalization ○ intellectual property ○ consumer behaviour ○ management 	
human capital + digital economy (N = 13)	<ul style="list-style-type: none"> ○ human capital (quality, level, stability, reproduction, development, management, categories, development effectiveness, transformation) (15) ○ competences (digital, communication, motivation, professional, personal, digital intelligence, measurement of competences) (12) ○ d.e. development (3) ○ education system (2) ○ measuring the d.e. (2) ○ digital technologies (2) ○ training ○ basics of the d.e. ○ digitization ○ innovation ○ entrepreneurial culture ○ robots ○ young generation ○ trends ○ learning ○ machine learning 	Russia (6)
international + digital economy (N = 1)	<ul style="list-style-type: none"> ○ remote working ○ taxation of work ○ reduction of the shadow economy (legalization of income) 	Russia China France Ireland Finland
business + digital economy (N = 27)	<ul style="list-style-type: none"> ○ business model (7) ○ technologies (AI, bases, cognitive, consumer, big data, simulation games) (6) ○ transformation (business, digital, etc.) (4) ○ platform (3) ○ potential (business, innovation, entrepreneurship) (3) ○ competitiveness (3) ○ competence (communication, etc.) (3) ○ digitization of processes (2) ○ transaction costs (2) ○ trends (2) ○ green and sustainable development (2) ○ corporate development ○ community development ○ self-sustainable organization ○ training, education ○ distributed teams ○ efficiency ○ business incubator 	Russia (6) Ukraine (3) China EU

Cont. table 4.

government + digital economy (5)	<ul style="list-style-type: none"> ○ transformation ○ e-commerce ○ inclusive green growth ○ protection of intellectual property ○ digitization ○ measurement of the d.e. ○ e-government ○ environmental regulation (GER) ○ entrepreneurship ○ equal opportunities in the information society 	China (2) Croatia Uzbekistan
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d.e. - abbreviation for digital economy.

Source: Own elaboration.

The articles found according to the strategy "technology and digital economics" in the title and abstract are mainly devoted to the problems of digital technologies transformation of a banking system (4). These items described solutions relating to financial technologies and innovations, application of mobile system and organization of the cybersecurity system. Articles with the theme of 'banking system + digital economics' attempted to identify and explain how the application of new digital technologies affects the economic growth of a region, country and their transformation process. They also presented applications in the supply chain, logistics system or e-government.

Among the 113 articles found in both databases having "green + digital economy" in the title and abstractions, the vast majority substantiated the thesis that the digital economy is helpful for advancing the green economy. The majority addressed issues related to innovation impact on green development (54), structure from transformation of industry/manufacturing (40) and also topics related to productivity and its measure - GTFP or spatial spillover (32 each).

Articles whose theme and abstract referred to the "consumer + digital economy" (17) dealt primarily with legal issues related to consumer rights and protection (7), ways of providing and obtaining information (4) and online shopping (3). Individual texts dealt with issues of awareness and psychology of the digital consumer and their behaviour, digital skills, engagement, experience or well-being.

Publications on the topic of the market in the digital economy addressed a wide range of issues, among which references to the labour market (14) and other markets, e.g. financial, education or healthcare, were relatively most common (3). In addition, measurement of various phenomena was popular, as well as modern technologies (e.g. AI, big data, IoT, etc. - 4 articles). Several articles (3) raised the topic of transformation, the fundamentals of the digital economy, as well as sustainability and innovation. Aspects of competition, business models, legal aspects and those concerning the telecommunications sector or the strategic dimension of the market were also of interest (2 publications each). Other issues presented in the table are related to the labour market mentioned above, as well as interesting topics such as energy intensity, digital competences, law, IT sectors.

Another dimension that was characterized on the basis of the content of abstracts of scientific publications concerned human capital. The most popular issue in the identified articles was competence (e.g. digital, communication, digital intelligence - 12 publications). The category of human capital was described in connection with characteristics such as quality, level, stability, development, reproduction, etc. (15). Selected articles dealt with the development (3) and measurement of the digital economy (2), as well as digital technologies (2) and the education system (2). Other items listed were issues such as training, digitization, robots, learning, etc.

The international dimension was addressed in one publication and concerned remote working, labour taxation and the legalization of income.

The articles on business and the digital economy identified within the search strategy given in the table were largely related to the issue of business models (7) and technologies (6). Transformation (4), platforms (3), human potential (3), competitiveness (3) and competences (3) were also aspects of interest to the authors. Digitization of processes, transaction costs, trends and green and sustainability were also of interest (2 articles each).

The last dimension, i.e. public administration, has become a focal point for issues such as transformation, e-commerce, green growth, digitalization, measuring the digital economy and ecology. The topics addressed in this dimension are diverse and no leading aspect emerges from it.

The publications identified in each dimension presented findings from research and analysis on a range of countries and community organizations. The largest number of articles referred to countries such as China (122) and Russia (25). Analyzing the regions of the world, it can be said that Asia is dominant, followed by European countries. A few publications refer to countries affiliated to communities such as the European Union (2), OECD and BRICS (1).

5. Conclusion and discussion

The results of the literature review conducted by authors lead to a few valuable conclusions.

The search strategy adopted by the authors made it possible to focus attention on the dimensions of the digital economy and the accompanying issues. The dimensions of the digital economy used in the search strategy of the publication are a proposal built on existing concepts in this area and the observation of development trends in the area of modern technologies such as the metaverse, as well as those relating to ecology (green economy). The dimensions of the digital economy are therefore not a closed catalogue of issues, but rather an evolving area, complemented by new proposals.

Scientific papers published in the WoS and Scopus databases between 2013 and 2023 on the dimensions of the digital economy indicate that this is an area of interest to researchers. The average number of articles per year during the time period under study is about 19 publications in the WoS database and about 22 publications in the Scopus database. Bearing in mind the popularity and reach of articles published in both databases, it can be said that these results are relatively low, which may be a rationale for considering that the dimensions of the digital economy are still a topic of little interest to researchers. It is worth recalling that the research conducted by the authors of this article on the research areas of the digital economy on the basis of articles published between 2010 and 2021 identified approximately 291 publications on the digital economy in the WoS database and 370 publications in the Scopus database.

The most cited dimensions of the digital economy by researchers are 'green' and 'business'. The highest results in terms of average number of citations are for the 'green' and 'government' dimensions. The search results for the 'green' area had the highest Hirsh index. It can be said that this is the dimension with the strongest scientific development, which may be due to a number of reasons, including, for example, the available funding for research in this area and the desire to solve environmental problems facing the modern economy.

The topics and issues addressed by the researchers in the identified publications represent a very broad area. Between the analyzed dimensions, one can notice a tendency to address the same aspects, e.g. transformation, digitalization, consumers, measuring the digital economy, entrepreneurship, sustainability, technology or public administration. In each dimension it is possible to see the leading issues and their connection to other dimensions.

The objective undertaken in this article, related to the identification and characterization of the dimensions of the digital economy, has been achieved; however, some limitations of the study carried out for this paper should also be mentioned. The article search strategy is a prelude to further activities related to the analysis of the results obtained. In this study, the analysis combines some elements of bibliometric analysis with a qualitative analysis of the abstracts, through which it was possible to identify the leading themes that are elements of the studies carried out by the different authors. An important step in further proceedings should be to learn more about the research results presented in the articles, so that a deeper analysis and identification of research gaps can be undertaken in studies carried out by researchers working on the digital economy. It is interesting to learn more about the methods and tools that researchers have used so far, through which they collect and analyze research material in terms of leading approaches, as well as those that are less or least used.

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SELECTED INSTRUMENTS FOR IMPROVING UNIVERSITY MANAGEMENT

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Purpose: The aim of the article is a theoretical and cognitive characterization of selected instruments for improving university management (such as concepts, systems and methods in the area of quality management), and then analyzing their knowledge and use on the example of the University of Bielsko-Biala.

Design/methodology/approach: The article is a theoretical and analytical study in the field of selected instruments for improving university management, based on a case study of the University of Bielsko-Biala. The analytical part of the article was carried out in the last quarter of 2023 and included the university's rector and other management staff.

Findings: The case study allowed to indicate which instruments for improving university management are known and used at the analyzed university. The presentation of some of the instruments was supported by practical examples of their use, in particular in the area of value stream mapping.

Research limitations/implications: Limitations in the implementation of the case study in the field of university management improvement instruments should be related to the instruments included in the analysis. Such action is usually subjective and the researcher is not always able to comprehensively address the issue at hand, taking into account the methodological and substantive aspects.

Practical implications: Through a case analysis, it was indicated which instruments for improving university management are known and used at the studied university. Such an analysis may be a contribution to further research and discussion on management improvement instruments that can be used by universities.

Originality/value: The added value of the article is the case analysis, which allowed for the identification of selected improvement instruments that can be used in university management.

Keywords: instruments, university, improvement.

Category of the paper: Case study.

1. Introduction

The organizational order of Polish public universities is based on the collective and term-of-term election of university managers, which is not conducive to the implementation of consistent management and organizational solutions that are implemented by foreign universities, in particular Anglo-Saxon and Western European ones. Due to the above, a deficit in effective management solutions in Polish public universities can be noticed. Therefore, many universities in Poland need organizational improvement based on the use of effective methods and world-proven management concepts. It is primarily about specific, implemented concepts and methods that improve the organizational functioning of universities, and not about bureaucratic or statutory requirements, such as the creation of formalized strategies or quality systems education. The source of effective solutions are the trends of new public management and governance applied to activities in universities and science, which, however, need to be adapted to the specificity of each university (Sułkowski, 2017, p. 10).

In addition to implementing concepts, approaches and systems at universities to support and improve the management of these entities, attention should also be paid to building an appropriate quality culture and attention to the quality of management. These issues are also discussed in this article.

The article is of a theoretical and cognitive nature and mainly presents selected instruments for improving university management. The cognitive part of the article presents an analysis of the knowledge and use of improvement instruments on the example of the University of Bielsko-Biala. In terms of practical examples, reference was made to an instrument important for the functioning of universities - value stream mapping.

2. Improving university management - theoretical aspect

It should be stated that the concept of "quality culture" was developed on the basis of management theory. One of many definitions states that it is "a set of values, traditions, procedures and beliefs accepted by its members organization, creating an environment conducive to shaping and continuous improvement of quality". Quality culture is strongly related to the management culture and culture of a given organization, together creating the so-called the triad of rational organizational operation. It should also be emphasized that quality culture is one of the key ones elements in Total Quality Management (Lendzion, 2019, pp. 25-27; Łukasiński, 2011, p. 2).

In the area of higher education, "quality culture" is understood as a combination of academic culture and business management of the university. Therefore, it is characterized by constant striving for improvement quality in every aspect of the university's functioning and an individual sense of belonging to the community. It most often appears in the context of building and improving internal quality systems. According to the European University Association, quality culture combines two distinct sets of elements: cultural and organizational. Cultural elements include: common sharing of values and beliefs and expectations related to quality, and the organizational elements are: a structural and management system with defined processes that strengthen quality and aim to coordination of activities, internal quality assurance and improvement systems and a defined organizational structure. Quality culture helps and strengthens the continuity and coherence of activities at the university positive behavior patterns (e.g., respect, appreciation, motivation, high personal culture) and activities (e.g., cooperation, partnership, commitment), improves communication between stakeholders, stimulates action, builds organizational culture, affects satisfaction, efficiency and quality of work (Lendzion, 2019, pp. 25-27; Sursock, 2011).

The concept of management quality is directly related to the issue of quality culture and instruments for improving university management. Quality culture creates the appropriate quality of management. This, in turn, somehow forces the use of instruments in university management that improve processes and services.

Management quality refers to the quality of work of managers providing management services, whose efforts cannot be limited only to human resources management. The quality of decisions and actions of university managers determines the quality of university management, including the system for ensuring the quality of education and the quality of educational services provided (Lisiecka, 2012, pp. 134-151). The quality of implemented processes and services results from the quality of planning processes (at each management level), organizing processes (actions taken to achieve the set goals), motivation processes (applying motivational stimuli to academic teachers and administration employees) and control processes (actions verifying the adopted goals, assumed effects, e.g., education, etc.) (Detyna, 2016, p. 89).

It should be noted that the quality of management, like many other aspects related to quality, is subject to improvement. T. Wawak points out a certain catalog of ways to improve the quality of management (Wawak, 2012, pp. 131-133):

1. Focus on value and results, including research, teaching and economics.
2. Orientation towards students and PhD students. Improving the quality of management must be determined by meeting the expectations of customers, which for universities are students and doctoral students.
3. Focus on leadership and development strategy. Improving management at a university requires management at each level to set clear goals and values visible to subordinate units, indicate strategies and directions for their development, and create an atmosphere enabling employees, students and doctoral students to focus on their implementation.

4. Process optimization in conditions of constant change, based on facts. Achieving high quality management requires implementing a process approach at the university.
5. Employee commitment and satisfaction. Improving the quality of management requires the release and use of employees' potential, their initiative and commitment to work. Quality management becomes the main feature and requirement of management, and the concept of Total Quality Management becomes the basic concept of university management.
6. Implementation of concepts, systems, methods, techniques and tools ensuring the desired level of quality at a given time and its improvement (e.g., Lean Management (Höfer, Naeve, 2017)).
7. A set of values shared by university management and employees as well as an organizational culture based on trust and leadership.
8. Partnership and relations with the environment. Improving university management requires, in order to increase the effectiveness of its operations, the creation and development of relationships with partners based on the principles of integration, trust and knowledge sharing. Building partnerships with other universities, research centers in Poland and abroad, and the economy enables mutual exchange of experiences in improving the quality of management.

In addition to improving the quality of management, one should remember about the need to evaluate it. It seems that an effective solution will be to develop an appropriate assessment model. The management quality assessment model should include criteria for assessing the levels of this quality. The stages of developing criteria for assessing the level of management quality at a university may be as follows (Tutko, 2016, p. 105; Wolniak, 2014, pp. 157-166):

1. Identification of determinants of management quality.
2. Identification of criteria and sub-criteria for assessing management quality.
3. Examination of the significance of criteria and sub-criteria for assessing the quality of management.
4. Giving weights to the criteria and sub-criteria for assessing the quality of management (parameterization of criteria).

Among the models operating in the area of broadly understood quality management, models based on the EFQM model (European Foundation for Quality Management), TQM (Total Quality Management) guidelines and the principles arising from the ISO 9001 standard may prove useful in assessing the level of management quality.

The EFQM model is based on the principles of excellence covering three areas: direction of action (the purpose of the organization, fulfillment of a specific strategy), execution (resources necessary to implement the strategy) and results (now and in the future) (The EFQM Model, 2019). It should be noted that the principles of excellence of the EFQM model are determinants of the quality of management at the university. The degree to which they are met by university managers and heads of organizational units of the university determines the level

of quality of university management. This level means the quality of management services provided by the managers of a university or an organizational unit of a university.

Total Quality Management constitutes the concept of quality management according to which all organizational units at the university and all its employees have an impact on shaping and improving quality (Slack, Chambers, Johnston, 2007, p. 651). The TQM concept is based on the soft aspects of management, including: leadership, respect, integrity, trust, honesty, commitment, customer satisfaction, ethics, continuous improvement, training, motivation, teamwork, error prevention and good communication. They can be used to create criteria for assessing the level of management quality at the university.

The implementation of the above aspects allows us to distinguish the following approaches to implementing TQM at universities (Abdus Samad, Thiagarajan, 2015, p. 625):

1. Student orientation - the quality of educational services is shaped and developed through employee development (training).
2. In the second approach, the focus is on university employees. Along with increasing responsibility for implemented activities, the motivation system should be strengthened, in particular in the area of appreciating employees for their efforts and improvement activities.
3. The third approach focuses on the services provided and aims to ensure their compliance with the adopted standards in key areas for these services.

The principles of quality management resulting from ISO 9001 can also be used to develop criteria for assessing the level of management quality at a university. The quality management system based on the ISO 9001 standard constitutes the following principles: customer orientation, leadership, people involvement, process approach, continuous improvement, making decisions based on facts and relationship management. They coincide with the above aspects regarding the EFQM model and the TQM concept.

3. Case study – University of Bielsko-Biala

This cognitive part of the article presents the case of the University of Bielsko-Biala (UBB) in the context of selected instruments for improving university management. This part presents selected improvement instruments in terms of their knowledge and use by the rector and other people responsible for university management. Then, attention was focused on the practical application of the Value Stream Mapping instrument in the area of research workers going on business trips. This instrument clearly reflects possible aspects of improvement. According to the above, the basic goal of this part of the study was analysis of selected instruments for improving university management, in particular in terms of their knowledge and use at the University of Bielsko-Biala. Further assumptions of the research presents table 1.

Table 1.*Assumptions of the research*

Items	Description
Research goal	Analysis of selected instruments for improving university management, in particular in terms of their knowledge and use at the University of Bielsko-Biala
Research method	Case study
The interviewees	The Rector and other managers of University of Bielsko-Biala
Date of realization	Last quarter of 2023

Source: personal elaboration.

Table two presents a catalog of improvement instruments that can be used to improve university management. The catalog has an open, subjective form and the author's intention is, in part, to spark a discussion on its shape, and more specifically on the improvement instruments suited to the specificity of the university.

Table 2.*Improving instruments*

Instruments for improving university management	Knowledge	Use
Total Quality Management	-	-
Quality management system according to ISO 9001	-	-
Management through processes	+	+
Standardization	+	+
Value Stream Mapping (graphical analysis and process improvement)	-	-
Kaizen – continuous improvement	-	-
PDCA (continuous improvement cycle – Plan – Do – Check – Act)	-	-
5S (workplace improvement)	-	-
FMEA method (identification of irregularities in the process and service - Failure Mode and Effect Analysis)	-	-
QFD method (service improvement – Quality Function Deployment)	-	-
Benchmarking (comparison to patterns)	+	+
Reengineering (process redesign)	-	-
Audit	+	+
Brainstorm	+	+
Block diagram	+	+
Ishikawa chart (descriptive analysis of the causes of abnormalities)	-	-
Pareto chart (quantitative analysis of the causes of irregularities)	-	-
Control charts	+	+
Checklist	+	+
Program chart of the decision process (methodology of conduct in the event of irregularities)	-	-
5Why (searching for the causes of the problem)	-	-
SWOT analysis	+	+
Knowledge management	+	+
Intellectual capital management	+	+
Training system	+	+
Employee suggestion system	+	+
Motivational system	+	+
Corrective actions	+	+
Preventive actions	+	+
Risk analysis	+	+

Source: personal elaboration.

The analysis of the table above clearly shows that the area of knowledge and use of instruments overlap. Knowledge and use of improvement instruments concern, among others, management through processes, standardization, benchmarking, audits and instruments related to human capital. Solutions specific to the private sector, such as ISO 9001, Kaizen, FMEA, QFD and others, do not apply to the analyzed university. This state of affairs shows how important issues in the area of management quality are, which emphasize the value of improvement.

Despite the passage of time, more years are needed to change this state of affairs. Training is necessary for broadly understood university management staff to point out instruments and approaches that have been proven in the economy but are still unknown at universities. Therefore, awareness and the need for improvement and self-improvement should be aroused.

In order to deepen the issue of using instruments for improving university management, an analysis was carried out using the Value Stream Mapping instrument in the field of a research and teaching employee going on a national delegation. The analysis and the states before and after the use of the instrument are presented in figures 1 and 2.

This process defined 16 activities from the moment of obtaining information about the scientific conference to the moment of submitting all required documents to the relevant university units after returning from the conference. The possibilities of improving such a process are severely limited due to the fact that individual activities are divided into several units. These include: the employee's organizational unit - department, rector's office, dean's office, human resources department and bursary. The waste of time and material resources is also very clear. The head of the employee's organizational unit signs several times on various documents, confirming the same information.

Suggestions for improvements include:

1. Elimination of an employee's approach to the university rector through the manager unit and the dean for permission to use a private car for business purposes and to wait for the rector's decision. After reporting to the conference, the employee provides such information to the human resources department, which checks whether the employee has the appropriate authorization to drive a private car for business purposes and notifies the dean of the faculty and the rector about this fact. If the employee has passed the appropriate tests and received the above-mentioned authorizations, it becomes a waste to ask the university rector for permission to do so each time he/she travels. If the organizational unit that sends an employee to a conference has secured funds for his delegation, there is no basis for the university rector to refuse such a trip.

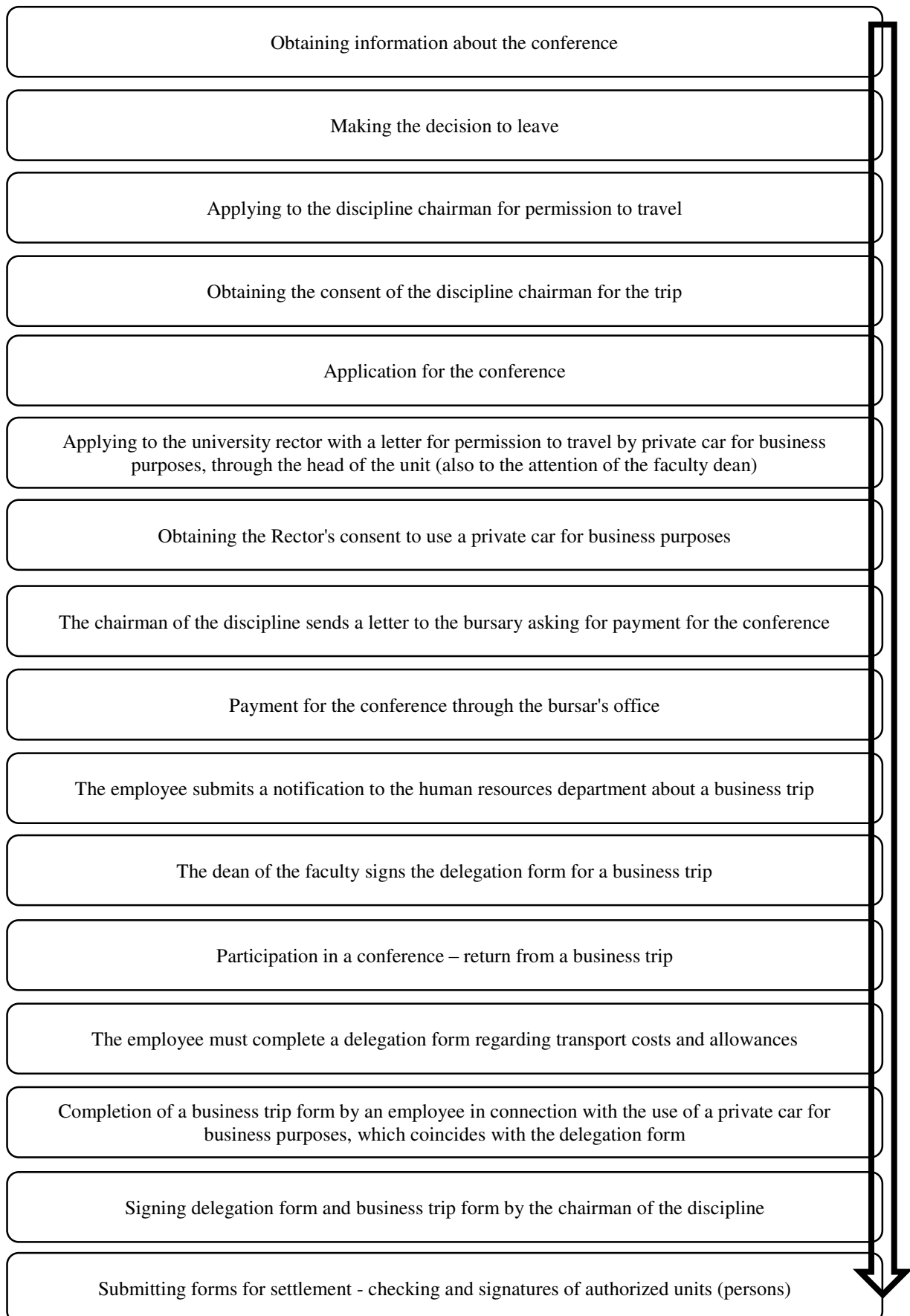


Figure 1. Value Stream Mapping – delegation proces (before). Adapted from: “Lean Management na publicznych uczelniach akademickich” by M. Jakubiec (2021).

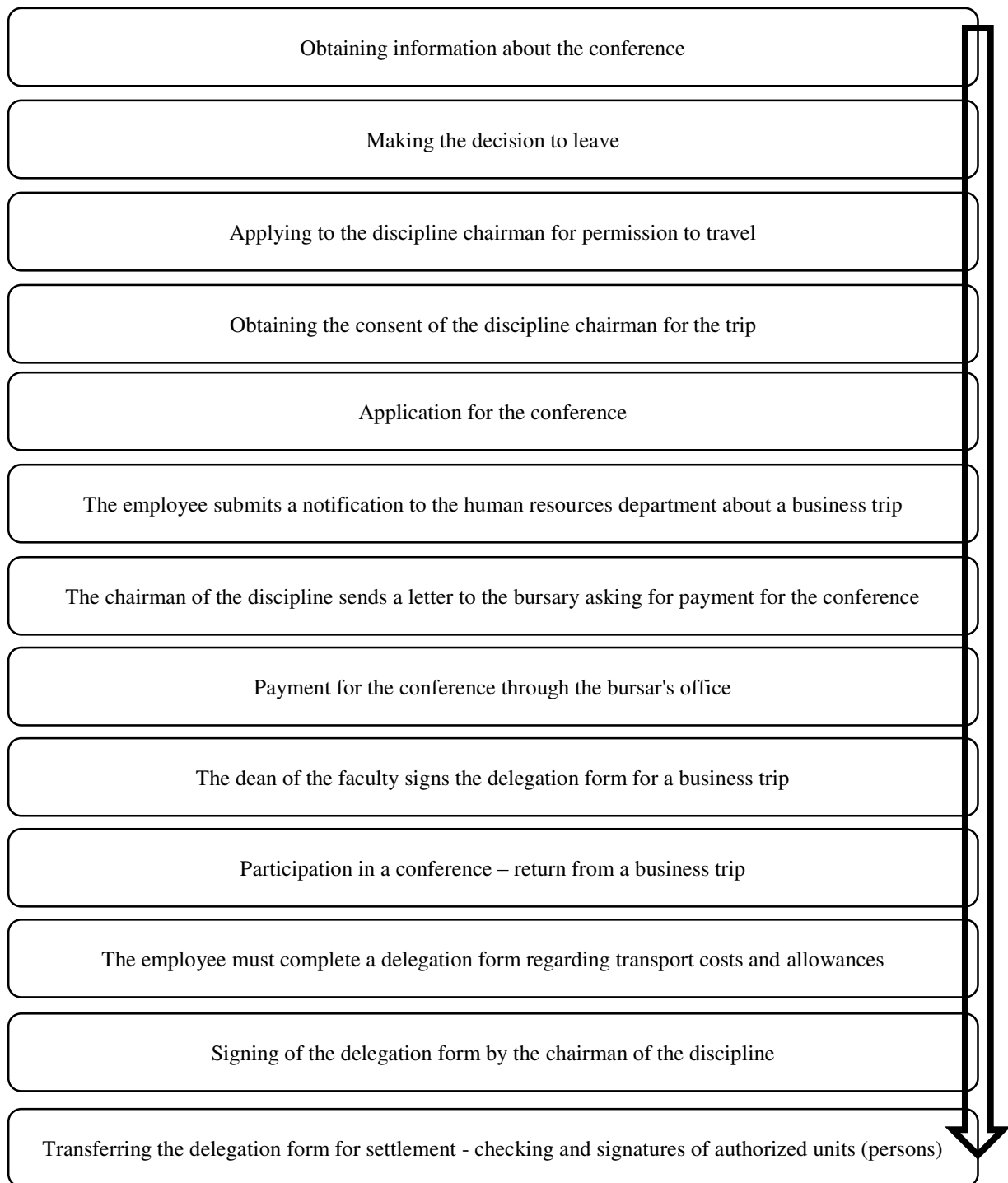


Figure 2. Value Stream Mapping – delegation proces (after). Adapted from: “Lean Management na publicznych uczelniach akademickich” by M. Jakubiec (2021).

2. Elimination of double settlement and reporting of delegations in terms of transport costs and allowances. If there is a formal delegation in circulation that contains all information related to the trip, it is a waste to complete another document signed by the same authorized persons as for the delegation.

The idea of using the Value Stream Mapping instrument, in addition to presenting the instrument itself, was also intended to draw attention to the proper structure of functioning of entities such as universities. Organizing tasks as processes is important. Then the possibilities

for improvement are much greater, and it is not only about reducing the number of tasks or decision points, but about actual improvement bringing measurable benefits related to time, resource consumption and finances.

4. Summary

The topic discussed in the article is important in the context of university management. It concerns instruments that can be used to improve this management. The article was based on the example of the University of Bielsko-Biala. In the context of the topic discussed, the author would like to draw attention to a fragment of research he conducted on a group of public academic universities in Poland in 2019-2020. It concerns selected ways of improving the management of the analyzed universities. The assessment of the degree of application of the presented improvement methods was performed on a Likert scale (from 1 to 5). The results of the analysis are presented in figure 3.

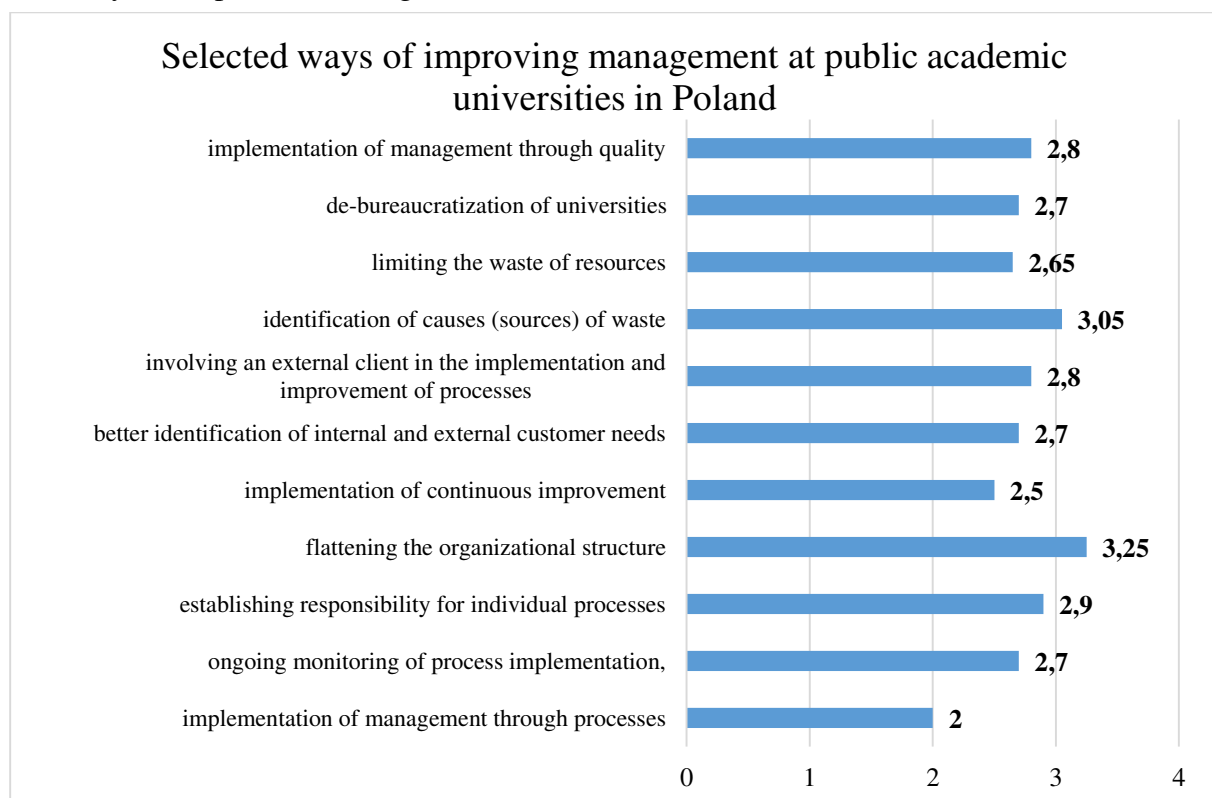


Figure 3. Selected ways of improving management at public academic universities in Poland. Adapted from: “Lean Management na publicznych uczelniach akademickich” by M. Jakubiec (2021).

As part of the research, the limit value of the average degree of application of the analyzed improvement methods was set at 3.0, which was considered sufficient. During the analysis, it turned out that only two improvement methods exceed this limit. These were: flattening the organizational structure (3.25) and identifying the causes (sources) of waste (3.05).

The remaining 9 analyzed improvement methods were considered to be of low use. These were: implementation of management through processes (2.0), implementation of continuous improvement (2.5), limiting the waste of resources (2.65), ongoing monitoring of process implementation (2.7), better identification of internal and external customer needs (2.7), de-bureaucratization of the university (2.7), including the external client in the implementation and improvement of processes (2.8), implementing management through quality (2.8) and establishing responsibility for individual processes (2.9).

The conclusion from the research was the need for further education in the field of management quality and improvement of management quality by undertaking appropriate improvement methods. The implementation of appropriate improvement methods by universities will contribute to more effective achievement of the assumed goals and university-wide organizational improvements.

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EXPLORING LITERATURE ON THE ACCEPTANCE AND APPLICATIONS OF QR CODES FROM MARKETING AND CONSUMERS PERSPECTIVE: A SYSTEMATIC ANALYSIS

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Purpose: In recent years, two-dimensional bar codes, most commonly found in the form of QR (Quick Response) codes, have become widespread. They are used to encode various information that can be read by smartphones, tablets and other electronic devices. The codes can convey information, at the same time triggering certain consumer reactions and behaviours. Despite the increasing use at the time of the pandemic, successful applications in promotional campaigns and a number of benefits for broadening the awareness of products labelled with them, the number of studies on QR codes is unsatisfactory. Adopting a micro-perspective of the consumer and marketing, a review of studies that address QR codes was conducted. The aim of the paper is to present publications and evaluate the current state of research relating to the acceptance and use of QR codes from the perspective of the consumer and marketing, and to identify future recommended lines of research.

Design/methodology/approach: In this study, a systematic review of studies based on two academic publication databases (WoS and Scopus).

Findings: Four main strands of research on QR codes from the consumers perspective were demonstrated: the acceptance of the new communication technology, the impact of the codes on the purchase decision process, their usefulness from the perspective of specific consumer needs, and the appearance and design of the codes. It can be expected that future research will focus on more specific issues, such as the acceptance of QR code technology in specific categories of products and services, including public services, representing a higher level of social trust, which is important in consumer optics. What is important in consumer behaviour are values, including environmental ones (buying environmentally friendly products, willingness to make sacrifices to protect the environment, and awareness of the consequences of consuming unsustainable products). They have so far been neglected in research and are an increasingly important motivation for consumers' information-seeking behaviours through QR scanning.

Originality/value: The findings gathered by the researchers on consumer behaviour toward QR codes can be useful in planning marketing and promotional strategies aimed at sustainable development and responsible consumption. They also serve theoretical and methodological development.

Keywords: QR code, consumer, marketing, marketing communication, systematic review.

Category of the paper: Literature review.

1. Introduction

The expanding scale of mobile device use has brought about significant changes in the ways people communicate, shop and access services. In 2022, more than 60% of Internet users will use mobile devices to surf the Web (Global Mobile Traffic Share by Region 2024, n.d.). While being inside a shop, four in 10 consumers use their phones in order to get access to product information and comparisons online. More than a third (36%) use them while standing in front of a product to compare the price in a shop or on a competing retailer's website (PricewaterhouseCoopers, n.d.). The growing use of mobile devices by consumers makes it justifiable to take a closer look at one form of connectivity between the physical and virtual worlds, namely QR (Quick Response) codes. These codes are one of the most promising technologies for increasing the possibility of influencing the consumer (Rotsios et al., 2022). Invented by Denso Wave in Japan in 1994, originally to track car parts, they began to be used in the pandemic as primarily a form of contactless payment, a vaccination passport, or to facilitate access to information. Today, the codes are a subject of interest due to developments in IoT technology, product identification (including a digital product passport), and concerns regarding the quality of goods. Marketing communication is also an important application area for QR codes (Hossain et al., 2018).

The digital product passport as introduced under the Green Deal in the European Union (Dyrektywa Parlamentu Europejskiego i Rady 2009/125/WE) is a collection of product data specific to a product category, such as the name and location of the manufacturer, how and where it was produced, composition, values, safety rules, but also other information that is desired or can be expected by the consumer (or other participants in the supply chain). The digital passport does not replace the information on the label and packaging but extends it and makes it easier to understand. It can provide up-to-date information about the quality of the product, which changes with time, and storage conditions. Finally, it can strengthen the consumer's experience derived from the relationship with the product. Its carriers are bar codes, QR codes, RFID (radio-frequency identification) or other digital solutions brought about by the development of modern technology. Due to its capacity and easy availability, it is QR code that is the recommended method of labelling by certification bodies such as GS1. The utility of QR codes is tailored to the needs of the supply chain participant (manufacturer, middleman, trade, consumer).

QR codes are a response to consumers' growing need for information about products introduced into the commodity market and their influence on health and life. Genetically modified grains flooding the Polish market during the war in Ukraine, pesticide or plastic content in food, bacterial contamination, defective product quality or counterfeit goods are just a few examples of current consumer concerns that can be mitigated by access to the information offered by the code. QR code labels bring greater transparency to supply channels. Moreover, their widespread adoption is expected to translate into more sustainable consumer behaviour and greater concern for environmental protection. A consumer motivated by environmental values can access detailed information about the path a product has taken and its carbon footprint. Therefore, codes mean access to product information that enhances consumers' position in relation to the retail company or manufacturer and supports them in more informed purchasing decisions.

On the other hand, QR codes are a new channel of brand-consumer communication connecting the offline and online worlds, called mobile communication (Vatanparast Butt, 2009). Unlike the traditional form of marketing communication, mobile devices offer personalized and interactive communication and make it easier for consumers to access marketing messages anywhere and anytime (Ryu, Murdock, 2013). Among the various mobile communication technologies, we distinguish between two forms: push and pull (on-demand). QR codes are assuming an increasingly important place in mobile advertising, since they are considered non-invasive and non-intrusive forms of messages (Narang et al., 2012). Jung et al. (Jung et al., 2012) define QR codes as innovative marketing tools to support companies in advertising products, services and private brands. A number of advertising experts expect QR codes to increase return on investment and boost consumers' interaction with the brand. Research findings indicate (Role of QR codes in advertising 2022, n.d.) that advertising campaigns aimed at Generation Z in particular should use QR codes. In addition, codes are categorized as effective forms of improving DOO (Digital Out-Of-Home) interactivity.

The use of codes increased during the pandemic, which prompted a shift in contactless payments via mobile apps, and QR codes became more popular as customers were able to pay for goods and services without having to physically carry cash or cards. Hamzah (2023) gives the example of Malaysia, where in the pre-pandemic period, interest in cashless transactions remained significantly low among both consumers and sellers. The pressure to remain cautious and detached created an opportunity for a rapid transition away from cash and card payments to contactless payments (after the pandemic, cash payments in that country accounted for 34% of all transactions).

The current state of knowledge on the use of the codes by end users is limited. We know that QRs are used in the home rather than in commercial settings (Ozkaya et al., 2015), more often by practical and highly committed users (Meydanoğlu et al., 2015), and the scale of their application varies from country to country. Users tend to be younger people, referred to as mavens, although research does not always confirm this. This systematic review is one of the first to analyse research on the use of QR codes from the perspective of consumers and marketing. The method adopted for the review is to identify the main directions of ongoing research on QR codes, to identify the penetrated areas of the consumer's relationship with this new communication channel, as well as those unexplored. The following objectives were set before the development of the review:

- to compare and evaluate the methodology of the research carried out to date in relation to the aim of the research and the theoretical framework adopted,
- to identify the research conducted in terms of the object/subject of the research, sample size, methods of analysis adopted,
- to compile the main empirical findings of the research,
- to identify the lines of future research.

An overview of the research can help scholars prepare research methodologies on the ground of the studies completed so far and to facilitate the selection of the scope of possible future research. By indicating synthetic research implications, it can provide a basis for building marketing strategies that shape and consolidate sustainable consumer behaviour.

2. Methodology of the systematic review

To achieve the aims of this paper, a systematic literature review was used. According to Kitchenham and Charters (2007), a systematic literature review is carried out in three stages: formulating the research questions, carrying out the analysis (including establishing the criteria by which the literature will be collected), and reporting. In this study, literature was reviewed from academic databases: Web of Science (WoS) and Scopus. Initial searches in these databases, for QR code/QR codes “all fields” entries, showed that interest in the subject was increasing (Figure 1).

Using OR/AND operators, we conducted several rounds of screening. The search string was (“QR code” or “QR codes”) and (“consumer” or “consumers”) and (“marketing”). Finally, we applied limiting criteria to the categories generally attributed to the disciplines of management and quality and economics and finance (in the field of social sciences); in the case of WoS, these were business, economics, management, and in Scopus: business, management and accounting. The preliminary search returned 37 publications, of which there were 10 in WoS and 27 in Scopus. After rejecting duplicates, we obtained 29 publications, while impaired

accessibility to seven of them caused them to be omitted from further analysis. After a detailed qualitative review of 22 papers, it turned out that four of them were not empirical and used only references to other sources. The final review was based on 18 articles (Table 1).

3. Evaluation of the collected material

A review of the publications in the WoS database and Scopus in which the keyword “QR code” appeared reveals that the first publications date back to 1990, while the largest number were published in 2023 (Figure 1). The vast majority (97%) were written in English and positioned in the area of engineering, computer science, engineering, telecommunication. The share of publications falling into the categories of management, business and economics/business, management and accounting was about 3% in WoS and 6% in Scopus, respectively.

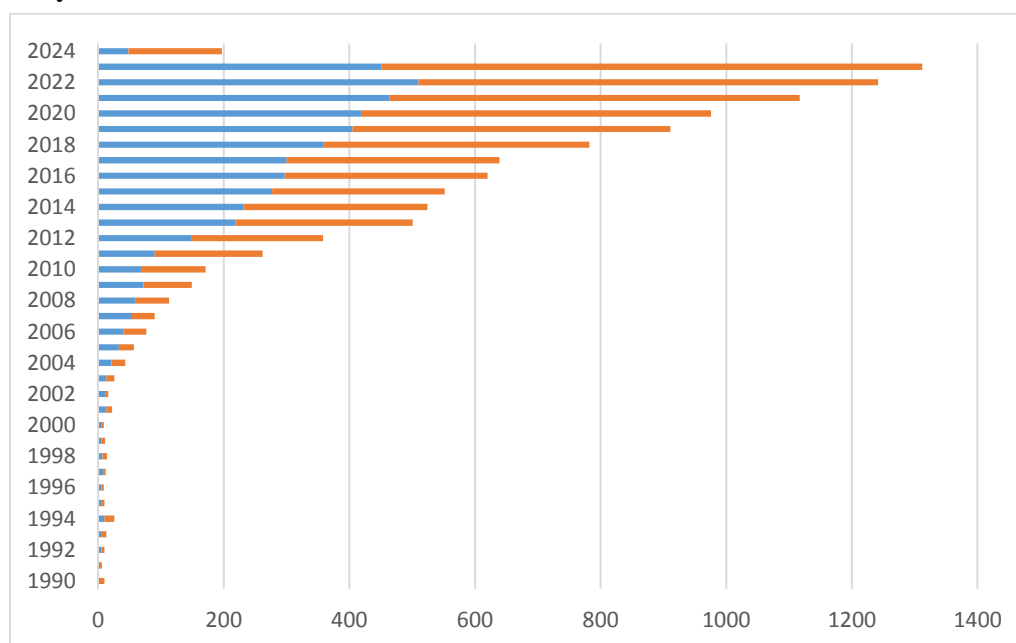


Figure 1. Number of publications in WoS and Scopus databases containing "QR code/QR codes" (all fields, not excluded, until March 2024).

Source: Own compilation based on WoS and Scopus.

An analysis of the results with respect to authors and publishing or funding institutions did not lead to any significant conclusions. The authors were unlikely to continue their studies, or at least they had not yet been published, no specific publisher was evidently interested in the topic, moreover, it was usually a state authority that funded the research.

The research issues focused on four main strands:

- the adoption of innovative communication technology, with a clear emphasis on mobile payments using QR codes (Eren, 2024; Hamzah, 2023; Le, 2022; Osman et al., 2021; Suo et al., 2022);
- the influence of QR codes on consumers' purchase decision process (Chen, Fu, 2015; Meydanoğlu et al., 2015; Trivedi et al., 2020);
- seeking information by specific groups of consumers, including those marked by a certain level of trust (Atkinson, 2013; Bashir, 2022; Ertekin, Pelton, 2015; Lombardi et al., 2017; Ozkaya et al., 2015; Tanner et al., 2019a);
- code features, aesthetics, appearance, brand fit, usability (Hossain et al., 2018; Okazaki et al., 2019a).

In their research projects, authors were most willing to use established theoretical models such as the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), the Modified Unified Theory of Acceptance and Use of Technology (UTAUT2), the Theory of Planned Behaviour (TPB), the Consumer Decision Making Model and the Protection Motivation Theory. Researchers were quite unanimous in pointing to utility, usefulness and enjoyment as factors contributing to the acceptance of QR codes (Bashir, 2022; Osman et al., 2021; Suo et al., 2022). Interestingly, it was emphasized that respondents tended to follow their social group, people important to them (social influence), and that there was a kind of social pressure to behave in a certain way, in this case to use QR codes (Le, 2022; Lombardi et al., 2017; Osman et al., 2021; Suo et al., 2022).

Access to information hidden in a QR code modifies the flow of the purchasing process, especially in its initial stages (Chen, Fu, 2015; Okazaki et al., 2019b; Trivedi et al., 2020), when the consumer is actively seeking product information and is curious about it. Tanner et al. (2019a) emphasize the role of the quality of the information provided. The package of information provided in a QR code is part of omnichannel communication and should be integrated with other marketing messages (Chen, Fu, 2015). If the information is a repetition of that available on the packaging, leaflet or other form of communication, it will be worthless and negatively affect the consumer's experience (Eren, 2024; Lombardi et al., 2017; Sang Ryu, Murdock, 2013). Consumers' trust in the sender is linked to the quality of information available in the QR code - it is higher in the case of government institutions than corporations (Atkinson, 2013). In turn, opinions gathered in focus interviews carried out by Ertekin & Pelton (Ertekin, Pelton, 2015) point to the need to control the information contained in the codes to enhance credibility.

Looking at the results of the review, one should emphasize researchers' interest in identifying segments of consumers who accept and use QR codes. In general, it can be said that researchers agree with the statement that this communication channel is dedicated to a specific group - fairly engaged consumers (Trivedi et al., 2020), causal (Hamzah, 2023; Le, 2022), innovators (Tanner et al., 2019a), motivated by environmental values (Atkinson, 2013; Bashir, 2022) and utilitarian information (Ozkaya et al., 2015), but also by the desire for benefits such as a discount coupon or reward (Meydanoğlu et al., 2015; Trivedi et al., 2020). While the pandemic period influenced the stigmatization of those inclined to use QR codes as those manifesting fear of COVID-19 infection (Hamzah, 2023; Le, 2022), after that time this trait was more likely attributed to a situation of uncertainty when acquiring new, unfamiliar or craft products (Tanner et al., 2019b). Researchers stress that the motivation to use a QR is created by the context of the situation - the appearance and design of the code (Bashir, 2022). The usability of the code and the value of the information conveyed from consumers' perspective motivates them to scan the code, but one cannot underestimate the aesthetic value of the code, which draws attention and encourages a "scan me" action.

Questionnaire surveys dominated the arsenal of research methods used, and there were also experiments and qualitative research (individual and group in-depth interviews). None of the works analyzed used neuromarketing methods, which could be valuable from the perspective of examining the visual attention of codes (eye-tracking) or studies classified as neurometric, such as functional magnetic resonance imaging, positron emission tomography, near-infrared spectroscopy or electroencephalography.

An analysis of the content of the articles led to a few conclusions: the subject of QR codes does not have a satisfactory empirical representation, the available articles, for the most part, residually present the issue of QR codes in the field of marketing, and the authors use only a limited armory of research methods, limited to minor extensions of existing work. It is evident that the topic of QR codes is at an early stage of development, clearly subject to the influence of pandemic habits related to fear of contagion (contactless m-payments, contactless checking of product information in the store) (Eren, 2024; Hamzah, 2023; Suo et al., 2022).

Table 1.*Summary of the research review (n = 18)*

Source	Research aim/model	Method/sample size	Method of analysis	Findings
(Eren, 2024)	Consumer experience with mobile payments via QR code. Research output model: ISSM (Information System Success Model), in which the following were considered: the quality of the system, the quality of the information and the quality of the service.	Questionnaire method, 207 respondents who have had experience with mobile payments via smartphone and QR code (Turkey). Sampling: convenience sampling, purposeful selection, snowballing.	Modelling of structural equations by the partial least squares method (PLS-SEM).	The quality of information and the quality of the system associated with the QR m-payment code positively affect the QR customer experience. The quality of service does not affect the consumer experience. There is no correlation between perceived risk associated with QR code m-payment and the customer experience. The optimistic outlook of users when looking at technology positively affects the QR experience. The positive customer experience associated with QR code m-payment has a favourable impact on the intention to use it in the future.
(Hamzah, 2023)	The acceptance of mobile payments in contactless transactions among retailers in the wake of fear of contamination during cash transactions. The Protection Motivation Theory (PMT) model proposed by Rogers was used (Rogers, 1975).	Questionnaire survey, 448 respondents - small merchants (owner or manager) offering QR code-based mobile payments for one year (Malaysia).	Modelling of structural equations by the partial least squares method (PLS-SEM).	The users are worried about the damage and burden caused by the Covid-19 infection, which makes them intend to continue using mobile payment services. Yet the risk of infection has a limited impact on the continued use of QR payments (the knowledge of infection and safeguards against it increases over time). The merchants are less favourably inclined to use mobile payments when they are more costly and time-consuming than credit and debit card payments. A sense of self-agency influences the willingness to continue with mobile payments. The intention to carry on with mobile payments is stronger for older, but the perceived usability and trust for younger people.
(Suo et al., 2022)	Consumer adoption of QR code mobile payments, UTAUT2 model.	Paper questionnaires distributed in shopping malls, 453 respondents (Malaysia).	Modelling of structural equations SEM -AMOS.	The expected length of effort, facilitating conditions and hedonic motivation are statistically insignificant. Personal innovation, expected performance, social impact, habit and price value are important.

Cont. table 1.

(Bashir, 2022)	Consumers' intention to use QR in order to obtain sustainability-related product information. Technology Acceptance Model (TAM).	Online survey and field experiment with two types of codes (four supermarkets in Oslo, three brands of everyday consumer products, 3,720 codes, actual consumer behaviour), 250 respondents (Norway).	Simple statistical analysis, means, significance tests.	The perceived ease of use and perceived usefulness of QR codes are important predictors of consumer attitudes and intentions to scan QR codes. The visual elements of the codes: the QR code in green with an environmental cue, the call to scan, and the location of the code on the front of the package affect the intention to scan. QR codes with an evocative appearance were scanned at a higher frequency than QR codes. In total, the conversion rate was 4.22% (157 people scanned the code). Scanning might have been influenced by the brand image: the eco-friendlier it has, the greater the consumer's willingness to establish a relationship with this brand.
(Osman et al., 2021)	What factors influence the willingness of millennial tourists to use an e-wallet. Technology Acceptance TAM model (Davis, 1985).	Questionnaire survey, 100 respondents (tourists from Kuala Lumpur, Malaysia).	Simple statistical analysis with the use of SPSS.	Perceived usefulness, ease of use and social influence have an impact on the use of an e-wallet. Security issues were not important to surveyed millennials.
(Le, 2022)	Acceptance of mobile payments using QR, based on UTAUT and PMT (Protection Motivation Theory: perceived health risks related to COVID-19 infection, self-efficacy).	Online survey, 411 respondents (78.8% of the sample were under the age of 30) who have had experience of using QR code mobile payments in supermarkets and shops or intend to use this method in the near future; convenience sampling method (Hanoi, Vietnam).	Modelling of structural equations (CB-SEM).	Behavioural intentions to use QR mobile payments are motivated by key factors arising from PMT fear motivation (perceived severity, perceived susceptibility and a sense of self-efficacy) and important UTAUT factors (including expected outcomes, expected effort time and social impact) and the physical distance norm.

Cont. table 1.

(Trivedi et al., 2020)	The influence of QR codes on the consumer decision-making process, used in ads for products with informational and emotional appeals and with different levels of engagement. Lavidge and Steiner's (1961) hierarchy of effects model, product involvement, informational and emotional appeals in ads.	Secondary data from the Ad Impact Monitor questionnaire survey of print ads with and without QR codes, from 26 high- and low-involvement product categories (Germany). Quota selection by gender, age and place of residence. Questionnaire method.	Multivariate regression model.	The effectiveness of QR codes is greater in the initial stages of the purchasing process in the case of products with a high level of engagement (to encourage information search). The codes are not effective for ads for low-involvement products, with informational messages. Ads for low-involvement products should include messages with emotional appeal (e.g., discounts, coupons, points in a loyalty program). QR codes with emotional appeals with low engagement can stimulate impulsive purchases.
(Okazaki et al., 2019)	How curiosity and complexity of visual design impact the intention to scan a QR code. The initial concepts are curiosity, complexity of the visual object, and brand fit of the advertisement.	Scenario-based experiment (four experimental groups; high/low complexity, good/poor matching). 663 questionnaires, non-random quota selection by age and gender (Spain).	Analysis of covariance ANCOVA.	Curiosity plays a key role in shaping the intention to scan a QR code. Curious consumers are more interested in visually complex ads and have a higher intention to scan the codes. They will scan the code even when adding it to the ad intensifies its complexity. For those less interested in complex adverts, a good fit between the ad and the brand will promote scanning.

Cont. table 1.

(Tanner et al., 2019)	The role of innovation and risk aversion with regard to the adoption and use of QR codes on low-involvement products (yoghurt).	Qualitative study, with semi-structured interview, the selection for the study based on the self-assessment of innovation (DSI scale, 38 out of 430 people were selected) (Ireland).	Means-end chain analysis (MEC), content analysis, thematic analysis using NVVo11 software.	<p>Seeking information online prior to purchase was done outside of the retail outlet despite the existing possibilities for accessing information in the shop. Consumers will be more likely to use QRs as information about product attributes in a retail environment when they offer clear details about the product's function and purpose. The respondents did not consider QR codes as important product attributes. Marauders were negative about the purpose of the codes, showing distrust of the information provided.</p> <p>The codes do not provide added value (everything is on the label).</p> <p>The respondents were confident in their knowledge of the products and declared that they did not need anything other than what was included on the label.</p> <p>Innovators showed more interest in QRs, referring to them especially for local and craft products, as a way to establish a more emotional relationship between the consumer and the producer. Potential promotional offers had a strong impact on the possible use of QRs.</p> <p>The codes should integrate a variety of information: from the retailer, other retailers and producers, and should showcase the product in the broader food landscape.</p>
(Hossain et al., 2018)	The influence of QR codes (usability, acceptability and feasibility) on satisfaction and intention to make an online purchase. The stimulus-organism-response (S-O-R) model.	Questionnaire survey. 420 respondents who have made an online purchase using QR in the past six months (China).	Modelling of structural equations based on covariance.	QR codes have an impact on the volume of online sales because they are useful (easy to use, quickly link to the shopping site, user-friendly), acceptable (graphics and text adequately convey information), feasible (convey up-to-date information). Codes have an immersive effect on the user, inducing satisfaction and leading to purchases.

Cont. table 1.

(Lombard et al., 2017)	Are consumers willing to pay a higher price for additional information about a food product (extra virgin olive oil). TPB - Theory of Planned Behaviour (Ajzen, 1991), TAM - Technology Acceptance Model (Davis, 1989), WTP - willingness to pay.	Questionnaire survey of a representative sample of 1,006 respondents (Italy).	Modelling of structural equations (SEM).	Attitudes and subjective norms influence consumers' willingness to pay for a product with a QR code. Perceived behavioural control (e.g., inability to use QR) negatively affects WTP. Similarly, prior negative experience discourages consumers from using QRs (Internet connections in shops are of poor quality, codes redirect to the manufacturer's website, which is difficult to navigate on a smartphone device). Consumers described as "mavens" have a positive attitude toward using the codes. In contrast, utilitarian motivation negatively affects the propensity to use codes. Consumers with higher hedonic motivation perceive shopping as a pleasant, emotional experience, which is usually accompanied by a social aspect (shopping with friends, family). Hedonic motivation increases the positive evaluation of QRs.
(Ertekin, Pelton, 2015)	Recognizing consumer attitudes toward the use of QR codes.	Focus group interview, 16 respondents from Generation X and Y, three focus groups (US).	-	According to the respondents, it is easy to use QR codes and they provide economic benefits. They want to use them in the future, they like the convenience and quick access to information. Concerns are raised about the quality of the information provided, so they call for increased reliability and control of the information provided by users.
(Meydanoğlu et al., 2015)	The influence of QR codes on the consumer purchase decision process. A model of the buying process (Kotler, Keller, 2011).	Questionnaire method, 759 young respondents (Turkey).	Cross-case analyses, logistic regression, modelling of structural equations (SEM).	The information-seeking process with the use of QRs is initiated by the need to be influenced by marketing incentives (direct contact with the product, shopping situation, advertising) and the curiosity (which can be enhanced by a discount coupon or a reward hidden in the QR) of the consumer. The ease, speed of access and content of the information provided by the QR affect the purchase decision.
(Ozkaya et al., 2015)	Investigating the factors influencing the use of QR codes.	Online survey questionnaire, 79 respondents (QR users, students, US).	Cluster analysis, regression analysis (SPSS, GPower).	The group of practical users (information-seeking and shopping-oriented) use QR codes more often than the group of experience-oriented consumers (socializing, entertainment). Innovator and early adopter consumers do not use QR codes more often than other consumers. Those who own more electronic devices (smartphone, tablet, computer) use QR codes more often, but familiarity with modern devices alone has no significant correlation with QR use. The perceived usefulness of QRs (TAM) is not related to the consumer's use of the codes.

Cont. table 1.

(Chen, Fu, 2015)	Evaluation of the use of mobile automatic identification and data storage technologies.	Qualitative study on a sample of 76 projects subsidized by the Taiwanese government.		<p>The use of various object hyperlinks (including barcode, QR, RFID, GPS, NFC, biometrics) was compared in the context of five stages of the purchasing process. It was found that QR and RFID are the most commonly used technologies. These systems are used in the identification of products and services, automatic payments, and for product comparison. Moreover, they can stimulate needs by providing incentives and advertisements tailored to the context in which the consumer is located (identifying the consumer and where he or she is). They also influence customer loyalty and increase satisfaction (discount codes, reward points).</p> <p>The effective use of hyperlinks serves to increase sales but requires the integration of business processes assigned to the various stages of the consumer purchasing process (the cooperation of marketing, logistics, and customer service).</p>
(Okazaki et al., 2013)	How gender affects the use of QR codes from the perspective of social anxiety (Kashdan, Roberts, 2004) and the level of engagement (Mittal, 1995).	Questionnaire survey with experimental measurement, banking services (high involvement) and supermarkets (low involvement), 667 respondents (Japan).	ANOVA	<p>The results of the study confirm gender differences in loyalty behaviour, with men being more willing to take risks and seek rewards, more willing to give up privacy and security to gain benefits, compared to women, who are conservative in situations of high involvement and uncertainty.</p> <p>Loyalty promotions using QR codes can be an effective tool to engage customers, but social anxiety must be taken into consideration when designing a campaign. Social anxiety was found to negatively affect loyalty.</p>
(Sang Ryu, Murdock, 2013)	Adoption of mobile marketing communications using QR codes. TAM model.	Questionnaire survey, 340 respondents (students, US)	Modelling of structural equations (SEM).	<p>The results of the study confirm that ease of use, usability and enjoyment are key factors influencing the positive attitude and willingness to accept the QR code.</p> <p>“Market mavens” show a strong tendency to adopt the QR code, which means that shops should target their marketing strategies more towards this consumer group.</p> <p>A QR code can be an effective marketing tool, but messages should be easy to use, contain useful and exciting content and be tailored to different consumer groups.</p> <p>The innovative use of QR codes, as in the case of Home Plus (an unmanned shop in Korea), can significantly increase online sales and attract new customers.</p>

Cont. table 1.

(Atkinson, 2013)	The identification of reasons for using mobile advertising in a retail environment. Uses and gratifications (U&G) theory.	Online questionnaire survey, 401 respondents (US).	Multiple regression.	<p>The study confirms the important role of trust as a motivating factor for individuals to use mobile advertising. Trust is an important element in the decision to rely on mobile advertisements, but is viewed here as a broader, institutional influence which encompasses trust in all sources of product information.</p> <p>Both trust in the government and distrust in corporations are significant predictors of the propensity to use QR codes when purchasing sustainable products. Trust in the government is associated with a greater readiness to use the information found on a QR code. In the absence of trust in corporations, consumers reach for QR codes when they are unsure of the truthfulness of claims made by the manufacturer regarding the sustainability of products.</p> <p>Engaging in boycotting (deliberately selecting products for environmental, ethical or political reasons) positively predicts the use of QR codes in the search for information about sustainable products. Boycotting requires greater product knowledge, making the information available on QR codes particularly useful for consumers interested in sustainable products.</p> <p>People with greater awareness of new products and market information are more open to new technologies such as QR codes.</p>
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Source: Own compilation based on WoS and Scopus.

4. Final conclusions

The review conducted, based on 18 studies on the use of QR in consumer communications, compares the research methodologies used, sample sizes, and summarizes the findings gathered. As a consequence of the adopted course of action, a number of interesting conclusions were drawn, but it should be pointed out that the analysis has its limitations. These are due to the limitations adopted concerning the selection of the bases of the scientific publications reviewed as well as the disciplines taken into account. The review was deliberately limited to the disciplines indicated, adopting a micro-perspective of the consumer and the enterprise. The number of publications in “business, management and accounting” journals remains relatively small compared to other disciplines. In contrast, insights into consumer behaviour toward QR can provide a basis for strengthening sustainability-oriented marketing strategies.

It is anticipated that future research should develop issues regarding the value of encoded information, acceptance of the technology with respect to specific product categories, and an analysis of the benefits from the perspective of various industries (including tourism, museums, concerts, healthcare, education) and market participants (manufacturer, middleman, retailer, government, NGO).

One important challenge for the future of QR will involve security issues (QR-phishing scam) and surveillance. Some studies minimize the importance of this problem, but rather based on the opinions of consumers who trust QR codes (Atkinson, 2013; Lombardi et al., 2017; Okazaki et al., 2013). The growing awareness of the use of consumers’ personal data (e.g., consumer location, identification of the device scanning the code) is raising concerns and the need for top-down, legislative restrictions.

The advisability of using QR codes in marketing campaigns should be monitored by the effectiveness and efficiency of this customer communication channel. A prediction should be made of the benefits and costs of using pull communication with QR.

The research review identified the problem of the information desired by the consumer provided in the QR code in the situation of high/low involvement, new/familiar product, in the situation of fear and danger, trust/lack of trust, utilitarian/hedonic motivation. This is a promising and needed current of research in the context of sustainable development.

Codes are criticized for being lacking in aesthetics, an additional element that affects the complexity of the message, increasing the consumer’s cognitive overload. Next-generation codes, having original shape and form, and using colours, can be an artistic experience that invites people to scan and have an emotional relationship with the brand (*You haven’t seen QR codes like this before. They’re like works of art*, 2023).

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RISK MANAGEMENT IN THE SUPPLY CHAIN IN THE LIGHT OF THE ENTERPRISES' EXPERIENCES DURING THE COVID-19 PANDEMIC

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Purpose: The purpose of the study was to identify key reasons for intensifying risk management activities in supply chains. To achieve the objective, the following research hypotheses were adopted: H1 - the extent of business activity is not correlated with problems related to demand constraints and timeliness of payments, H2 - disruptions in supply chain continuity during a COVID-19 pandemic are independent of the type of chain.

Design/methodology/approach: These paper highlights the importance of risk management in the supply chain management in addressing the pandemic induced disruptions and supply chain risk management activities. Achieving the stated goal requires answering two questions: (1) What problems are companies facing due to the coronavirus pandemic, and (2) What actions are companies taking to ensure supply chain continuity, especially in Poland conditions. 137 enterprises participated in the research, including 118 with foreign capital. The survey was conducted online. The research sample included entities from the manufacturing, trading, and service sectors located throughout Poland. Companies were selected using a snowball method, starting with supply chain managers from friendly entities and asking them to identify other entities that could take part in the study.

Findings: The research showed that the continuity of supply chains in Poland was not maintained, and companies were able to keep inventories only at a minimum level. The research also analysed the impact of remote work on the effects of the functioning of enterprises and assessed the effects of support under anti-crisis shields.

Originality/value: The research has been carried out in order to identify the factors that have the greatest influence on the efficiency of the supply chains of Polish enterprises. The research showed that the continuity of supply chains in Poland was not maintained, and companies were able to keep inventories only at a minimum level.

Keywords: risk, risk management, supply chain, COVID-19, pandemic, enterprise, Poland.

Category of the paper: research paper.

Introduction

Supply chains that form a network of organizations involved, through links with suppliers and customers in various processes and activities that create value in the form of delivered consumers are extremely complex systems of interconnected vessels. In managing such a complex structure, there are always events and phenomena that are difficult to predict, and the probability of violating any of the links is usually high. Therefore, skilful risk management in supply chains becomes a key competence (Bevilacqua et al., 2020). This became particularly apparent after the shock of the SARS-CoV-2 pandemic, at which time all players, regardless of industry, had to take a series of countermeasures to ensure their continued operation and viability.

For almost two years, the world has been overwhelmed by problems resulting from the SARS-CoV-2 pandemic. The pandemic has redefined the way companies look at the world. The prevalence of health problems has changed the balance between productivity, profitability, job security, occupational health, and the environment. It has restricted access to labour and imposed social distance (Ashokka, 2020). COVID-19 has caused massive disruption to global supply chains. The pandemic is an example of the so-called black swan, i.e. an unpredictable event with a huge impact on the reality a high diversity of risks (Taleb, 2007). The factor that makes the SARS-CoV-2 pandemic different from other threats that have taken place in recent decades is its global scope and duration. As a high-risk event, the pandemic has triggered an unprecedented crisis and exposed the flaws in the existing supply chain management system and the vulnerability of companies working with a limited number of trading partners, often located in remote parts of the world. Due to the supply chain disruptions, companies dependent on global sourcing had to make difficult decisions regarding crisis management strategies. The decisions made can be affected by both the lack of labour to physically move goods and government restrictions on the operation of seaports and airports, causing difficulties in loading and unloading goods (Schoenfeld, 2020).

In such a complex structure like supply chains there is always a threat of random events and phenomena that cannot be fully predicted due to unknown causes, as in the case of the COVID-19 pandemic. COVID-19 not only caused a global tragedy (human deaths - from the beginning pandemic 5.01.2020 to 25.02.2024, there have been 774 771 178 confirmed cases of COVID-19, reported to WHO (<https://covid19.who.int>, 10.03.2024) but also affected supply chains. Therefore, the importance of risk management in the supply chain, understood as a decision-making process supporting the achievement of the planned goal at optimal cost with the help of procedures that enable the complete elimination or reduction to an acceptable level of any risks that threaten its achievement, increased. The pandemic has disrupted supply chains, forced businesses to remodel their structures and make concerted efforts to reduce potential risks in a post-pandemic world (Jabbour et al., 2020; Paul et al., 2021; Yang et al., 2020).

With this in mind, the goal of the article is to identify pandemic-induced disruptions and supply chain risk management activities. Achieving the stated goal requires answering two questions: (1) What problems are companies facing due to the coronavirus pandemic, and (2) What actions are companies taking to ensure supply chain continuity. The following hypothesis was adopted: the COVID-19 pandemic has disrupted supply chains, regardless of the nature of the business. In addition, it was assumed that the extent of business activity is not correlated with problems related to demand constraints and timeliness of payments. The study used methods of descriptive statistics and basic methods of statistical inference to test the relationship between variables (chi-square independence test).

Our research is relevant to both theory and practice. We point to a model-based approach to risk management, highlighting the need to take into account factors caused by the pandemic, and thus develop complex scenarios. The assumption that the pandemic disrupted all supply chains, regardless of industry, has been positively validated. The practical dimension of our research is reflected in the discussion of the results obtained.

This research logic determined the structure of the article. The first step of the research was a literature review, where the main focus was on presenting the nature of risk and its management in the supply chain in the era of the pandemic. The methodology describes the data collection and analysis process that was used to understand the impact of the pandemic on risk management in supply chains. We identify the determinants of supply chain risk management during a pandemic based on empirical research. The problems faced by companies after the pandemic outbreak are identified, as well as the steps that players had to take to stay in business. The research design is presented in Section 2. This section presents the rationale for undertaking research, methodology of the research. The paper ends with conclusions summing up the achievements of the undertaken problem – Section 3. Conclusions are presented in Section 4. It concludes by highlighting the consequences of a lack of risk management for all links in globalized supply chains and the need for a strategic approach to the issue.

Literature review

The management of supply chains relies on the active and systematic flow of goods and services, which includes all processes that transform raw materials into final products (Best, Williams, 2021; Tang, 2005). Risk is an inherent feature of supply chain management resulting from its complex structure. We can define it as a danger or threat that may prevent the achievement of the company's set goals.

Over the last 20 years, supply chain management has become a more sophisticated discipline. To cope with such turbulences and the changes inherent in today's supply chains, great attention, both in practice and research, has been given to strategies that minimize supply chain risks (Bakshi, Kleindorfer, 2009; Hendricks et al., 2009; Kern et al., 2012; Wieland, Wallenburg, 2012; Pisz, Kauf, 2022). The fundamental vision has been to create an integrated approach to a company's end-to-end supply chain, from the furthest upstream suppliers to its end customers, with participants working in concert toward common goals. Through practices such as lean manufacturing, outsourcing, and supplier consolidation, companies have made tremendous progress in achieving that vision. For many companies and their customers these efforts have led to lower costs, higher quality, shorter time to market, and increased business agility (Marchese, Paramasivam, 2013).

On one hand risk in business is becoming an increasingly important issue, mainly as a result of constantly increasing consumer awareness and intensifying globalisation processes. Globalisation processes started just after World War II. Companies looked for opportunities to save costs and began to enter into strategic alliances (through outsourcing and foreign direct investment) with entities located even in the most remote parts of the world. Production facilities moved from countries with high labour costs to Asia and Africa, where labour costs were low. This resulted not only in cost efficiencies but also in market expansion (Caniato et al., 2015; Caniato, Größler, 2015). Expanding the territorial coverage entails an increase in the dynamics of market processes, forcing a fast and flexible response to changing demand. Each time, this is accompanied by uncertainty and unpredictability. As a result, global supply chains are exposed to a number of risks, such as long execution times, delays, and over- or understocking. On top of this, there are risks typical of countries in which partners in the chain are based, which leads to a snowballing effect for local high-risk events.

On the other hand The Global Risks Report (2024) year warned of potential knock-on economic risks that are now clear and present dangers in many area of life and economics. Supply chain disruptions, inflation, debt, labor market gaps, protectionism and educational disparities are moving the world economy into choppy waters that both rapidly and slowly recovering countries alike will need to navigate to restore social cohesion, boost employment and thrive. These difficulties are impeding the visibility of emerging challenges, which include climate transition disorder, increased cyber vulnerabilities, greater barriers to international mobility, and crowding and competition in space (Figure 1). The Global Risk Report 2024 19th edition identifies tensions that will result from diverging trajectories and approaches within and between countries and then examines the risks that could arise from such tensions. This year's report also highlights the implications of these risks for individuals, governments and businesses (GRIR, 2024).

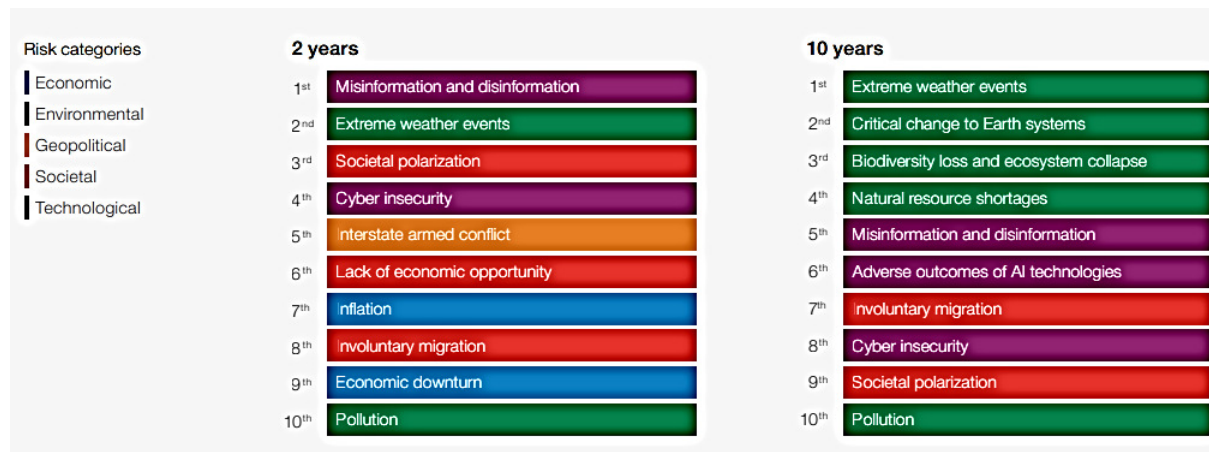


Figure 1. Identify the most severe risks on a global scale over the next 10 years.

Source: The Global Risks Report 2024, 19th Edition, World Economic Forum, 2024.

Risk management in the supply chain is a critical and increasingly complex issue. As economic practice shows, supply and sales markets are becoming gradually more distant from each other, while supply chains are becoming longer, more complex, and involve more partners. Moreover, given the constant economic changes (as a result of the global economic crisis and the uncertainty of the economic situation), political changes (growing threat of terrorism, wars, other military operations, and ship hijacking by pirates), technological changes (new technologies and shorter product life cycles), social changes (growing consumer awareness and demands, development of the information society, and faster spread of epidemics due to greater mobility of people), and climatic changes (increasingly frequent natural disasters, such as hurricanes and earthquakes) as well as the outbreak of the COVID-19 pandemic, the risk of the supply chain disruptions significantly increases.

Knowledge of supply chain risks is a critical success factor for the efficiency of the supply chain. The ability to anticipate risks and develop a scenario for use in an emergency is a key process for risk management in supply chains (Bakshi, Kleindorfer, 2009; Hendricks et al., 2009; Kern et al., 2012; Sodhi et al., 2012; Sharma et al., 2021).

Risk management at every node of a supply chain can help to prevent cascade failure of the supply chain (Wieland, Wallenburg, 2012). We should add that each node within a supply chain should play a value-adding role, additionally some nodes are typically more critical than others, for example production node or distribution node (Jüttner, Maklan, 2010; Lin, Wang, 2011). With respect to the field of risk management in the area of supply chain, this has been brought into full view because of COVID-19 pandemic. To cope with such turbulences as COVID-19 pandemic in today's supply chains, great attention, both in practice and research, has been given to strategies that minimize supply chain risks. The pandemic showed the increased role of risk management in the global chains, where the most of nodes gathered in the supply chains are located in the China (Dmitry et al., 2019; Dmitry, Das, 2020).

Rangel et al. (2015) identifies a lack of consensus among authors regarding the types of risks that affect supply chains and proposes a supply chain risk classification to address this gap. Paulsson (2003) characterizes the existing scientific knowledge in supply chain risk management and finds that the research area is fairly new and limited in terms of the number of articles available. Jüttner et al. (2003) emphasizes that the concepts of supply chain vulnerability and risk management are still in their infancy and calls for future research in this area. Singhal et al. (2011) discusses the need to consider risk issues as prime concerns in supply chains and provides a multi-layered taxonomy to classify and codify the literature, suggesting future research directions. Taschner & Charifzadeh (2020) emphasize that risk management is crucial in supply chains and suggests potential risk responses such as adapting the supply chain design and adopting a collaborative approach with supply chain partners. Vilko et al., (2011) focuses on the need for information exchange and cooperation among supply chain actors to effectively manage risks. Wiengarten 2016 explores the role of risk and risk management practices in the success of supply chain integration, suggesting that supplier integration and supply chain risk management practices can be effective even in high-risk environments. Ouabouch & Paché (2014) focuses on the impact of risks on the logistical performance of supply chains, emphasizing the need to anticipate and manage risks for maintaining a competitive advantage. Overall, these papers underscore the critical role of risk management in ensuring the resilience and performance of supply chains.

Jafarnejad et al. (2014) identifies financial risks, demand risks, and supply risks as the most important risks in the context of small and medium-sized enterprises (SMEs). Narasimhan et al. (2009) emphasizes the significance of risk management in supply chains due to industry trends such as strategic outsourcing, globalization, and reliance on suppliers and supply networks. Ouabouch 2014 examines the impact of risks in the upstream and downstream supply chain on logistical performance, based on a survey of Moroccan manufacturers. Bahroun (2015) focuses on the modern retail supply chain and emphasizes the need for decision support tools to manage supply chain risks, proposing a framework for categorizing risks and assessing their impact on performance. In summary, these papers collectively emphasize the importance of risk management in supply chains and provide insights into identifying, assessing, and managing various risks in different contexts.

Additionally, these papers collectively highlight the importance of risk management in the supply chain and identify areas for further research. Bahroun (2015) emphasizes the need for decision support tools to manage supply chain risks in the modern retail industry. Singhal (2011) discusses the impact of outsourcing and global partnerships on supply chain vulnerabilities and proposes a taxonomy for classifying and codifying risk issues. Pfohl et al. (2010) provides an overview of the state of the art in supply chain risk management research and offers a roadmap for its implementation in practice. Narasimhan (2009) acknowledges the significance of risk management in supply chains and highlights the need for further research

in this area. Overall, these papers underscore the need for effective risk management strategies in the supply chain and suggest avenues for future investigation.

Mańkowski et al. (2022) identifies three research gaps in managing supply chains during the pandemic, including concepts, methods, and tools for supply chain management. Fares & Lloret (2023) identify barriers to supply chain performance measurement during disruptions like the pandemic, such as uncertainty of investment and disrupted cash flows. Van Hoek (2021) explores the progress of supply chain risk management during the first year of the pandemic, finding that risks have increased in severity and that multifaceted approaches are needed for risk mitigation. Queiroz et al. (2020) highlights the impacts of epidemic outbreaks on supply chains, emphasizing the need for adaptation, digitalization, and sustainability in supply chain management during the pandemic. Ma'ady 2022 focuses on the importance of supply chain resilience during the pandemic for enterprise risk management. These papers collectively provide insights into the challenges and strategies for managing supply chain risks during the COVID-19 pandemic.

Additionally, these papers provide insights into risk management in supply chains during the COVID-19 pandemic. Trautrimis et al., (2020) highlights that the pandemic has increased the vulnerability of workers to modern slavery in supply chains. Woong & Goh (2021) identify various risk management strategies employed by companies, with partnerships being the most frequently used strategy. El Baz & Ruel (2020) emphasize the role of supply chain risk management practices in enhancing supply chain resilience and robustness during disruptions. Szuster & Lotko (2022) discuss the need for a change in attitude towards risk management due to the impact of the pandemic. Overall, these papers emphasize the importance of proactive risk management approaches and the need for collaboration and adaptability in supply chains during times of crisis.

Capgemini's study "Rethinking chain resilience for an after-COVID-19 world" (Capgemini, 2021) found that more than 80% of companies have experienced pandemic-related disruption to their supply chains. Sherman (2020) reports that as many as 94% of Fortune 1000 companies have experienced disruptions resulting from COVID-19. Ernst&Young (2020) indicates that only 20% out of the 500 managers of the largest global corporations were confident in their ability to react quickly to such a big risk. The main causes of disruption included supply delays and international trade restrictions (Capgemini, 2021). Faced with disruptions on the demand and supply side, global supply chains have proven to be inflexible. The pandemic has disrupted many lean supply chain operations that rely on Just in Time and zero inventory management strategies, making them excessively susceptible to epidemic disruption. This forced executives and supply chain managers to almost immediately modify their supply chains and move towards agile and resilient approach to effectively manage black swan events (Belhadi et al., 2021). While it is possible to identify the short- and medium-term effects of COVID-19 given the persistent epidemic state, the long-term ones still remain

undetermined. Therefore, in supply chain risk management, on-going measures should not overshadow strategic considerations as short-term changes have a long-term impact.

The SARS-CoV-2 epidemic in Wuhan, China, has stopped imports of many key components to countries in Europe and beyond. As a result, the existing supply chains have been disrupted and relationships with suppliers and customers had to be re-examined with respect to the following risks:

- input risks involving delivery of goods from suppliers and their capabilities to provide goods (delays in delivery due to pandemic restrictions, the need to renegotiate payment terms, delays in the transport of goods due to local restrictions, such as closure of airports and seaports or border difficulties, and shortage of staff to receive shipments);
- output risks involving delivery of goods to customers (shortage of goods in the warehouse, the need to adapt packaging to new sanitary requirements, changed means of transport, and shortage of transport staff).

The crisis triggered by COVID-19 has made companies realise that relying on suppliers from just one region is too risky. The same is true for multi-tiered, geographically dispersed networks of subcontractors as a single disruption can lead to a knock-on effect. Therefore, in the short term, it seems necessary to identify products that are particularly dependent on a single supplier and consider diversification of supply sources and allocation of stocks. It is likely that managers will consider regions that they have not taken into account so far. Costs will certainly play a major role although not necessarily as a decisive factor. Companies will particularly focus on procedures to handle a crisis, such as a positive COVID-19 test, and how they are prepared to work remotely, implement new technologies, and find new ways to serve customers. The number and location of subcontractors will also be important. To mitigate the knock-on effects in the medium term, the following measures may be useful: (1) safety stock buffers for critical components and (2) time buffers (delay in the production of goods for which demand is unpredictable) (McMaster et al., 2020). In this respect, current and forecast demand should be continuously analysed based on information from key customers and the related risks should be assessed (Teodoro, Rodriguez, 2020). Identification of products available from stock also plays a significant role. Classifying the products by priority can be a starting point in determining production priorities and assessing the stockout risk. To classify the components required for production in a simple way, the classical ABC analysis can be used (Kauf, Thuczak, 2015). Due to the risk of large fluctuations in supply, some companies may seek to hold more stock, relying too heavily on capital.

In the long term, based on the analysis of the potential risks and benefits and being aware of the excessive interdependence of economies resulting from globalisation, companies may decide to regionalise their supply chain. Regionalisation can not only mitigate the effects of disruption but also reduce transport-related delivery costs and the cost of renting warehouse space as a result of shorter delivery times.

Risks of global chains arise from many internal and external factors. Some are related to macro trends - with the increasing globalization of supply chains and the increasing importance of the links between them, chains become more and more susceptible to disruptions. Other risks arise from the continued drive to improve efficiency and reduce operating costs. It is typical for supply chains be faced with the pressure of maintaining short lead times and low costs. Relying on a small number of suppliers can heighten risk of supply chains disruption in unexpected circumstances, as seen with the global COVID-19 pandemic.

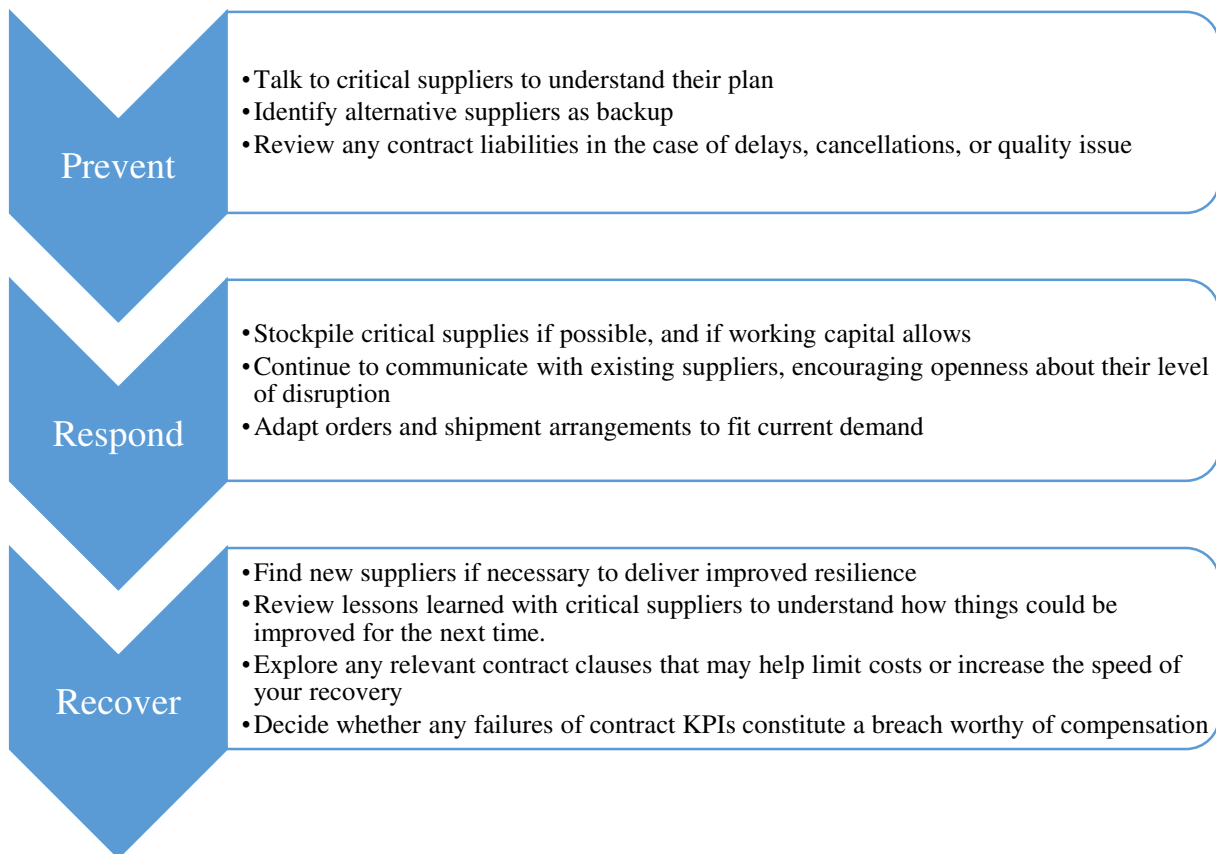


Figure 2. A three-step risk management plan Complex systems of polygamous holes made from one cluster to several coal deposits.

Source: own elaboration.

In the age of pandemics, in evaluating the effectiveness of the existing supply chain or planning its reorganisation, companies should (1) identify key suppliers; (2) consider diversification and regionalisation of the supply chain; (3) identify alternative sources of supply for suppliers in high-risk regions; and (4) build relationships with suppliers without a multi-stage, geographically dispersed network of subcontractors. By creating a simple three-step action plan, they can manage the impact of the COVID-19 pandemic (Figure 2).

Developing a comprehensive action plan will make the supply chain more flexible making it easy to quickly change a supplier. Those companies that manage to build strong relationships with key suppliers as well as develop and implement systems to ensure transparency across the

supply network will become more resilient to disruption and more quickly return to operation and a state prior to the black-swan disruption (Dolittle, 2021).

As previously indicated, the SARS-CoV-2 pandemic is a unique set of circumstances, different from events that have appropriate risk mitigation mechanisms and strategies in place. Over a period of almost two years of the pandemic, there have been different experiences and thus different ways of mitigating risks are required. It is not surprising that there is a lot of research (Ketchen, Craighead, 2020; Van Hoek, 2021) intended to provide ideas and solutions that can be applied to reduce supply chain risk.

There is a timely motivation to investigate supply chains in this uncertain situations. Disruptions in the functioning of global supply chains have become an impulse to conduct research among entities, especially located in Poland. The purpose of the research is to identify the key reasons for intensifying activities around risk management in the supply chains. Therefore, this paper attempts to identify the risk supply chains under COVID-19 pandemic in the context of already existing research in literature and on the own research in the Polish chosen companies. The research showed that the continuity of supply chains in Poland was not maintained, and companies were able to keep inventories only at a minimum level. As a result of the disruptions, many entities decided to reevaluate their activities, moving some of them to the network, in particular in terms of sales and customer service. The research also analysed the impact of remote work on the effects of the functioning of enterprises and assessed the effects of support under anti-crisis shields.

Research methods

Disruptions in the operation of global supply chains have triggered research among entities located in Poland. To explore companies' experiences during the pandemic and mitigation techniques, a survey questionnaire was used to ask respondents about the key issues they faced during the pandemic, particularly those related to maintaining the continuity of supply chains. Respondents were asked about changes in procurement during the pandemic and the automation tools that helped mitigate disruptions and improve pandemic supply chain management. The focus was on the measures taken by the companies to ensure the continuity of their supply chains. To identify the influence of various factors on the entities, closed single-choice, semi-open multiple-choice, and Likert scale questions were used in the questionnaire.

- H1 - the extent of business activity is not correlated with problems related to demand constraints and timeliness of payments,
- H2 - disruptions in supply chain continuity during a pandemic are independent of the type of chain.

Taking into account the adopted research objective and hypotheses, the survey questionnaire was developed taking into account the multidimensional and multifaceted impact of the pandemic on the operation of supply chains. Key variables such as availability of supplies, decrease in demand, reduction in employment, need to keep inventories at a lower level, lack of supplies, delays in deliveries for assessing risks were identified on the basis of a review of the literature on the subject, newspaper articles, reports from national and international institutions and consultations with experts in the field of supply chain management. The questionnaire items and response scales were constructed in accordance with the accepted principles of question formulation and scaling. The results obtained from the survey were subjected to a validation process, i.e. checked for completeness, reliability and distribution of variables.

The survey was conducted online. The research sample included entities from the manufacturing, trading, and service sectors located throughout Poland. Companies were selected using a snowball method, starting with supply chain managers from friendly entities and asking them to identify other entities that could take part in the study. Although the sampling was determined by the availability of respondents, it was possible to gather a relatively large base of entities (845 companies) involved in various supply chains. At the turn of May and June 2021, the entities received e-mails with a link to the survey attached asking them to complete the questionnaire. As much as 137 companies responded, including 118 with foreign capital. The response rate was 16.2%, which is a satisfactory result.

The largest share was accounted for by companies that carried out manufacturing activities (52%), followed by trading companies (31%) and service companies (17%) (Figure 3).

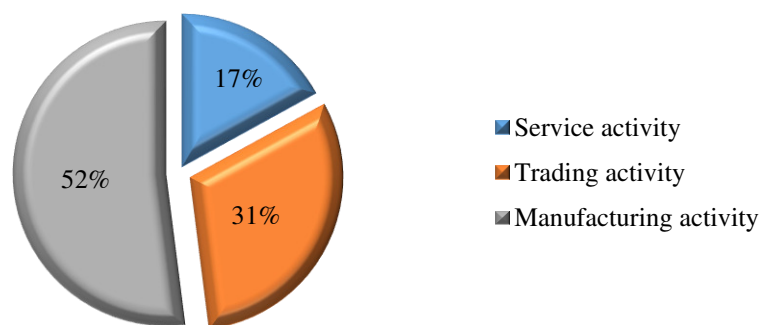


Figure 3. Structure of companies by activity.

Source: own elaboration.

The companies varied in terms of the number of employees. The companies employing up to 50 people prevailed and companies employing over 250 people were represented by the fewest respondents (11%).

Although this sampling is not representative, thanks to the great diversity of businesses and the range of influence of the entities, it is possible to conduct an extensive analysis, not limited to a particular industry or position in the supply chain.

The data were analysed using descriptive statistics methods showing changes in responses to individual questions and basic statistical inference methods for examining relationships between variables (chi-square test).

Discussion of the results

Risks to supply chains during the pandemic arise from both internal and external factors. The factors most frequently reported by respondents include (1) staff shortages due to some staff being in quarantine and on care leave, (2) insolvency of contractors, (3) delays in payment, and (4) reduction in demand for the goods offered (Figure 4).

The data in the figure shows the reduction in demand for the services/products offered and timeliness of paying for orders (about 37% of respondents) were the key factors. Based on the results of the chi-square test, it can be concluded that there is no relationship between the occurrence of problems and the type of activity carried out by the respondents ($\chi^2 = 2.38517$, p-value = 0.495702 for the reduction in demand and $\chi^2 = 3.2538$, p-value = 0.187727 for timeliness of payment).

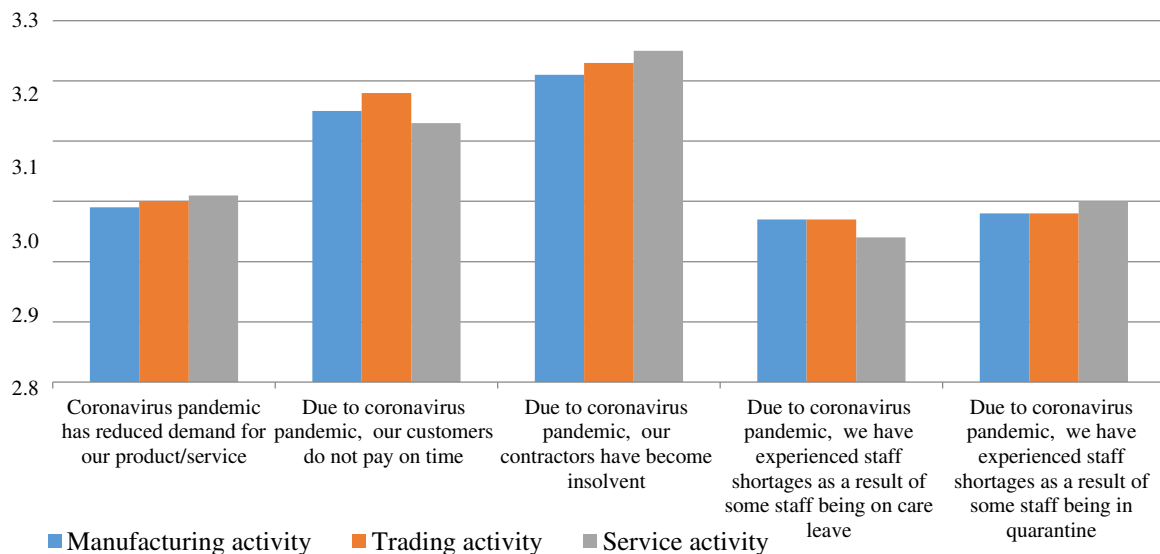


Figure 4. Most frequent problems by type of business.

Source: own elaboration.

The problems experienced during the pandemic did not have an impact on staff reductions; 110 respondents indicated that they were not forced to dismiss some staff. Staff shortages due to some staff being in quarantine or isolation and on care leave due to the closure of kindergartens and schools were more onerous. The problems depended on the number of employees employed, being far less frequent in companies with more than 250 employees (8% of respondents) than in companies with up to 10 employees (38% of respondents).

The difficult period of the pandemic affected the continuity of the supply chain. In this area, respondents highlighted the following factors: (1) problems with supplies from abroad; (2) the need to keep stocks at the lowest level; (3) broken supply chains due to the lack of supplies; (4) delays in supplies; (5) broken supply chains due to the supplier bankruptcy.

Most problems were diagnosed in the area of timeliness of deliveries (30% of respondents), twice as often there were shortages of deliveries (15% of respondents). There were correlations for timely deliveries and shortages with the type of business, each time the p-value was 0.0000. Supply issues have translated into inventory levels, with 30% of businesses resulting in keeping inventory at a minimum for an extended period of time. Here, however, was no relationship with the type of activity ($\chi^2 = 4.68862$, $p = 0.570571$).

Supply-related changes during the pandemic resulted in an increase in foreign suppliers (37% of indications), which was associated with the occurrence of a foreign ownership relationship ($\chi^2 = 4.15873$, $p = 0.164283$). The decision to increase the number of foreign suppliers was made mainly in enterprises where the owners represented foreign capital.

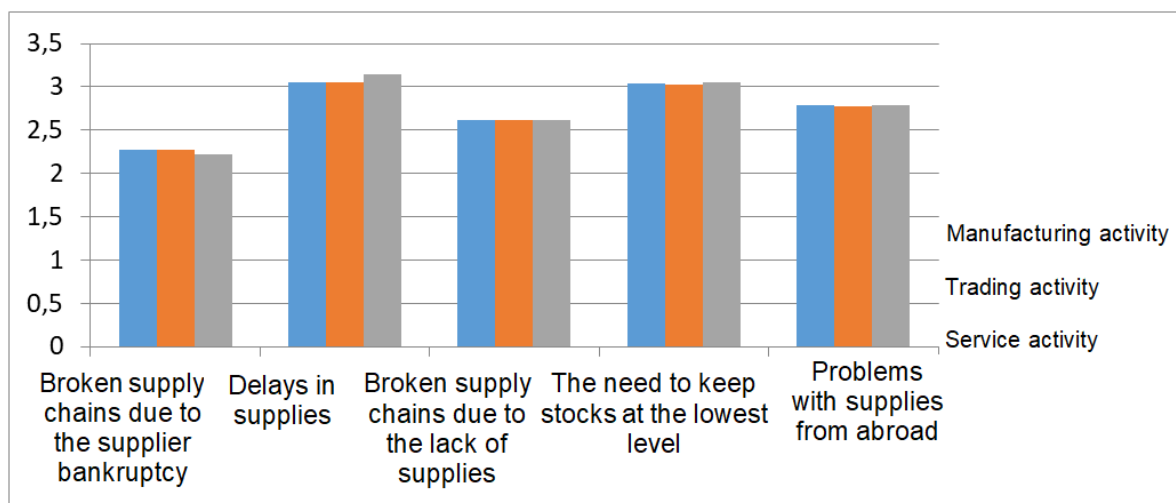


Figure 5. Problems affecting supply chain continuity by type of business.

Source: own elaboration.

The pandemic has forced entrepreneurs to move their business from the real world to the virtual reality. The departments that were most often moved to the virtual reality were sales (32%) and customer service (33%). However, as many as 58% of the respondents chose not to move their business online and this was not related to the type of business ($\chi^2 = 2.99900$, $p = 0.223242$). The restrictions put in place during the pandemic caused some employees to take advantage of the remote work opportunity. Employees from the following departments used this opportunity most often: accounting and human resources (43%), sales (44%), and customer service (37%). Based on the significance test of differences and at the 5% significance level, it was determined that there were no differences between the listed occupational groups. The remote form of work is associated with difficulties in interpersonal contact, while it does not affect the efficiency of employees and does not delay the implementation of tasks (Table 1).

Table 1.*Occurrence of problems during remote work*

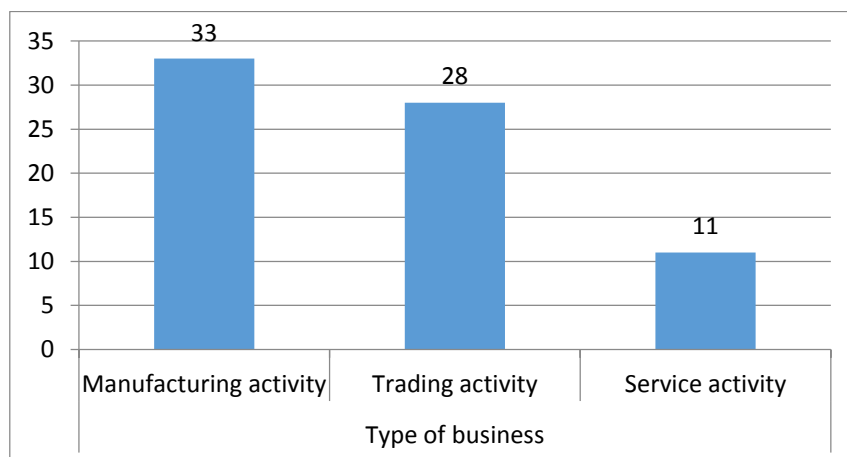
Answers	Remote work has made it harder to connect with people	Remote work has slowed down tasks	Remote work has reduced the effectiveness of our workforce
I disagree	1	63	59
I don't have an opinion	27	39	46
I agree	83	9	5

Source: own study.

The time of the pandemic necessitated other improvements besides remote working to maintain supply chain continuity. They include (1) intensifying the use of e-mail and telephone communication; (2) placing orders in advance; (3) intensifying cooperation with the local market; (4) increasing the level of inventory held; (5) strengthening cooperation with existing partners; and (6) monitoring the financial condition of regular contractors.

It was also important to comply with the requirements of the restrictions, including maintaining a social distance and a sanitary regime. In companies with continuous and shift work (mainly manufacturing), it has become critical to separate workers and maintain breaks between shifts.

In order to mitigate the effects of the COVID-19 pandemic on many businesses, the government has drafted what is known as an “anti-crisis shield.” Among the surveyed companies, a little more than a half (54%) received aid under the Government Anti-Crisis Shield (Figure 6), but it should be noted that this aid was much more often obtained by companies that were involved in production or trade. The report „Tarcza kryzysowa. Koło ratunkowe dla firm i gospodarki? [Anti-Crisis Shield. A safety net for companies and the economy?]” (Dębowska et al., 2021) shows that 86% of the surveyed companies were beneficiaries of the solutions available in the anti-crisis shield. Most of them (92%) used more than one aid instrument (Figure 7).

**Figure 6.** Aid under the Government Anti-Crisis Shield by type of business.

Source: own study.

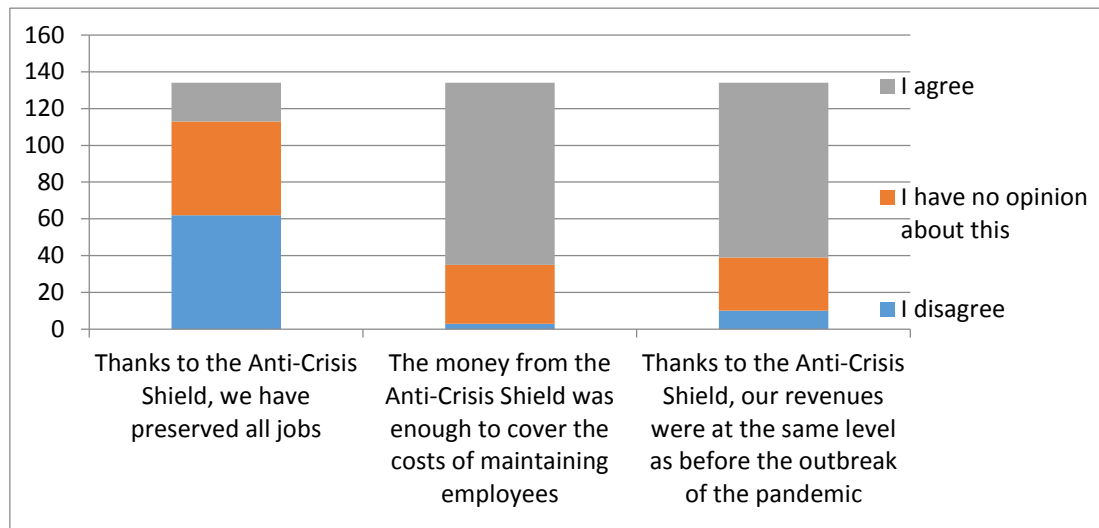


Figure 7. Aid under the Government Anti-Crisis Shield by type of business.

Source: own study.

It cannot be unequivocally stated that the actions taken under the Government Anti-Crisis Shield were positively evaluated by the respondents. According to the report (Dębkowska et al. 2021), the state aid was assessed at 3.5 (on a scale from 1 to 5).

Certainly, these actions helped preserve jobs, but not enough to cover all the costs of maintaining employees. Many times, employees have been deprived of additional benefits as part of their compensation. However, the long-term effectiveness of the aid instruments is yet to be seen, and the process of saving the economy and emerging from recession is still underway. Similarly, many business areas are still vulnerable to operating under the uncertainty of a pandemic.

Conclusions

The results of the study clearly show that the COVID-19 pandemic has significantly affected the functioning of supply chains, and this is true regardless of the industry or type of company. Virtually every company felt the effects of the pandemic. The crisis has brought many problems, which Polish (and not only) companies faced and still have to deal with. From the results of the study, a pattern emerges in which the main problems are late payments (the so-called payment backlog), which threaten the functioning of companies, and the progressive economic recession and galloping inflation. Even before the crisis emerged, payment backlogs were among the problems faced by almost 70% of Polish companies (Intrum, 2021). The European Payment Report¹ shows that the largest payment backlog is in the public

¹ The report is based on a survey that was conducted simultaneously in 29 European countries between 26 January and 16 April 2021. A total of 11,187 companies from 11 industries across Europe participated in the survey. In Poland, 540 companies took part in the survey.

sector at 20 days and in the B2B sector at 17 days. The problem, however, is not only the number of days the payment backlog spans, but also the payment period itself. It extended to 54 days in the public sector and 36 days in the B2B sector.

Delayed payments negatively impact financial liquidity and threaten the continued operation of businesses. The report also shows that 46% of Polish companies consider themselves lucky to have survived the pandemic crisis. Moreover, 57% of Polish respondents admit that the pandemic has reduced their companies' profits. The infamous list of sectors that suffered the most were business services (60%), industrial and chemical products (58%), hospitality industry (58%), and real estate and construction (57%) (Intrum, 2021).

The cited results from our own research and from the ERP highlight the effects of the pandemic felt by all entities along the supply chain, from suppliers of raw materials and supplies, through manufacturers and public sector entities to end users. This fact will certainly force many companies to rethink and transform. The events of the last virtually years have shown that globalisation and increasingly interlinked supply chains are increasingly vulnerable to disruption.

Instability and unpredictability become an everyday reality in pandemic conditions, forcing economic actors to take a number of measures to prevent the negative effects of the crisis. Given the impact of the pandemic, actors along supply chains should become increasingly conscious of managing risk by: (1) developing strategies to secure business continuity by geographic diversification of suppliers, (2) using key raw materials or products from different sources to reduce reliance on a single supplier, (3) developing inventory strategies to safeguard operations against supply disruptions in the supply chain, (4) building (sustainable) relationships with key suppliers, (5) implementing systems to ensure good transparency of the supply chain, (6) seeking to increase agility in processes, manufacturing and distribution networks so they can be quickly reconfigured and maintain supply to meet demand.

Bearing in mind the above problems, several recommendations and suggestions can be made for risk management in the supply chain based on the pandemic situation: (1) the further deepening of practical knowledge in the field of risk management and the implementation of appropriate risk strategies; (2) integrating a digital transformation based on the concept of Industry 4.0, not only with a company's operational departments but also with a supply chain's global strategy. The crucial role in the supply chain is played by small and medium enterprises as their level of digitalization impacts on ability to compete by smart supply chain idea. This approach will minimize the risk of incorrect current decisions and facilitate contact and communication with the employees; (3) guaranteeing data security, not only on the scale of an individual enterprise but throughout the entire value-creation chain; (4) integrating early with partners, which will allow for the establishment of appropriate technical standards; (5) stimulating a culture of cooperation characterized by flexibility and openness; (6) implementing a training system (including e-learning) that raises the competences and qualifications of the employees; (7) establishing interdisciplinary project teams consisting of

engineers, programmers, marketing, logistics specialists, etc.; (8) developing new models of working times and methods of remunerating employees that will stimulate creative thinking and co-create value (for clients and the enterprise); and (9) introducing such information systems and data exchanges between participants of the nodes within supply chain that will be based on openness with and trust in all partners.

From the supply chain management perspective, the best way to minimise risk is to increase trust and ensure integration, cooperation, and joint risk management. However, when managing supply chain risk, they should start with employees and ensure their safety.

One of the most noticeable impacts of the COVID-19 pandemic is the uncertainty surrounding the continuity of supply chains. Emerging disruptions resulting in discontinuity of supply chains (interrupted supply chains) are the result of, among other things, the occurrence of individual COVID-19 outbreaks, which result in downtime in production enterprises or the closure of entire factories (as we observed particularly at the beginning of the pandemic in China and individual European countries). Economic practice shows that Europe will not be able to function independently of Asian producers and suppliers for a long time to come so disturbances in that part of the world have an impact on the health of the global market. Disruptions in supply chains have a negative impact on the operation of their businesses.

From the supply chain management point of view, it is important to recognise opportunities and threats facing the entities comprising a given supply chain, as well as to make the right decisions in order to implement an appropriate risk management strategy. Globalisation, competition, and uncertainty in the management of resources generate the need to develop logistics and take an appropriate approach to managing risks in the supply chain. Changes in the focus of logistics and changes in the nature of logistic managers' activities in an individual company as well as in the entire supply chain result in the need to develop and implement an appropriate risk management approach. The effects of the lack of risk management or inadequate risk management in the supply chain can be very negative for companies, as evidenced by the COVID-19 pandemic outbreak.

Failure to effectively manage supply chain risk can have a significant negative impact on organisations not only through direct financial loss and bankruptcy due to inability to fulfil orders. It can also lead to reduced product quality, damage to property and equipment, loss of reputation in the eyes of customers and other business partners, or even a sharp drop in an organisation's stock price and shareholder conflicts. Additionally, it can result in the loss of health and life of employees and customers.

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AGILE PRACTICES OF ENTERPRISES IN THE FACE OF THE CHALLENGES OF DIGITIZATION

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Purpose: The aim of the article focuses on identifying the ways in which companies respond to the requirements of digitalization and what actions they take to maintain their competitiveness.

Design/methodology/approach: The article presents the results of research conducted in April and May 2023 on a research sample of 303 respondents, aimed at understanding the adaptation of organizations to the challenges of digitalization through agile practices.

Findings: The findings underscore the importance of fostering organizational culture that promotes adaptation and continuous learning, investing in digital skills training, embracing new technologies, and enhancing operational flexibility through agile practices.

Research limitations/implications: Limitations include the potential lack of representativeness in the research sample, reliance on self-reported data, and the absence of longitudinal data. Future research could focus on expanding the sample size, conducting longitudinal studies, and exploring success factors in agile implementation.

Practical implications: Practical implications include recommendations for companies to focus on developing organizational culture, investing in digital skills training, adopting new technologies, and enhancing operational flexibility through agile practices to improve competitiveness and resilience in the digital era.

Social implications: Social implications involve fostering a culture of continuous learning and innovation within organizations, which can contribute to economic growth and job creation in the digital economy.

Originality/value: This article's originality comes from its thorough analysis of agile practices within digitalization, combining literature and empirical research to offer practical advice for companies facing digital transformation challenges.

Keywords: organizational agility, digitalization, enterprise, agile practices, management.

Category of the paper: research paper.

1. Introduction

In the face of digitalization challenges that contemporary enterprises encounter in the dynamically changing business environment, the necessity for adaptation and swift response to new conditions becomes crucial for maintaining competitiveness and innovation (Kurnia, Chien, 2020). Digitalization, understood as the process of implementing digital technologies into all aspects of business activity, brings both opportunities for development and numerous operational, strategic, and organizational challenges (Rahimi, Mansouri, 2019). In this context, agile practices, originating from information technology project management methodologies, gain significance as tools enabling flexible and effective adjustments to continuous changes (Brown, Jones, 2018).

However, despite growing interest and implementation of these practices across various sectors, there is a gap in the literature regarding a comprehensive analysis of agile practices in the context of digitalization challenges. Thus, it is essential to investigate how enterprises utilize agile practices to cope with digitalization challenges, based on a broad literature review and empirical research.

An introduction to the issues of digitalization and agile practices in the business context allows for a better understanding of the dynamic changes occurring in the world of entrepreneurship and points out ways in which organizations can effectively respond to these changes using agile practices. This study aims to fill the existing knowledge gap and provide practical recommendations for companies striving to implement digital changes effectively in their operations. The originality of the material presented primarily stems from a comprehensive approach to analyzing agile practices in the context of digitalization challenges faced by contemporary enterprises. Previous research mainly focused on individual aspects of digital transformation or agile project management methodologies in IT, overlooking the broader perspective of integrating these areas. This study fills this gap by providing a comprehensive analysis of how enterprises can utilize agile practices to address digitalization challenges, which is crucial for maintaining competitiveness and innovation.

2. Literature Review

2.1. Theoretical Framework for Organizational Agility and Agile Practices

Organizations that can quickly adapt to changing conditions are more likely to succeed in the long run. The term "organizational agility" is frequently encountered in academic literature (Kidd, 1994), though definitions can vary. In general terms, this concept refers to an organization's capacity to quickly respond and adapt to new circumstances in response to

unexpected and constantly dynamic changes in business (Meredith, Francis, 2000). Immediate reactions allow the organization to flexibly adjust each of its elements to unforeseen changes in the environment (Sanchez, Nagi, 2001).

Originally, organizational agility was a concept used in the context of manufacturing, but it was noted that its principles could also be applied to other organizational functions (Goldman, Nagel, Preiss, 1995). These observations led to the development of the concept of organizational agility as a universal term (Chen, Siau, 2020). Currently, there are many interpretations of this concept. Some of them explore organizational agility as a combination of an effective human resource management strategy (Skyrius, Valentukevič, 2020) with efficient use of the latest technologies and production methods (Cappelli, Tavis, 2018). Another definition interprets agility as the integration of all flexible technologies along with the knowledge and experience gained in the process of comprehensive quality and production management in a just-in-time supply system (Zhang, Sharifi, 2000).

Other approaches to organizational agility are more detailed and focus on the ability to quickly adjust to market conditions. In this context, agility is viewed as a strategic capability of the organization to quickly adapt to unexpected and rapid market changes (Bray et al., 2019).

Organizational agility is also understood as an organization's ability to immediately and adequately respond to dynamic changes, as well as the ability to survive in variable market conditions (Almahamid, Awwad, Adams, 2010). This is possible by developing an appropriate mechanism for responding to dynamic changes in the business environment (McNamee et al., 2012).

Agility is also interpreted as the ability to effectively modify the level of operations in response to increasing customer demands (Yang, Liu, 2012). In this context, organizational agility is defined as the ability of an organization to effectively manage changes by developing survival skills despite various threats in the market environment (Narasimhan, Talluri, Mahapatra, 2006). Organizational agility is also seen as the intelligent and quick exploitation of emerging opportunities in the business environment, which enables gaining a competitive advantage in a short time (Chen, Li, 2021; Kt, Sivasubramanian, 2023; Akkaya, 2021).

Thus, organizational agility can be understood as an organization's ability to immediately respond to changes in the internal and external environment, as well as to take proactive actions to exploit new opportunities arising from these changes (Oelschlaeger, Huskey, 2012).

2.2. Polish enterprises in the era of digitization challenges

In the current era marked by the rapid evolution of digital technologies, Polish enterprises are confronted with the imperative of integrating digital technologies to maintain competitiveness and respond to consumer demands for innovative products and services (He, Harris, 2021; Brown, Jones, 2018). The adoption of digital technologies enables the introduction of novel products and services, necessitating the implementation of new business

models and a willingness to embrace technological changes (Prieto, Talukder, 2023; Rahimi, Mansouri, 2019).

Collaboration and continuous learning in the realm of digital advancements are crucial, as they facilitate the enhancement of digital competencies (McNamee et al., 2012; Ramadhana, 2021). The deployment of artificial intelligence and ICT tools is essential for firms aiming to leverage data for improved decision-making and operational efficiency (Chen, Li, 2021; Routledge, 2020).

The agility to swiftly adapt to market conditions and the development of strategic agility are fundamental for firms to thrive in the digital age (Sajdak, 2021; Kurnia, Chien, 2020). This agility is supported by fostering a culture of innovation and flexibility, enabling organizations to effectively manage change and capitalize on emerging opportunities (Seifollahi, Shirazian, 2021; Sedej, Justinek, 2021).

Moreover, enhancing employee agility and empowering workers are pivotal strategies for achieving organizational agility and sustaining competitive advantage (Sherehiy, Karwowski, 2017; Varghese, Bini, 2019). The integration of organizational intelligence plays a significant role in this process, facilitating the adaptation to and management of digital transformation challenges (Skyrius, Valentukevič, 2020; Stuart, Huzzard, 2017).

Furthermore, the ability of organizations to navigate through crises, such as the COVID-19 pandemic, underscores the importance of organizational agility in crisis management and ensuring firm performance under adverse conditions (He, Harris, 2021; Chen, Li, 2021). This resilience is achieved through strategic management accounting and the effective use of business intelligence agility, which are key to building a sustainable and agile organization capable of facing future challenges (Kurnia, Chien, 2020; Skyrius, Valentukevič, 2020).

In conclusion, the imperative for Polish enterprises to integrate digital technologies and foster an organizational culture that is open to innovation, continuous learning, and strategic collaboration is evident. These efforts, coupled with the enhancement of digital competencies and the adoption of agile business models, are essential for firms to navigate the complexities of the digital landscape successfully (Skrzypek, 2017; Stroiska, Trippner-Hrabi, 2016). The strategic alignment of organizational agility with digital transformation initiatives will enable Polish enterprises to achieve sustainable growth and maintain a competitive edge in the evolving global market (The First Pillar: Organizational Agility, 2020; Zagazig City Study, 2020).

2.3. Organizational agility in the face of the challenges of digitalization

Organizational agility is an essential element of business strategies in the face of digitalization challenges (Kocot, Kwasek, 2022). In the era of digital transformation, where traditional business models are being redefined by technological advancements, an organization's ability to quickly adapt and innovate becomes crucial for its survival and growth (Leberecht, 2016). This agility enables companies not only to effectively respond to

changing market conditions but also to leverage new opportunities brought about by digitalization.

In the context of digitalization challenges, organizational agility is demonstrated through the implementation of new technologies such as cloud computing, big data, artificial intelligence, and the Internet of Things (IoT), which allow for the collection, processing, and real-time analysis of large amounts of data (Felipe, Leander, Roldan, Leal-Rodriguez, 2020). Such actions not only enhance operational efficiency but also enable the personalization of offerings and a better understanding of customer needs, which is crucial for gaining a competitive advantage.

Furthermore, in the face of digitalization, organizational agility requires continuous improvement of internal and external processes, which is achievable through flexible project management methods such as Agile and Scrum (El-Wakeel, 2019a; 2019b). These approaches promote iterative development, adaptive planning, and ongoing collaboration among teams, enabling faster innovation implementation and more effective change management.

The cultivation of an innovation and learning culture within the organization is another crucial aspect of agility in the digital age. Developing digital competencies among employees, promoting openness to change, and fostering a pro-innovation mindset are essential for effectively harnessing the potential of digital technologies (Galvin, 2019). In this context, training programs and workshops play a significant role in enhancing skills and knowledge exchange within the organization.

Collaboration with external partners, such as technology startups, research institutions, or other companies, can further support the development of organizational agility. These partnerships provide access to new technologies, expert knowledge, and innovative solutions that can be used to optimize business processes and create new operational models (Krull, Mackinnon, 2016).

In summary, organizational agility in the face of digitalization challenges is the cornerstone of building sustainable competitiveness in the market. Through a flexible management approach, investment in digital competencies development, and a culture of innovation and collaboration, Polish enterprises can effectively adapt to a rapidly changing environment and leverage new technologies to create value for their customers and stakeholders.

3. Research Methodology

The research object of the article is to understand how organizations adapt to the challenges of digitalization through agile practices. The aim of the article focuses on identifying the ways in which companies respond to the requirements of digitalization and what actions they take to maintain their competitiveness. An effort was made to find out: What agile practices are used

by companies in response to digitalization? How does digitalization affect the organizational agility of enterprises? Research hypotheses were formulated: Companies that successfully implement agile practices are better able to cope with the challenges of digitalization. The use of ICT tools and the development of employees' digital skills is key to increasing the organisational agility of enterprises.

In this article, the results of research conducted in April and May 2023 are presented. The research sample consisted of 303 respondents. In the research process, demographic data were obtained. Respondents were divided by gender, with men accounting for 58.7% of respondents, and women for 41.3%. Among the respondents, the majority were individuals under 25 years old (47.2%), while those aged 26-35 accounted for 30.4% of the participants, and those aged 36-45 constituted 19.5%. Only a small percentage of respondents (3%) were over 45 years old.

Regarding their occupation, the majority of respondents were employees (57.4%), while middle-level management represented 25.2% of the survey participants. Low-level management accounted for 11.1% of respondents, and top-level management was 6.4%. As for years of work experience, 47.7% of respondents had worked for up to 5 years, 33.4% had 6 to 10 years of experience, 13.6% had 11 to 15 years, 3.6% had 16 to 20 years, and only 1.7% had worked for more than 20 years.

Analyzing the size of the companies where respondents worked, the majority were in small businesses (37.5%), followed by micro-enterprises (26.4%), medium-sized enterprises (20.1%), and large enterprises (16.1%). In terms of the company's duration of operation, 34.9% of respondents worked in companies that had been operating for 1 to 3 years, 27.1% for 4 to 7 years, 26.1% for over 8 years, and 11.9% worked in companies that had been in operation for more than a year.

Considering the industry, the majority of respondents worked in the retail sector (54.8%), followed by "other" industries (26.4%), education (10.4%), the automotive industry (5.4%), and healthcare (3%). Regarding the geographical scope of the company's operation, 32.5% of respondents worked in companies with a regional scope, 31.5% in companies with a national scope, 18.3% in companies with an international scope, and 17.6% in companies with a local scope. Finally, the majority of respondents (55.6%) assessed their company's financial situation as good, 19.9% as very good, 16.9% found it difficult to assess, 4.6% rated it as poor, and 3% as very poor.

4. Results

The focus of this paper was to understand the behavior of agile organizations in the face of the challenges of digitalization. The survey was conducted based on an analysis of the responses

of 303 respondents who assessed various aspects of the organization's adaptation to the dynamically changing business environment caused by technological progress. The aim of the study was to identify how organisations are responding to the challenges of digitalisation and how they are taking action to maintain their competitiveness.

Table 1 presents the results on the agile behavior of organizations in response to the challenges of digitalization. The survey was conducted on a sample of 303 respondents. The results are presented in the form of a five-point scale, which included ratings from "Definitely NO" to "Definitely YES" for different behaviors of the organization. The behaviors studied included:

- Having the ability to respond to change and unpredictable situations: The results show that 161 respondents strongly said that the organization had this ability, and 89 responded that they would rather have it.
- Adoption of new digital technologies: 152 respondents strongly said that the organization is implementing new digital technologies, while 103 answered that it would rather do.
- Introducing innovative products and services: 159 respondents strongly said that the organization innovates products and services, and 94 responded that they would rather do so.
- Rapid change to new business models: 152 respondents strongly said that the organization is quick to adapt to new business models, and 98 responded that it is more likely to do so.
- Regular training of employees and development of their digital competences: 149 respondents strongly said that the organisation regularly trains employees and takes care to develop their digital competences, while 105 respondents said that they would rather do so.

Table 1.

Agile behavior of organizations in the face of digitalization challenges, N = 303

	Definitely NOT	Rather not	I don't have an opinion	Rather YES	Definitely YES
Has the ability to respond to changes and unpredictable situations (1)	12	27	14	89	161
Implement new digital technologies (2)	8	22	18	103	152
Introduces innovative products and services (3)	9	29	12	94	159
Quickly reorients the offer to new models (4)	11	26	16	98	152
Provides regular training to employees and takes care of the development of their digital competences (5)	10	24	15	105	149
It is open to technological change, collaboration and continuous learning in this area (6)	13	28	13	96	153

Source: own elaboration based on conducted research.

Table 2 presents the results of the correlation analysis between different aspects of organizational agility in the context of digitalization. The study covers the same aspects as shown in Table 1. The correlation results are presented in the form of a correlation matrix, where the values in the cells indicate the degree of relationship between the individual aspects.

Correlation analysis allows you to understand how these different behaviors of an organization are related to each other. Notably, the results in Table 2 show a high correlation between multiple pairs of aspects of organizational agility. The aspects 'Implements new digital technologies' (2) and 'Introduces innovative products and services' (3) have a very high correlation of 0,99. This means that organizations that are willing to adopt new digital technologies are also willing to introduce innovative products and services.

Similarly, aspects related to the organisation's flexibility, such as 'Quickly pivots to new models' (4) and 'Is open to technological change, collaboration and continuous learning' (6), also show a high correlation of 0.99. This suggests that organizations that are quick to adapt to new business models are also willing to be open to technological change and collaboration.

Analysing the correlation between these aspects can help you better understand how organisations are developing their agility in the face of the challenges of digitalisation. Ultimately, these results can be a valuable guideline for organizations that seek to effectively manage their digital transformation process and remain competitive.

Table 2.

Correlation between different aspects of organizational agility in the context of digitalization

	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
1	1					
2	0,98	1				
3	0,99	0,99	1			
4	0,99	0,99	0,99	1		
5	0,98	0,99	0,99	0,99	1	
6	0,99	0,99	0,99	0,99	0,99	1

Source: own elaboration based on conducted research.

Similarly, aspects related to the organisation's flexibility, such as 'Quickly pivots to new models' (4) and 'Is open to technological change, collaboration and continuous learning' (6), also show a high correlation of 0.99. This suggests that organizations that are quick to adapt to new business models are also willing to be open to technological change and collaboration.

Analysing the correlation between these aspects can help you better understand how organisations are developing their agility in the face of the challenges of digitalisation. Ultimately, these results can be a valuable guideline for organizations that seek to effectively manage their digital transformation process and remain competitive.

Several important conclusions can be drawn from the analysis of Table 2:

1. High correlation between different aspects of organizational agility: Table 2 shows that there is a significant correlation between different aspects of organizational agility. All correlation values are close to 1, which means very strong connections between these aspects. This suggests that organizations that exhibit certain digitalization-related behaviors tend to exhibit other behaviors in the same category as well.
2. Focus on innovation and digital technologies: The results show that innovation-related aspects such as 'Adopts new digital technologies' (2) and 'Introduces innovative products and services' (3) show the highest correlation. This suggests that organizations that invest in new digital technologies are also willing to introduce innovative products and services.
3. Flexibility and openness to change: Aspects related to flexibility and adapting to change, such as 'Quickly pivots to new models' (4) and 'Is open to technological change, collaboration and continuous learning in this area' (6), also show a high correlation. This suggests that organizations that are willing to adapt to changes in the environment are also willing to be open to new technologies and collaboration.
4. The need for a holistic approach: The findings of Table 2 highlight the importance of a holistic approach to managing organizational agility in the digital age. Focusing on one aspect can lead to improvements in other aspects, which can contribute to a more comprehensive and effective digital transformation of the organization.

Ultimately, analyzing the correlation between different aspects of organizational agility can be helpful for decision-makers and organizational leaders to better understand what areas require attention and action in the process of adapting to digitalization.

5. Discussion

Future research directions may focus on several areas. First, it would be worthwhile to extend the research to a larger research sample, covering a variety of types of organizations and industries. In addition, longitudinal research could provide a more comprehensive understanding of the dynamics of change in organisations in response to digitalisation and the long-term effectiveness of agile practices. In addition, research can focus on identifying success factors in the implementation of agile practices and assessing their impact on business outcomes, such as innovation, profitability, and customer satisfaction. Additionally, research can also explore the relationships between organizational agility and other management concepts, such as knowledge management or customer relationship management.

When comparing the presented research findings with analyses from other authors (Stettina et al., 2021; Backx et al., 2019; Kocot, Kwasek, 2022; Galvin, 2019), common trends can be observed that highlight the key role of agile practices in the context of digitalization. Studies conducted by Aliber et al. (2019) show that organizations that have successfully undergone agile transformation have achieved significant benefits, including improved productivity, employee engagement, and customer satisfaction. This correlates with the observation that investments in employees' digital competencies and organizational adaptability strengthen their market position. High-quality agile transformations translate into increased organizational capabilities for innovation and faster introduction of new products and services, which is consistent with conclusions regarding the relationship between investments in human capital and the organization's capacity for innovation.

Future research directions can focus on several crucial areas. Firstly, it would be beneficial to expand the research sample to include a larger number of organizations covering a variety of types and industries. This would allow for a deeper analysis and better understanding of how agile practices impact different organizational environments. Additionally, longitudinal studies could provide a more comprehensive picture of the dynamics of change in organizations in response to digitization and the long-term effectiveness of implementing agile methodologies.

Another important direction is identifying success factors in the implementation of agile practices and assessing their impact on business outcomes, such as innovation, profitability, and customer satisfaction. Research could also focus on the relationships between organizational agility and other management concepts, such as knowledge management or customer relationship management.

Moreover, it would be significant to investigate how organizations can better adapt to the rapidly changing business environment through the effective use of digital technologies and innovative technological solutions. It is also worth exploring how organizational culture and openness to learning influence an organization's ability to agilely adapt and innovate.

6. Conclusions

The collected literature and empirical material allows us to draw extended conclusions about agile practices in the context of digitization. Data analysis indicates a significant ability of organizations to adapt and respond flexibly to dynamic market changes, which is crucial to remain competitive. The development of employees' digital competences and investments in new technologies are considered to be central elements of an agile strategy, highlighting the link between investment in human capital and an organization's ability to innovate and quickly introduce new products and services. In addition, a willingness to embrace technological change and promote a culture of continuous learning lay the foundation for agile transformation.

The high correlation between the different aspects of agility suggests that these activities are interconnected and mutually supportive, which strengthens the organization's position in the digital ecosystem. In conclusion, success in the digital age requires a holistic approach to agility, encompassing both technological and cultural organizational aspects.

On the basis of the conducted research, several recommendations can be made for enterprises. Companies should focus on developing an organizational culture that promotes adaptation and continuous learning. Investing in employee training to develop digital competences is crucial, as is embracing openness to new technologies and innovations. Companies should also strive to increase their operational agility, allowing them to adapt quickly to market and technological changes. Implementing agile practices across different business areas can be mutually reinforcing, fostering sustainable growth and competitiveness.

The added value of this article is a comprehensive analysis of agile practices in the context of the challenges of digitalization, based on both literature analysis and own empirical research. The article provides a deeper understanding of how organizations respond to changing market conditions and what actions they take to remain competitive in the digital age. In addition, the article offers practical recommendations for companies that can be used to shape their strategies and improve management practices in the context of digital transformation. As a result, companies can gain valuable tips on how to adapt to changing business conditions and increase the efficiency and innovation of their organizations.

Based on the conclusions of the analysis, the recommendations for companies mainly cover three areas of action. First, it is necessary to develop an organizational culture that is conducive to adaptation and continuous learning. Companies should promote an open environment that encourages experimentation, knowledge sharing, and embracing change. Implementing digital competence development programmes among employees and building an atmosphere that supports innovation can contribute to increasing organisational flexibility.

Secondly, companies should actively invest in new technologies and digital tools. Adapting to the rapidly changing business environment requires constant monitoring and implementation of new technological solutions. Taking the risk of innovation and constantly looking for new ways to use technology can give companies a competitive advantage in the market.

Thirdly, it is important to increase the operational flexibility of companies by implementing agile practices in various areas of the business. Companies should strive to eliminate unnecessary bureaucracy and hierarchies, which will enable faster decision-making and responsiveness to changing market conditions. Adopting agile organizational structures and agile working methods can help improve operational efficiency and respond better to change.

By consistently working in these three areas, companies can increase their ability to survive and succeed in the digital age, becoming more competitive and resilient to changing market conditions.

In the article, the research encountered several significant limitations. First, the research sample may not be representative of all types of organizations, which may limit the generalization of the results. In addition, the research was mainly based on the self-opinions of the respondents, which may introduce some errors resulting from subjective assessment. In addition, the lack of longitudinal data limited the ability to analyze changes over time and assess the impact of agile practices on the long-term performance and competitiveness of enterprises.

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IT OUTSOURCING AND FACTORS OF INCREASING THE COMPETITIVENESS OF ENTERPRISES

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Purpose: The aim of the article was to examine the factors of increasing the competitiveness of enterprises by separating services in the field of information technology (IT) and their importance for enterprises.

Design/methodology/approach: This study utilized a mixed-methods approach, combining quantitative data from a Likert-scale questionnaire distributed to a wide range of businesses. The research aimed to explore how IT outsourcing impacts corporate competitiveness across various dimensions.

Findings: The study reveals that IT outsourcing significantly contributes to enhancing business competitiveness by offering cost savings, improved efficiency, access to advanced technologies, and allowing firms to focus on core competencies.

Research limitations/implications: The study recognizes its limitations, including potential bias from self-reported data and limited generalizability due to focusing on a specific market segment. Future research will aim for wider industry representation and investigate the long-term effects of IT outsourcing.

Practical implications: For practitioners, the study underscores the strategic value of IT outsourcing in achieving cost efficiency and leveraging technological advancements. It suggests a structured assessment of outsourcing opportunities, considering both operational and strategic impacts.

Social implications: By delineating how IT outsourcing can drive business efficiency and innovation, the study implies broader societal benefits, such as job creation in the IT service sector and enhanced consumer experiences through higher quality products and services.

Originality/value: This research advances both theoretical and practical knowledge of IT outsourcing's impact on business competitiveness, blending quantitative and qualitative data for a detailed analysis of its diverse benefits.

Keywords: IT outsourcing, digitization, enterprise, competitiveness, management.

Category of the paper: research paper.

1. Introduction

In the face of continuous digital transformation, enterprises worldwide are challenged to adapt to rapidly changing market and technological conditions. This constant evolution forces organizations to seek new pathways to enhance their competitiveness and operational efficiency (Turban et al., 2018). In this context, IT outsourcing, understood as the strategic external delegation of IT functions to specialized service providers, emerges as a key element enabling companies to achieve these goals. It allows businesses to focus on developing core competencies and primary activities while also providing access to the latest technologies and world-class expertise without the need for substantial internal investment (Yin et al., 2020).

The growing significance of IT outsourcing in business strategies also stems from the increasing need for operational flexibility and scalability, enabling companies to quickly adjust to changing market demands and capitalize on new business opportunities (Kabus, Cichoń, Lenort, Kabus, 2023). Additionally, IT outsourcing opens doors to the global market of talents and innovations, which is particularly crucial in the context of rapid technological progress and global competition (Zhen et al., 2021).

Understanding the impact of IT outsourcing on the competitiveness of enterprises is thus vital not only for theorists studying the dynamics of contemporary organizations but also for business leaders seeking effective strategies to maintain and strengthen their market position. The discussion on this topic allows for a deeper exploration of both the benefits and challenges associated with external delegation of IT functions, as well as the identification of best practices and strategies for managing relationships with service providers.

Therefore, it becomes necessary to examine this multifaceted topic, presenting how IT outsourcing affects various aspects of a company's operations, including innovation, operational efficiency, and the ability to respond quickly to market changes. Through a combination of thorough theoretical analysis and empirical research findings, this article aims to build a comprehensive picture of the role of IT outsourcing in shaping competitive advantage, offering valuable insights for both scholars and practitioners aiming to understand and leverage the potential of this strategy in a global context.

2. Literature Review

2.1. The Essence of Outsourcing

Outsourcing, as a strategy for using external resources, is widely analyzed in the scientific literature. It is defined as the process by which companies transfer some of their functions or processes to third-party service providers. This process is often motivated by a desire to increase efficiency, focus on core competencies, and reduce costs (Brynjolfsson, McAfee, 2017).

Modern approaches to outsourcing often focus on long-term contracts that delegate responsibility for the management and development of specific business processes or infrastructure to external vendors (Kane et al., 2015; Kern et al., 2013). In this perspective, outsourcing is understood not only as a way to reduce costs, but also as a strategic tool that allows companies to access advanced technologies and expertise (Krull, Mackinnon, 2016; Lacity, Willcocks, 2009).

Other researchers emphasize the importance of outsourcing as a tool for acquiring skills and competencies that are necessary to improve the organization's operations (Kłos, 2009). They emphasize that by outsourcing, companies can focus their resources on the most strategic tasks while benefiting from the expertise of external suppliers (Pandita, Singhal, 2017).

In conclusion, outsourcing is recognized as a key element of business strategy that enables companies to adapt to a rapidly changing business environment and take advantage of the expertise and technologies available on the market (Turban et al., 2018).

2.2. IT outsourcing and its importance in the process of market digitization

IT outsourcing, i.e. the process of outsourcing IT services to external providers, plays a key role in the process of digitization of the market. Companies are increasingly using this strategy to meet rapidly evolving technologies and dynamic changes in the business environment (Yin et al., 2020).

IT outsourcing enables organizations to access advanced technologies and expertise, which is especially relevant in the age of digitalization, where information and communication technologies (ICT) are becoming the foundation of market competitiveness (Galvin, 2019; (Kabus, Dziadkiewicz, Miciuła, Mastalerz, 2022).

IT outsourcing allows companies to adapt faster to changing market and technological conditions. IT service providers offer access to the latest technologies and innovations, which allows companies to effectively implement digital solutions such as cloud computing, big data, artificial intelligence, or the Internet of Things (IoT) (Kocot, Kwasek, 2022). This allows companies not only to increase their operational efficiency, but also to create new business models and revenue streams (Kern et al., 2015).

IT outsourcing allows companies to flexibly scale IT resources depending on current needs, without the need to invest in expensive infrastructure and hire IT specialists. Service providers can quickly adjust support levels and resources in response to changes in the market or in company strategy, which is crucial in a rapidly changing business environment (Lacity, Willcocks, 2013). IT outsourcing can contribute to reducing the operating costs of an organization. Companies do not have to invest in developing their own IT infrastructure or incur costs related to the recruitment and training of IT employees. IT service providers offer effective solutions that allow companies to save time and money (Quelin, Duhamel, 2003).

IT outsourcing allows companies to benefit from the knowledge and experience of IT specialists. Service providers often have teams of experts in various fields of computer science, which allows them to solve even the most complex technical problems (Porter, Heppelmann, 2014).

To sum up, IT outsourcing is an important tool supporting the process of market digitization. It allows companies to accelerate digital transformation, increase operational agility, reduce costs, and access expertise and technology. In the era of dynamic technological change, it is a strategy that can bring many benefits and enable companies to remain competitive in the market (Qureshi, 2016).

2.3. Factors of increasing competitiveness through IT outsourcing

IT outsourcing can significantly contribute to the competitiveness of enterprises by providing access to advanced technologies and deep specialization, which are crucial in a dynamically changing digital environment (Raišienė et al., 2019).

The benefits of IT outsourcing are an important topic for today's enterprises as they look for ways to improve their efficiency and competitiveness in a dynamic business environment (Cullen et al., 2005). IT outsourcing can be considered in the context of various aspects of business operations, such as cost savings, increased operational efficiency, focus on core competencies, use of the latest technologies available from IT service providers, improved quality of services/products, faster adaptation to changing customer requirements, better protection against cyberattacks, and access to the latest technological innovations.

Making a decision about IT outsourcing requires taking into account many factors, such as business strategy, industry specifics, current needs of the organization, and the risks associated with delegating certain functions and data to external providers. Enterprises must also consider the potential benefits and challenges of IT outsourcing in order to make optimal decisions for their operations and business goals (Constantinides, 2014).

By using third-party IT vendors, companies can focus on their core competencies, thereby increasing their organizational agility (Felipe et al., 2020) and ability to respond quickly to market changes. Outsourcing also enables better risk management and data security, which is essential in the face of growing cyber threats (Danneels, Kleinschmidt, 2016). Cost flexibility, achieved by the ability to scale IT services according to current needs, allows for more efficient

allocation of financial resources (Dhillon, Backhouse, 2001). Cooperation with external IT experts enables companies to adapt to new technological and market requirements, which is crucial for maintaining and increasing competitiveness in the market (Chakrabarty, 2006).

IT outsourcing also follows an organizational agility approach that allows companies to adapt to change (Gupta et al., 2006). Organizational agility is an important factor in the effective use of ICT (Ravichandran, 2016), which is confirmed by research on the impact of IT capabilities on corporate performance (Leberecht, 2016).

In addition, IT outsourcing supports an agile approach that promotes an iterative and adaptive approach to project management (Lacity, Willcocks, 2010). Agile Project Management is a key tool in today's business environment, ensuring the delivery of valuable products and services (Uhl-Bien, Arena, 2017). The integration of third-party IT vendors can enable companies to better leverage agile methodologies in their project processes.

With the growing importance of e-commerce (Zhen et al., 2021), aligning competitive strategy with the role of information technology in the industry is becoming crucial to achieving competitive advantage (Cavusgil et al., 2014). IT outsourcing can enable companies to better align their IT strategy with their business strategy, which is crucial for success in the digital age.

It is also worth noting that cooperation with external IT providers can contribute to improving the adaptability of organizations (El-Wakeel, 2019), which is important in an increasingly complex and uncertain business environment. By providing new tools, knowledge, and experience, third-party vendors can support organizations in adapting to changing market and technology conditions (Zhen et al., 2021).

To sum up, IT outsourcing can be a strategic tool supporting the development and competitiveness of enterprises by providing access to modern technologies, increasing organizational flexibility and enabling effective use of financial resources.

3. Analysis of own research

3.1. Research Methodology

Between May and September 2023, a scientific study was conducted using an online survey. We managed to collect 723 completed questionnaires, which was possible thanks to the use of the method of computer-assisted online interviews (CAWI). With this method, it was possible to reach a large number of respondents quickly and effectively. Study participants completed questionnaires via an online platform. The CAWI method made it possible to contact people from different locations, ensuring high technical standards during the study and minimizing errors resulting from manual data entry.

The aim of the study was to investigate the factors of increased competitiveness through the separation of information technology (IT) services and their importance for enterprises. The aim of the study was to identify what benefits enterprises can gain through the external provision of IT services and what factors may influence the decision to use this form of services. The research questions focused on the assessment of the importance of individual factors for the competitiveness of enterprises and on the identification of preferences in the use of external IT services. The research hypothesis assumed that the separation of IT services could contribute to the improvement of the efficiency of the company's operations and increase its competitiveness through cost savings, access to the latest technologies, better quality of services or faster adaptation to changing market conditions.

In the course of the research, sociodemographic data of the respondents were collected. Of the 723 respondents, 50.5% were women and 49.5% were men. In terms of age, 20% were under 25 years old, 30.4% were between 26 and 35 years old, 24.9% were between 36 and 45 years old, and 24.6% were over 45 years old. In terms of positions held, 6.9% are top management, 21.1% are middle management, 29% are junior management, and 42.9% are employees. The length of service in the study group was as follows: 27.6% had up to 5 years, 24.9% 6-10 years, 20.7% 11-15 years, 16.6% 16-20 years, and 10.1% over 20 years. In terms of company size, 27.6% were micro-enterprises, 24.9% were small enterprises, 24.9% medium-sized enterprises and 22.5% large enterprises. The period of operation of the companies was as follows: 13.8% operated for more than one year, 27.6% for 1 to 3 years, 30.8% for 4 to 7 years, and 27.6% for more than 8 years. In terms of industry, 19.9% of those surveyed were active in the automotive and retail industries, as well as in education, healthcare, and other industries, each with a share of 20%. In terms of geographical coverage, 27.6% operated locally, 24.9% regionally, 23.5% nationally, and 23.9% internationally. The financial situation of the companies was as follows: 13.7% assessed it as very good, 30.9% as good, 27.4% as bad, 13.7% as very bad, and 14.2% it was difficult to give an unambiguous opinion on this issue.

3.2. Presentation of Research Findings

The research sought to identify various factors for increasing competitiveness by separating information technology (IT) services in the context of enterprises. Table 1 presents the results of survey assessments of these factors in the form of a Likert cafeteria, where respondents had the opportunity to choose one of five points of the scale: "Definitely NO", "Rather NO", "I don't have an opinion", "Rather YES", "Definitely YES".

On the basis of tabular data, it can be seen that the majority of respondents positively assessed the potential benefits of separating IT services. It is worth noting that the highest number of responses in the "Definitely YES" category were given by factors related to cost savings, increased efficiency and the ability to focus on key competencies. On the other hand, the lowest values in this category were achieved by factors related to protection against cyberattack and access to the latest technological innovations. It is also important that there is

a group of respondents who, in many cases, did not express a clear opinion ("I have no opinion").

In the context of business decision-making, the results of this survey can provide information about the priorities and expectations of enterprises in relation to the external provision of IT services and help to identify areas to focus on in order to increase competitiveness.

Table 1.

Factors for increasing competitiveness through the separation of IT services (Likert scale)

	Definitely not	Rather not	I don't have an opinion	Rather yes	Definitely yes
Cost Savings (1)	35	87	159	246	196
Increase efficiency (2)	40	92	155	232	204
Opportunity to focus on core competencies (3)	38	96	158	239	192
Leveraging the latest technologies available from IT service providers (4)	45	103	156	230	189
Offering better quality of service products (5)	41	94	162	228	198
Faster adaptation to changing conditions and customer requirements (6)	39	91	166	227	200
Better protection against cyberattack (7)	43	98	161	224	197
Access to the latest technological innovations (8)	38	90	165	230	200

Source: own.

Table 2 presents a matrix of correlations between the various factors of increased competitiveness through the separation of IT services, as defined in Table 1. In the context of the first factor, i.e. cost savings, a high correlation with the other aspects examined in the study can be observed. The values of correlation coefficients for this variable ranged from about 0.995 to 0.999. Such strong links suggest that there is a clear relationship between cost savings and other elements studied, such as increased efficiency, focus on core competencies, use of the latest IT technologies, improved quality of services or products, faster adaptation to customer needs, better protection against cyberattacks, and access to the latest technological innovations. These results suggest that cost savings are closely linked to other drivers of increased competitiveness through the separation of IT services, which may be important for strategic decisions regarding the outsourcing of IT services in enterprises.

Table 2.

Correlation between factors of increased competitiveness through the separation of IT services

	1	2	3	4	5	6	7	8
1	1							
2	0,996	1						
3	0,999	0,995	1					
4	0,997	0,995	0,999	1				
5	0,996	0,998	0,996	0,996	1			
6	0,994	0,996	0,994	0,993	0,999	1		
7	0,995	0,998	0,996	0,996	0,999	0,999	1	
8	0,995	0,997	0,995	0,994	0,999	0,999	0,999	1

Source: own.

On the basis of the data contained in Table 1 and Table 2, several important conclusions can be drawn. First of all, the factors of increasing competitiveness through the separation of IT services are strongly correlated with each other. This is due to high correlation coefficients, which indicate the existence of strong relationships between various aspects, such as cost savings, increased efficiency or access to the latest IT technologies.

Secondly, in the context of the first factor, which is cost savings, it can be seen that there is a positive relationship between this factor and the other aspects of competitiveness examined. This means that cost savings are a key factor in improving the efficiency of the company's operations, enabling it to focus on key competencies, providing access to the latest technologies and conducive to offering better quality services or products.

It's also worth noting that some factors, such as faster adaptation to changing market conditions or better protection against cyberattacks, show slightly less correlation with cost savings. However, despite this, they are still important for increasing competitiveness through the separation of IT services and need to be taken into account when making strategic decisions regarding IT outsourcing in companies.

4. Conclusions

IT outsourcing is a strategic tool that contributes to increasing the competitiveness of enterprises. It provides access to modern technologies, increases organizational flexibility and enables more efficient use of financial resources. In the era of dynamic technological and market changes, IT outsourcing enables companies to adapt faster to new requirements, which is crucial for maintaining and increasing competitiveness on the market.

The analysis of the literature and the presented studies entitles us to formulate several conclusions. First, a significant majority of respondents see IT outsourcing as beneficial for cost savings and operational efficiencies, suggesting that enterprises can gain significant financial and operational benefits by choosing to spin off IT services. Secondly, the ability to focus on core competences, access to the latest technologies and offering better quality services and products are considered to be important factors for increasing competitiveness. This indicates that companies are aware that IT outsourcing can contribute not only to cost reduction, but also to improving the quality of the offer and adapting to market requirements. In addition, strong correlations between factors have been demonstrated, suggesting that success in one area (e.g. achieving cost savings) can have a positive impact on other aspects of competitiveness, such as increased efficiency or better protection against cyberattacks. This highlights the complexity and interconnectedness between the different aspects of IT service management and their impact on a company's competitiveness.

The presented conclusions entitle us to formulate several recommendations for enterprises. Companies should actively consider IT outsourcing as a way to optimize costs and increase operational efficiency. It is also important to focus on core competencies, while using external suppliers to access modern technologies and innovations. In addition, enterprises should ensure that they are constantly updated on new cybersecurity solutions to better protect their data. Working with suppliers who offer access to the latest technological innovations can also help to increase your company's competitiveness in the market.

The study encountered some limitations that may affect the generalization of the results. One limitation may be the method of data collection, which was based on respondents' self-assessments, which can lead to subjective assessments. In addition, the study focused on a specific group of companies, which may limit the possibility of extrapolating the results to other sectors or markets. Future lines of research may include expanding the sample to more industries and regions to increase representativeness and understanding of the global impact of IT outsourcing on the competitiveness of companies. It is also worth studying the long-term effects of IT outsourcing on the financial performance of enterprises, which can provide deeper insight into the strategic benefits of such decisions. The added value of the article results from a comprehensive approach to the analysis of the impact of IT outsourcing on the competitiveness of enterprises, combining quantitative data with qualitative conclusions.

Comparing the findings from presented studies with other scientific papers, one can observe some consistencies and differences in terms of the impact of IT outsourcing and logistics outsourcing on the competitiveness of companies. According to the study by Munim et al. (2023), logistics outsourcing is positively associated with cost-based competitiveness and financial outcomes of companies. In outsourcing relationships that are focused on cost reduction or strategic partnership, companies strive to develop and ensure the alignment of activities within and between organizations. Another study that addresses operational resource issues in outsourcing relationships is a comparative analysis between India and the DACH region (Germany, Austria, Switzerland), showing differences in expectations towards logistics service providers in these regions. In India, there is a greater gap between manufacturing companies and logistics service providers compared to the DACH region, indicating differences in perceptions and expectations between these markets (Acquah et al., 2023).

Furthermore, a study on the impact of supply chain management on the competitiveness of the automotive industry highlights the importance of strategic decisions regarding organizational boundaries, which have consequences for the company's outcomes. The decision to outsource or vertically integrate (internal production) is not only an economic decision based on costs but also a strategic one for the company. Outsourcing can be a way to reduce costs and improve outcomes by entrusting activities to specialists, however, it should always be considered from a strategic perspective in order not to lose the company's competencies and to leverage the capabilities of specialized suppliers (Baah et al., 2022).

These conclusions show that the success of outsourcing depends on many factors, including a strategic approach to managing relationships with suppliers and aligning them with key business objectives. This highlights the complexity of the outsourcing decision and the need to consider various aspects of supply chain management and technology in the decision-making process.

Future research directions in the impact of IT outsourcing on the competitiveness of companies could focus on several key areas to deepen understanding and leverage the potential of this strategy. First, it might be essential to examine the impact of organizational culture and readiness for change on the success of IT outsourcing, considering how these aspects affect cooperation with providers and adaptation to new technologies. Second, a comparative analysis of different models and practices of outsourcing across various sectors and regions of the world could provide valuable insights into best practices and potential pitfalls. The third direction is to study the long-term effects of IT outsourcing, including its impact on innovation, the ability to quickly implement changes in products and services, and ultimately on the financial outcomes of companies. Additionally, deepening knowledge on risk and security management in the context of IT outsourcing, especially in the face of increasing cyber threats and data protection requirements, might be significant.

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PROMOTION OF ENVIRONMENTAL ACTIONS AND ATTITUDES IN POLISH CITIES

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Purpose: The cognitive aim of this article was to elucidate the importance of ecological marketing endeavours within urban settings for fostering city identity, as well as to accentuate the role of residents in environmental stewardship within the city. The objective of the study was to determine how cities promote pro-environmental actions and attitudes among various consumer groups.

Design/methodology/approach: Primary research employed the CAWI method, utilizing a proprietary questionnaire. The study was conducted in 2022. The subjects of the study were cities in Poland. The questionnaire was distributed to all cities, and the analysis was performed on 414 returned and properly completed questionnaires. The presented results constitute a segment of the entire research.

Findings: Cities clearly focus on social media and their own publications for promotion. A large part of the activities is directed at residents, especially the youngest ones. This is manifested in the organisation of festivals and events for residents of all ages. Events of various types are organised on a fairly large scale in cities (picnics, family events, city days, festivals), with environmental issues as their main theme. Encouraging ecological activity and raising awareness also occurs, albeit to a much lesser extent, through activities targeting teachers, business representatives, or employees working in municipal offices. However, what stands out is the low level of cooperation with non-profit and business entities in the area of pro-environmental activities.

Research limitations/implications: The study was quantitative in nature; future research could be expanded to include qualitative studies that would more specifically pinpoint the initiatives undertaken in the city regarding the promotion of pro-environmental actions and green city marketing.

Originality/value: This paper is directed at all individuals interested in environmental marketing, especially city mayors, who are responsible for promotion within cities.

Keywords: green marketing, environmental marketing of cities, ecology promotion, city identity.

Category of the paper: research paper.

1. Introduction

The deterioration of environmental quality, felt effects of pollution accumulation such as smog, noise, waste issues, and the high costs of pollution neutralization have compelled cities to seek alternative development paths. The question of reorientation to environmental considerations is influenced not only by economic and business factors, but also by social issues related to the depopulation of most cities in Poland and changes in ecological awareness in society. These are the premise for cities to reorient their approach to environmental issues. International, political, and economic conditions also played a significant role, triggering the search for new development concepts, including urban development. Environmental dilemmas are not only a problem for city authorities but also for residents and other stakeholders who influence the quality of the natural environment in the city. Therefore, territorial marketing should not only focus on ecological actions but also on building ecological awareness among residents.

Ecology in human life may have various dimensions - intellectual, moral, moral, legal and economic. Ecology transcends mere tangible actions, encompassing all ideas of human development in the world. The severe and progressive degradation of the natural environment, a result of past economic and social progress, poses a significant threat to the sustainability of life on Earth. Conversely, continuous economic development is deemed a necessary condition for improving human quality of life and constructing a civilization based on information and knowledge. The relationship between the realm of technological and economic progress and that of natural environmental conditions is dichotomous. For cities and their inhabitants, not only the global environmental state matters but, more importantly, the micro-world related to living conditions in a specific city. Hence, the primacy of ecological actions has become a significant element of cities' image strategy. On the one hand, the European Union's ecological requirements force cities to implement specific pro-environmental solutions; on the other hand, promoting ecological behaviours among groups that are stakeholders of the city is another issue, not necessarily related to the requirements of EU structures. Managing a city and its environment is not a simple task. Environmental management involves the management of the use, protection, and shaping of the environment (Deluga, 2015). Many cities struggle with limited budgets, which impacts the quality of pro-environmental investments. In cities, in addition to shaping the environment, it is also crucial to form ecological attitudes and awareness among residents and other groups related to the city, as they significantly influence the city's environmental state.

The human approach to ecology is shaped by many factors, including the environment in which one lives, the family background from which one comes from (Kłosowska, 2000). The way ecological ideas are conveyed by the educational system and media also matters. Through the media, we enter the world of ecology, understand the symbolism of the message,

and learn the norms governing the world. Throughout life, individuals assimilate the principles of social resocialization, participating, often unconsciously, in the cultural shaping of their own personality (Niziołek, 2015). The way environmental issues and possible solutions are communicated by city authorities also significantly influences the formation of ecological attitudes. Hence, perceiving green policy through green practices is of great importance (Chang, Chen, Luan, Chen, 2019).

2. Ecological Marketing and Place Identity

Ecological marketing is a relatively new trend in marketing. It is crucial to understand marketing from the perspective of social marketing, which assumes that an organisation will meet the needs, desires, and interests of target markets by delivering desired satisfaction more efficiently and effectively than competitors, but in such a way as to improve the well-being of both consumers and society simultaneously (Kotler, Keller, 2020). The previous marketing perspective, without

Without considering the social aspect, traditional marketing often overlooked the discrepancy between immediate consumer expectations and needs versus their long-term needs and existence. This prospective view becomes particularly vital in the era of environmental issues, resource scarcity, and the global climate crisis. Hence, incorporating an environmental perspective in marketing planning appears to be a necessity. The importance of communicative and promotional organizational actions aimed at supporting pro-environmental social campaigns, promoting a healthy lifestyle, and conveying information about the ecological and environmental aspects of an entity's activities also emerges (Pilarczyk, Nestorowicz, 2010; Papadas, Avlonitis, Carrigan, 2017). This social dimension of marketing also applies to entities such as cities. The essence of territorial marketing, in line with the relational paradigm, is creating a friendly community by initiating, maintaining, and enriching long-lasting ties between the city's stakeholders and local government units (Glińska, 2017). Territorial marketing is a directed and regularly conducted activity of local government administration and distinct services and institutions. In this activity, the desires and needs of the local community are recognized, shaped, and satisfied. Actions are tailored to the interests of residents, other groups of people, and economic entities (Szromnik, 2016). J. Gehl sees the relationship between the city and its beneficiaries as mutually dependent, stating that "first we shape cities, then they shape us" (Gehl, 2014). These reciprocal relations between stakeholders and the city stem from various factors (historical, economic, social) and can also be shaped by local government authorities.

Ecological territorial marketing should be one of the priorities for cities where environmental issues are a serious challenge. What is ecological marketing? R. Dahlstrom defines ecological marketing as the process of planning and executing the marketing mix to enable the consumption, production, distribution, promotion, packaging, and recycling of products in a way that maximally supports environmental protection (Dahlstrom, 2011). Similarly, R.M. Dangelico and D. Vocalelli define ecological marketing as the process of planning, implementing, and managing product development, pricing, promotion, and distribution in a manner that meets the criterion of satisfying consumer needs, achieving business objectives, and integrating these processes with the ecosystem (Dangelico, Vocalelli, 2017). It is crucial in the ecological marketing of cities to incorporate environmental issues into the city's identity. The ecological aspect is significant not only for providing adequate living conditions for residents and other groups associated with the city but also for the identity of people living in the area and their connection to the place.

Identity can be considered in terms of city, territorial, or regional identity. It is this identity that constitutes the authenticity of a place and has significant implications for the sense of belonging and the community's engagement with its environment. Incorporating environmental concerns into the identity of a city not only enhances its livability and attractiveness but also strengthens the community's commitment to sustainable development and ecological stewardship.

The subjective character of the identity of the place (Łuczak, Leśnik, 2021). A place is closely connected to a specific location and also carries an emotional resonance. It is natural for places to have their identity, which can be shaped over centuries or merely momentarily. Place identity can be defined as the core that integrates various values of a place, thus generating a bond between individuals and the place (Łuczak, Leśnik, 2021). The identity of the city is shaped by people and has an individual and subjective character, as it is primarily formed by the surrounding environment (Owerczuk, 2017).

The identity of place influences the formation of individual identity and collective identity. Each individual interacts with a place differently. In perception, the meaning of history, memories, associations, and surroundings, etc., play an important role (Pazder, 2008). A place should not be understood as a space in the physical sense, but as the sum of three elements: physical location, meanings attributed to it, and activities undertaken within it (Bańka, 2002). Place identity is a strong identification with one's place of residence, usually leading to the development of a sense of connection with the group inhabiting a given space. It is also the elusive atmosphere of a place that makes it achieve the highest degree of social acceptance. Thus, what obviously connects a place to public space in a social sense is the location and the activities undertaken there. Both places and public spaces (as understood here) have their locations and social actors who undertake actions in them. More debatable is the significance related to the place, which is directly linked to two other important categories: the identity of the place (and public space) and the *genius loci* (Bierwiazzonek, 2016, 2018). In this context,

an example can be the approach of Christian Norberg-Schulz, who sees *genius loci* as a component of place identity. According to the Norwegian architect, "genius loci is created by the meanings that buildings possess, which gather (within themselves) the characteristics of the place and make it close to man" (Norberg-Schulz, 1980). In such circumstances, at the expense of losing spatial identity, we receive a certain pseudo hyper-modernity. According to Auge, a place should have its specific identity, distinguished by having social and historical characteristics. The antithesis of this is the non-place as difficult to define, without any distinguishing features. This boundary between place and non-place is increasingly being crossed within the built spaces of structures and objects (Auge, 2008). In cities, there are more and more spaces that create non-places. According to J. Jacobs, urban space is a physical, social, and cultural area that encompasses places inhabited by people and elements of infrastructure and architecture. It is a comprehensive concept that considers both material structures and social interactions occurring in a given area. Urban space is where people live, work, meet, and cooperate (Jacobs, 1961).

In the context of competitiveness, productivity, and economic benefits, we begin to move more rapidly between home, its immediate surroundings, workplace, and recreation sites. We only perceive the inconveniences of personal life, overlooking the nuisances created by the urban environment. The most critical elements of the contemporary living environment become blurred, leaving only the dilemma associated with moving between them. Human streams in the open public space and architectural objects intersect in many directions (Gaweł, 2020). In this rush, living on the go, in the liquid modernity as Z. Bauman calls it (Bauman, 2006), pausing and feeling a connection with the place can be an important element of personal identity creation. The emotional bond is the most primal form of an individual's connection with the physical-spatial environment. A positive emotional bond with a place creates a safe attachment pattern. Moreover, attachment to a place provides a sense of control, creativity, mastery, privacy, significance, or tranquility. At the group level, there will be a spiritual connection with other people such as family, friends, communities, and culture. In addition to the affective dimension, the cognitive and behavioural dimensions play a significant role. In the former, these are specific meanings (feelings and symbols) of the place for an individual, the accuracy of place knowledge, and the intensity of beliefs. They are based on the physical experience of space, which encompasses real and symbolic relationships with other people. The behavioural dimension relates to the bond with the place, which is a function of an individual's activity in the environment, is a source of responsible behaviours, and forms a structure of purposeful behaviours on an individual and social level (Bańka, 2018).

One of the aspects that influence the identification of residents with the city and its various parts is the state of the natural environment and the approach of the city authorities to ecological issues. However, urban development strategies largely based on social (human) capital require municipal authorities to cooperate and encourage grassroots initiatives, especially in the area of pro-environmental actions. Cooperation and a sense of joint responsibility for the city are

related to the trust residents have in city authorities. The city's social capital allows the utilization of other forms of capital and creates relationships, builds connections, which lead to trust. Social capital thus also has significance in promoting pro-environmental behaviors and the ecological image of the city. People's ecological awareness, their relationship to the city, translates into its development. It must be assessed as friendly for the well-being of stakeholders (Koszembar-Wiklik, 2022). Ch. Landry considers people as assets, paying particular attention to the agency of a creative society combined with the creative policies of city authorities. Greenery in the city is an area where private initiatives are very visible. In no other area of urban life do such intense private initiatives appear, e.g., flowers in windows and on balconies or privately arranged and maintained gardens at homes and apartment buildings. In addition, Landry emphasises the impact of urban policy on the creativity and innovation of residents (Landry, 2013).

Thus, technological solutions for environmental protection in the city must go hand in hand with the education of residents. Also, revitalization actions, as well as those related to environmental reclamation and ecological activities, are easier if the city takes care of the social participation of residents or business entities.

3. Method and Results of the Study

The activities undertaken by cities in the field of promoting green marketing actions should be directed to various recipient groups. Building ecological awareness and the importance of ecology for the well-being of the city, among both children and adults, contributes not only to increasing the acceptance of local government actions but also to creating a new identity for the city and to undertaking civic initiatives for the protection of the urban environment.

The results presented below come from our own research. The study covered a wide range of questions concerning green marketing in the city. The survey was conducted in 2022, using the CAWI method. Questionnaires were sent via the internet to all 954 cities, with 414 returns received. Thus, the research sample is representative with a confidence level of 95% of 95% and a maximum error of 5%. The presented results cover part of the study that answers the research question: What actions do cities take to shape pro-environmental attitudes among different groups? How do cities promote activities in the field of green marketing? Are there any studies conducted among residents in the city concerning needs in the area of environmental protection?

As established and presented in the earlier article, the priority target groups for green city marketing remain residents, and promotional activities are primarily directed towards them. The actions are aimed at both children and adults (Koszembar-Wiklik, 2023).

A vast majority of 84% (of cities run educational programmes aimed at kindergartens and schools. Only 8% indicated that they do not carry out such activities. Also in the case of older residents, the cities are active in making them aware of the importance of environmental activities, 70% of cities. Only 14% do not undertake any activity in this area towards older groups (Koszembar-Wiklik, 2023).

However, awareness-raising activities are also conducted on environmental issues involving business representatives, teachers, and municipal employees. Understanding the importance of education in shaping ecological attitudes, some cities direct their actions not only directly to children and youth, but also organise workshops related to environmental education for teachers, who, having an influence on young generations, can impart pro-ecological ideas to them. However, only every third city declares conducting such workshops (12% responded definitely yes, 24% rather yes), 31% could not determine whether such actions are taken, and 34% declare that they do not conduct such activities (Figure 1). It follows that cities prefer to carry out direct actions aimed at the young, while activities in the environment of teachers working in schools in the city are considered supportive.

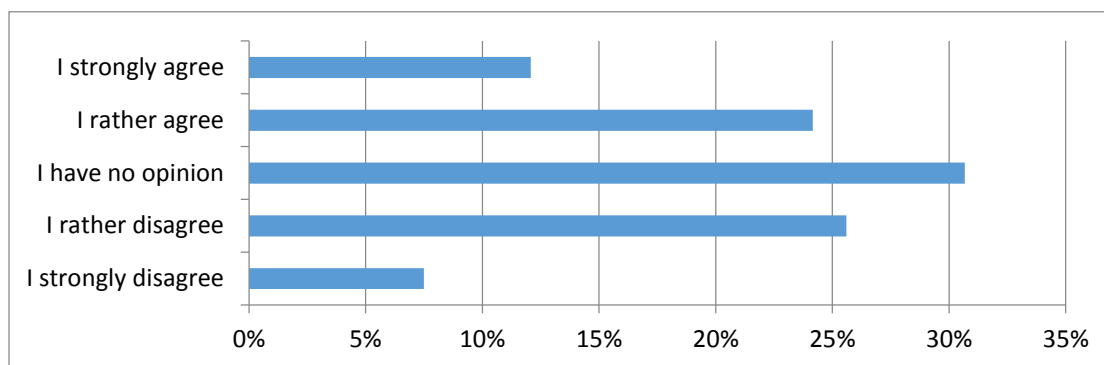


Figure 1. The city organises workshops for teachers related to environmental education.

Source: own research.

40% of cities declare that they take initiatives to attract businesses and entrepreneurs who, in their business practices, prioritise environmental well-being and invest in ecological solutions. Every third city (31%) does not undertake such initiatives (Figure 2). Companies operating in the city have a direct impact on the quality of the environment and life in the city. The city authorities engage in discussions and strive to support those business entities interested in improving the ecological quality of their operations, originating not only from legal regulations.

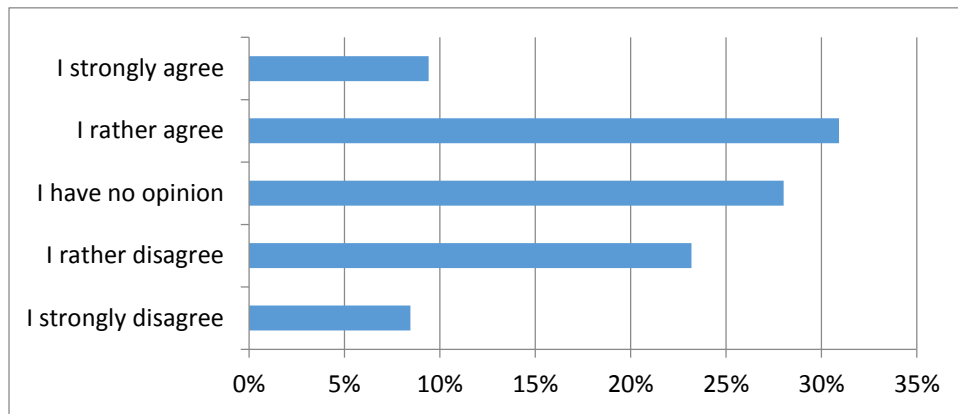


Figure 2. The city undertakes initiatives to attract businesses (entrepreneurs) that invest in ecological solutions.

Source: own research.

In response to the question about cities collaborating with non-profit entities to create a "green city" image, a large percentage of cities responded that they do not engage in such cooperation - 44%. One-third of cities (33%) declared that such cooperation is indeed conducted (Figure 3).

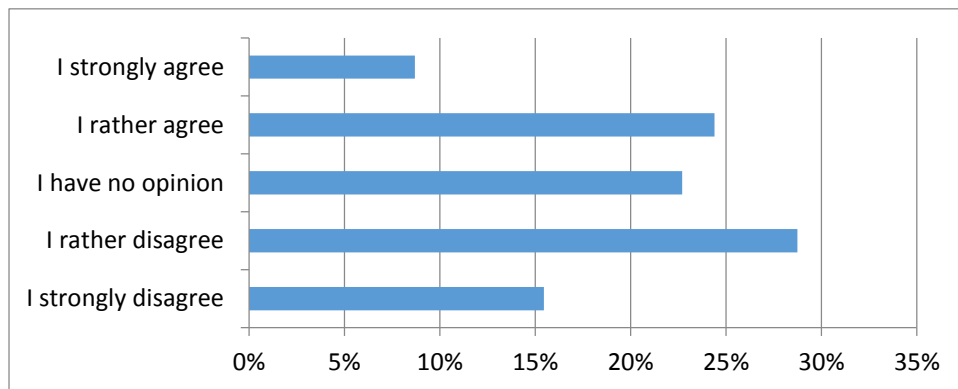


Figure 3. The city closely collaborates with non-profit organizations to create a "green city" image and implement environmental initiatives.

Source: own research.

However, the majority of cities also declare that they do not cooperate with local universities and colleges to develop solutions related to environmental protection and to promote the "green city" image - 54% of responses. Among the surveyed cities, 24% cooperate with universities in this regard (Figure 4). This may be due to the fact that many cities, especially smaller ones, do not have campuses or departments of higher education institutions. However, such collaboration could yield tangible results, as universities can develop specific practical environmental solutions and, through joint initiatives such as seminars and conferences, promote these solutions and raise awareness of the importance of ecology in the city.

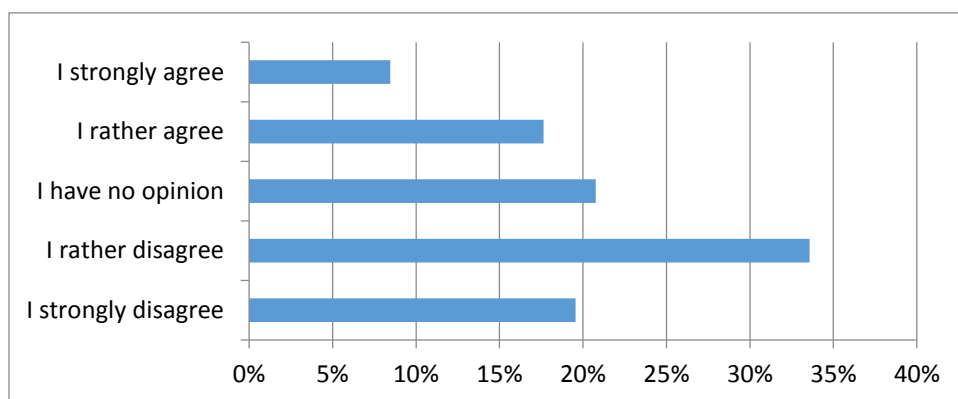


Figure 4. The city collaborates with universities located within the city or nearby areas to develop solutions in the field of environmental protection and to promote the image of a "green city".

Source: own research.

Additionally, cities invest in raising awareness among municipal employees. Forty-three percent indicate that training sessions are conducted for employees regarding environmentally friendly practices and their promotion. Thirty-seven percent do not organise training sessions to increase awareness among employees. Twenty-one percent were unable to provide an answer regarding the organization of such training sessions (Figure 5).

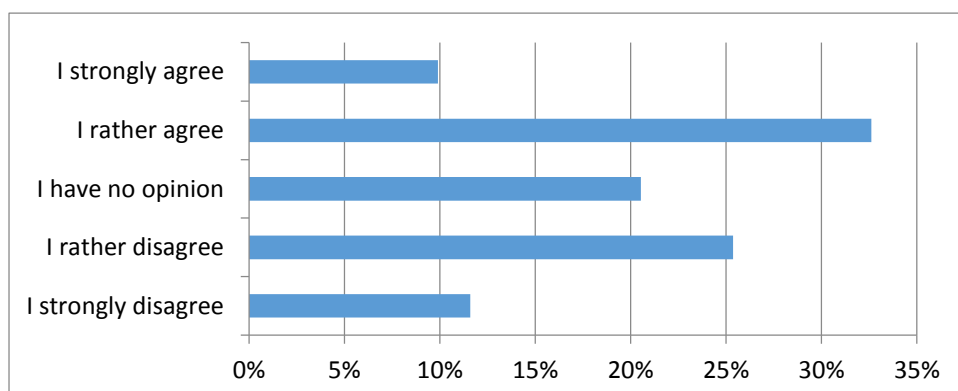


Figure 5. Training sessions for municipal employees regarding environmental protection actions and their promotion are conducted at the City Hall.

Source: own research.

Furthermore, a high percentage of cities (76%) have representatives who participate in conferences, seminars, and congresses related to environmental activities, such as those addressing renewable energy sources (Figure 6).

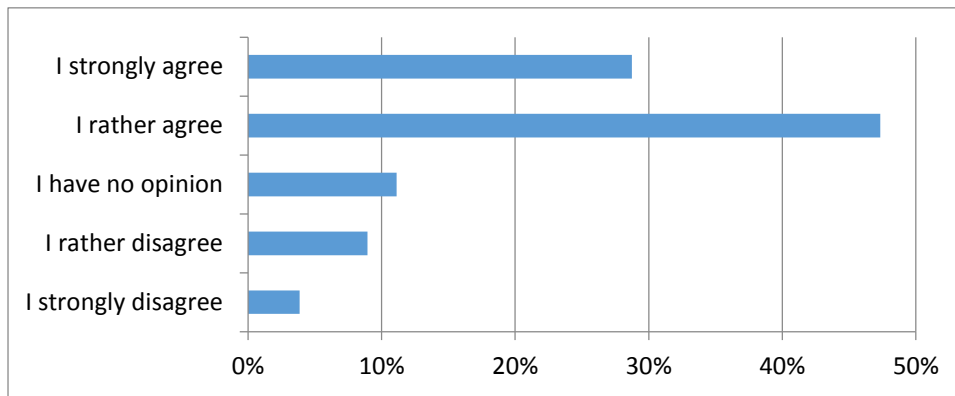


Figure 6. City representatives participate in conferences, seminars, and congresses focussing on environmental initiatives such as renewable energy sources.

Source: own research.

One in four cities (24%) collaborates with businesses, social organisations, and educational institutions to jointly organise seminars or conferences dedicated to environmental protection in the city. However, more than half (54%) do not engage in such collaboration (Figure 7).

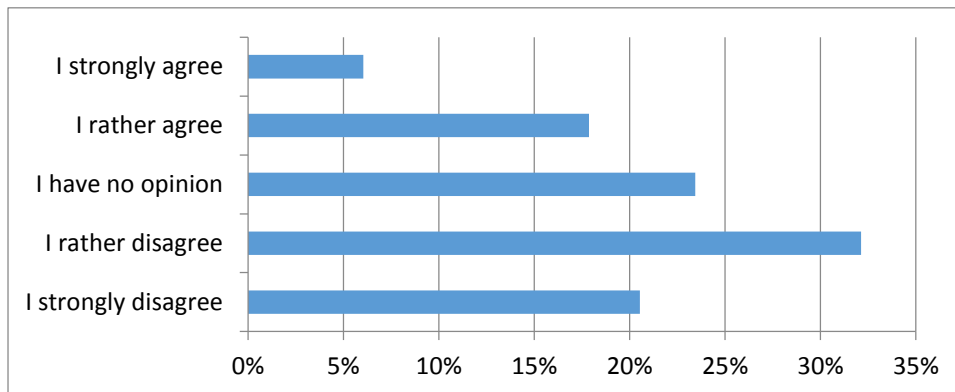


Figure 7. The city organizes congresses, conferences jointly with representatives of businesses, social organizations, and educational institutions concerning environmental protection in the city.

Source: own research.

Over half of the surveyed entities - 55% of cities - declare that they closely collaborate with the media (TV, radio, press) to promote pro-environmental attitudes and actions in the city (Figure 8). The importance of traditional media is particularly significant in communicating with the older generation of residents, which is less rooted in social media. Collaboration with both local and national media therefore increases the reach of influence. 27% of cities do not cooperate with the media in shaping pro-environmental attitudes.

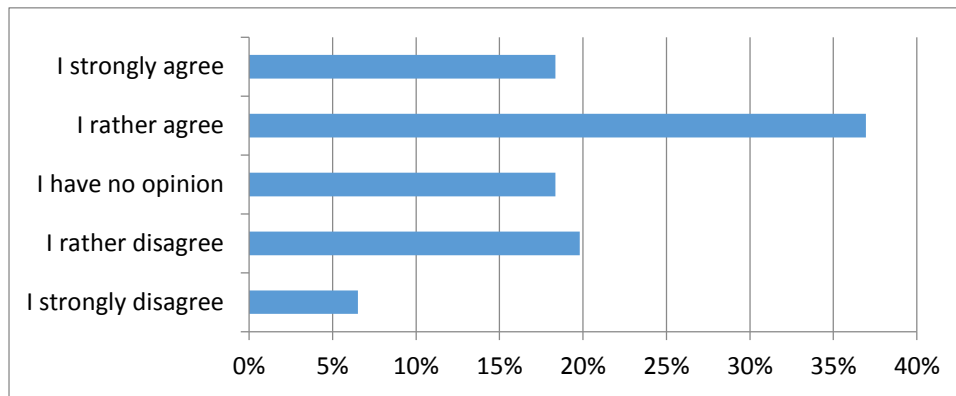


Figure 8. The city closely collaborates with the media (TV, radio, press) to promote pro-environmental attitudes and actions in the city.

Source: own research.

In addition to cooperating with independent media, city authorities use social media platforms eagerly. As many as 73% declare that they promote pro-environmental attitudes using media such as Facebook, Instagram or Twitter. 15% do not use social media platforms for this purpose. To promote pro-ecological attitudes, cities use communication tools that are primarily characteristic of the young and middle-aged generation.

40% of the surveyed cities declare that they post videos promoting environmental protection in the city on the internet, primarily on YouTube and on the City Hall website, with only 16% stating that they do so decisively. 36% do not distribute audiovisual materials related to ecology on the Internet. One in four surveyed cities could not answer whether such videos are available (Figure 9).

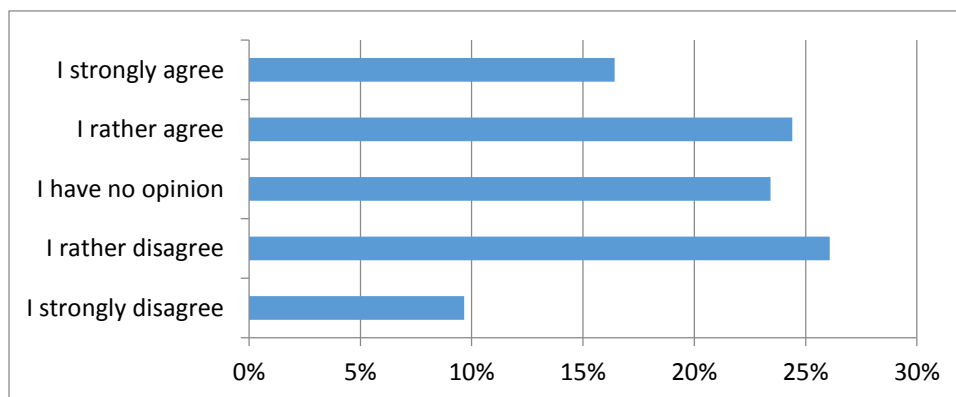


Figure 9. The city develops and disseminates promotional videos regarding environmental protection in the city on the internet (e.g., on YouTube, on the City Hall's website).

Source: own research.

The majority of cities (61%) declare that they have their own publications, such as newsletters, leaflets, and information brochures, which are used to promote pro-environmental attitudes and actions. Having their own publications allows the city to be independent from local or national media. It enables the dissemination of the city's strategy, including in the field of green marketing. 26% of cities declare that they do not have such publications, as they entail costs that not every city can bear. Additionally, in addition to

financial investments, it requires the participation of individuals who will be responsible for these publications (Figure 10).

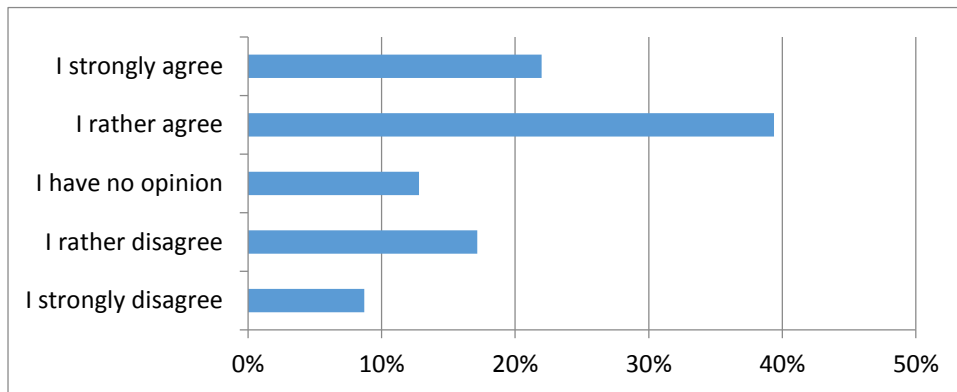


Figure 10. The city has its own publications (newspapers, leaflets, brochures) promoting pro-environmental attitudes and actions.

Source: own research.

In an effort to promote pro-environmental lifestyles and farming among residents, a large percentage of cities 64% organise festivals and outdoor events. Thanks to such events, residents can learn not only about environmental problems in the city, but also about ways to solve them or reduce their negative effects. It is also an opportunity to meet and activate residents. 19% of the cities surveyed do not organise this type of event. 18% could not specify whether such events take place in their city (Koszembar-Wiklik, 2023).

A small percentage (16%) of cities declare that they use the image of well-known individuals associated with the city, such as athletes, actors, cultural figures, politicians, influencers, and celebrities, to promote environmental protection and pro-environmental attitudes in the city.

To promote environmental protection in the city, the image of well-known individuals associated with the city (such as athletes, actors, influencers, etc.) is utilised. Additionally, unconventional forms of promotion such as street art are used on a small scale to promote ecological attitudes. This form of promotion was declared by 17% of the surveyed cities (with only 5% indicating "definitely yes"). 63% do not utilise street art in any way, while 20% were unable to respond (Figure 11).

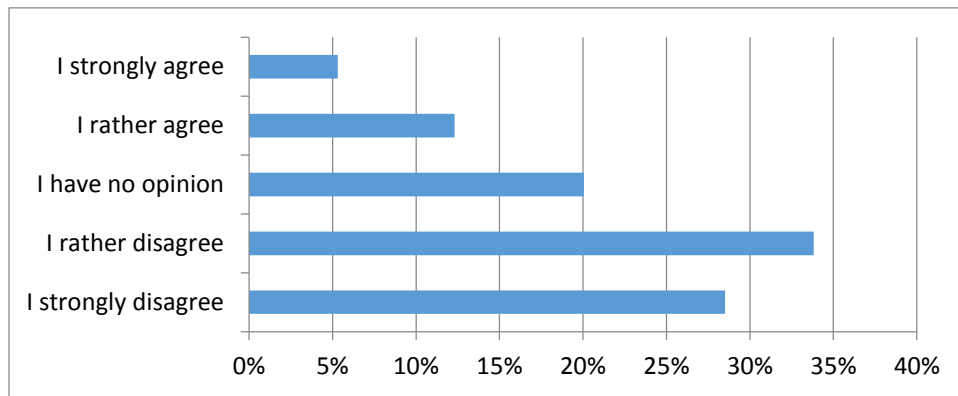


Figure 11. In the city, street art (such as murals, graffiti, stickers) is used to promote ecology.

Source: own research.

In addition to promoting attitudes and awareness-raising activities, cities declare that they initiate various actions in which residents participate. 73% carry out actions to mobilise residents, such as planting trees or cleaning up litter in the city. This approach certainly increases the residents' sense of empowerment and impact on the immediate environment around them.

Another activity that allows inhabitants to participate in activities for the benefit of ecology are competitions organised for inhabitants, in which they can submit projects to improve the environment in the city. According to the declarations, such competitions are organised by more than half of the cities surveyed - 56%.

Additionally, in the surveys, respondents were asked, in a multiple choice question, what actions are taken to promote ecology in the city. The best choice was to provide information on city websites (85%). On the second place, respondents indicated information posted on Facebook - 61%, as well as 61% mentioned distributing leaflets, newsletters, or brochures, while 38% also mentioned other social media platforms, and 22% publish videos on YouTube. There is a small percentage of mentions for using TV or radio advertisements, both local and national. However, 12% of cities indicated that they include podcasts on their websites that cover topics, including ecology. Among actions not directly related to city media, respondents stated that they organize promotional events related to ecology within the city (38%), sponsor ecology-related events (33%), and endorse environmental events organized by entities other than the city (17%). 22% mentioned organising or co-organising conferences or seminars on environmental protection. Sometimes, eco-related gadgets are distributed at such events. There is minimal use of billboard campaigns, virtual reality, or urban games to promote pro-ecological attitudes.

4. Conclusions

Cities (understood as those responsible for city management) notice and understand the issues related to shaping pro-environmental attitudes within the city. This awareness is an essential element of city functioning, especially as it is currently a widely raised issue in Europe. Cities utilize a wide range of activities to highlight environmental problems to both residents and other stakeholder groups. Among promotional activities, some are more common than others. Cities clearly focus on social media and their own publications for promotion. The widespread use of websites, Facebook, or other online media is economically and socially justified. Cities often have very limited budgets for promotion, so relatively inexpensive promotion using social media has its financial justification. The social aspect is also significant. Considering the media habits of different groups and the fact that a large part of their daily activity takes place on social media, choosing this medium is justified. On the other hand, own media such as publications, TV, radio, or YouTube channels are justified not only economically but also in terms of control. Own media give the city control over the content conveyed. Moreover, the interest of nationwide media in environmental issues in a specific city is not easy to garner, as they, driven by profitability, seek more popular topics. A large part of the activities is directed at residents, especially the youngest ones. This is manifested in the organisation of festivals and events for residents of all ages. Events of various types are organised on a fairly large scale in cities (picnics, family events, city days, festivals), with environmental issues as their main theme. Such actions provide city representatives with the opportunity to have direct contact with residents. However, these are tactical actions and should be treated as supportive rather than as the main way of shaping ecological attitudes. Such meetings with residents provide an opportunity to learn about their views on environmental issues in the city. Few cities conduct surveys of residents' opinions, yet they constitute the essence of city functioning. Encouraging ecological activity and raising awareness also occurs, albeit to a much lesser extent, through activities targeting teachers, business representatives, or employees working in municipal offices. However, what stands out is the low level of cooperation with non-profit and business entities in the area of pro-environmental activities. It is worth considering broad cooperation and greater networking of cities with city stakeholders. Cities could invest more in internal marketing, for example, in training and building awareness among municipal office employees. City representatives participate in various events, but they are usually small groups or individuals. Officials, as individuals having direct and indirect contact with residents, businesses, and NGO organizations, influence the city's image. Regular training on environmental issues will not only translate into the individual awareness of officials but can also be passed on further.

A small percentage of cities use the image of well-known individuals associated with the city to promote environmental actions. The aspect of supporting the city's promotion strategy by recognisable individuals is significant, especially in the current era of authority crisis, when young people are influenced by the examples presented by celebrities, influencers, and look to them for cultural models to emulate. It is worth paying attention to the broader use of the image of individuals who are associated with the city and are recognizable to a wider audience. The problem is that not every city is associated with well-known individuals, and these individuals may not necessarily be willing to lend their image even for the rightful purpose of promoting environmental awareness. The task facing those responsible for promotion is to find such well-known individuals, who may also be locally known figures, and encourage them to participate in the prepared strategy promoting ecology.

The use of virtual reality and street art for promoting ecology by cities is negligible. Virtual reality is a form that is not widely used in city promotion in general. It is not a form that could be applied on a mass scale. The very limited use of street art forms is understandable, as many people (residents) associate murals with acts of vandalism or expressions of rebellion rather than with an artistic form promoting the city. This awareness is slowly changing as cities commission murals to be painted. Some murals serve a promotional function while others are decorative elements of the city. Cities opt for forms that are relatively inexpensive and have a broad appeal, such as promotion on social media. There is still much work ahead for cities in building environmental awareness of residents and promoting environmental actions conducted by the city. These efforts are significant not only for shaping proactive environmental attitudes but also for fostering residents' sense of connection to their place of residence.

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THE ECONOMIC INSTRUMENTS AND MACROECONOMIC STABILIZATION ON THE DECARBONIZATION OF CENTRAL AND EASTERN EUROPEAN COUNTRIES

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Purpose: This paper aims to assess the impact of energy economic instruments and macroeconomic stabilization on decarbonization in the Central and Eastern European Countries (CEECs) from 2005 to 2019. The central research hypothesis (H) is "The impact of economic instruments and macroeconomic stabilization on decarbonization varies in the Central and Eastern European Countries from 2005 to 2019".

Design/methodology/approach: We use the Ordinary Least Squares (OLS) to verify our hypothesis.

Findings: The impact of economic instruments is varied. The most effective instruments are the EU Emissions Trading System, outlays on renewable energy sources, and futures contracts for CO₂ emissions.

Research limitations/implications: The availability of data, the choice of normalization method and the choice of estimation method for both the one-equation model.

Practical implications: The results show that economic instruments and macroeconomic stabilization have a positive impact on the decarbonization of economies, hence shaping their appropriate level is important for sustainable development.

Social implications: Economic instruments impact on decarbonization and thus improve the quality of life.

Originality/value: The impact of economic instruments is varied. The most effective instruments are the EU Emissions Trading System, outlays on renewable energy sources, and futures contracts for CO₂ emissions.

Keywords: economic instruments, macroeconomic stabilization, decarbonization.

Category of the paper: research paper.

1. Introduction

To ensure Changing the global energy mix is crucial to ensure appropriate conditions and quality of life for the present and future generations (Månberger, 2018; Sachs et al., 2019). The energy transformation and the "green deal" help develop renewable energy sources, create new markets and workplaces in energy sectors, improve energy efficiency, and reduce carbon dioxide emissions. A key challenge is decarbonization, which systematically reduces carbon dioxide (CO₂) emissions to the atmosphere. It shifts the economy to zero-emission or low-emission energy sources and helps stop global warming (Habert et al., 2020; Stef, Ben Jabeur, 2020).

Economic instruments play a significant role in decarbonization because they, directly and indirectly, impact on the environmental strategies and decisions made by enterprises, households, and public institutions. Their main aim is to reduce the emission of harmful substances into the environment. Additionally, the effectiveness of decarbonization depends on macroeconomic stabilization, which is a challenge for states' economic policy (Mazzanti, Ugo Rizzo, 2017; Peñasco et al., 2021).

This paper is empirical, and its main aim is to assess the impact of economic instruments and macroeconomic stabilization on decarbonization in the Central and Eastern European Countries (CEECs) from 2005 to 2019. Moreover, we want to examine the strength and direction of the impact between the variables. We focus on eleven countries, which are developing economies, and they started in the last few years the transformation of their energy system. The research period covers the years from 2005, the time of accession to the European Union and the possibility of full use of European funds and policies.

A novelty in the research is assessing the impact of energy economic instruments on decarbonization, which also consider the macroeconomic stabilization for their effectiveness in reducing the emission of harmful substances to the environment. The issues raised are paramount and, at the same time, relatively poorly researched. There is a lack of research on the impact of economic instruments and macroeconomic stabilization on decarbonization in the CEECs. Such analyzes are extremely important for acting and implementing policies to reduce CO₂ emissions.

To verify the central hypothesis, "The impact of economic instruments and macroeconomic stabilization on decarbonization varies in the Central and Eastern European Countries from 2005 to 2019", we use the Ordinary Least Squares (OLS). We created a decarbonization indicator (DeCO₂), the macroeconomic stabilization pentagon (MSP) and assessed the impact of economic instruments such as financial outlays on environmental protection (x1), environmental taxes (x2), outlays on renewable energy sources (x3), prices of futures contracts for CO₂ emissions (x4), outlays on R&D (x5), EU Emissions Trading System (EU ETS) (x6), and macroeconomic stabilization on decarbonization. The selection of variables for the model is limited to the instruments of the energy economy. Thus, we overlook other important economic instruments such as credits, loans, and mutual funds.

The presented models have serious limitations. Undoubtedly, the results are influenced by the choice of indicators for analysis, but it can support economic decisions that respect the climate aspect. The model will also help identify which instruments are more effective from the decarbonization process and what changes could be made to the selected instruments to make them more decarbonized.

2. Conceptual background

Carbon reduction, energy supply stability, and energy efficiency are factors for the prosperity, security, and development of modern economies. Decarbonization is the systematic reduction of carbon dioxide (CO₂) emissions to the atmosphere. It requires the use of renewable energy sources, modernization of energy infrastructure, support for sustainable transport, investments in research and development, urban regeneration, modernization of technology, and eco-innovations (Mateusz, Wojciechowski, 2012; Jenniches, 2018; Verburg et al., 2019; Louche et al., 2019).

Although decarbonization requires certain financial outlays on the modernization of economies, the benefits of reducing CO₂ emissions to the atmosphere are undeniable to the environment, climate and living conditions (Gouldson et al., 2018; Papadopoulou et al., 2020; Simionescu et al., 2021). Decarbonization requires implementing regulations, plans, skills, and financial support tools (Rivera, 2020; Kolosok et al., 2021).

Economic instruments, or more specifically energy economic instruments, play an important role in decarbonization. They, directly and indirectly (through the financial factors: costs and prices), impact enterprises' decisions and strategies. They can be positive (subsidies, tax breaks or excise duties, rates depreciation, preferential loans, R&D) or negative (taxes on energy or pollution, emissions trading). Economic tools are based largely on the principle that polluters should cover external costs (the polluter pays) (Mazzanti, Ugo Rizzo, 2017; Peñasco, 2021).

Among the energy economy instruments, we can distinguish financial outlays on environmental protection, environmental taxes, outlays on renewable energy sources, prices of futures contracts for CO₂ emissions, outlays on R&D, EU Emissions Trading System.

The development of R&D, renewable energy sources and increasing the financial outlays on environmental protection increase the innovation. It also promotes new models and solutions that reduce harmful substances' emissions into the natural environment. Expenditure on environmental protection should increase in the state budget, and it is also important to maintain macroeconomic stabilization (Månberger, 2018; Sofia et al., 2020; Halder, Sethi, 2020).

Environmental taxes are crucial to protect the climate, and their base is a physical unit (or a proxy of it) that has a proven specific negative impact on the environment (OECD, 2005). It seems that countries implementing environmental policy should strive to increase the share

of environmental taxes in fiscal revenues. However, it is extremely important to define the so-called optimal rates, as their too high level may adversely affect economic growth (Hany, Khaled, 2017; Catalano et al., 2020). Some researchers encourage introducing a global carbon tax to accelerate the decarbonization process (Papadis, Tsatsaronis, 2020; Fajczak-Kowalska et al., 2021).

Futures contracts for CO₂ emissions are a market instrument that is influencing carbon dioxide emissions. The higher the future contracts for CO₂ emission, the bigger the impact on the energy sector's investment in low-carbon technologies such as wind, solar, and energy efficiency. The low prices of futures contracts for CO₂ emissions can be a result of over-licensing in the market. As the research results show, this may be a consequence of the economic crisis and unstable markets.

The Emissions Trading System is an essential element of the European Union's environmental policy, reducing greenhouse gas emissions (Rosendahl, 2019; Flachsland et al., 2020). Firms receive or buy emission allowances to trade according to their needs (within certain limits) (Flachsland et al., 2020). Creating a single market for the environment is a success for the EU. Although EU ETS positively affects decarbonization, several studies show no evidence that the EU ETS caused carbon leakage (Naegele, Zaklan, 2019). Some researchers focus on EU ETS reform and discuss complementing it with a carbon price floor (Hintermayer, 2020).

The tightening EU ETS and the European Green Deal will lead to speeds up transformation by 3-17 years, higher shares of energy from renewable sources, decreases cumulative emissions, only small increases costs. Moreover, fossil, and nuclear unavailability does not affect results (Pietzcker et al., 2021). They also indicate that reforms to the EU ETS are unlikely to achieve their stated objectives in the power and industrial sectors. However, they can reduce emissions proportionally to the minimum requirements (Drummond, Ekins, 2017).

Decarbonization must be accompanied by macroeconomic stabilization (equilibrium in the real and monetary sphere) (Monnin, 2018; Pieloch-Babiarz et al., 2021). What is more, there is a relationship between these two variables. Macroeconomic stabilization is conducive to taking ecologically responsible actions (Brazovskaia et al., 2021). Moreover, macroeconomic stabilization is one of the conditions for the stable development of economies, and it should reduce carbon dioxide emissions to the atmosphere in the long term (Umar et al., 2020).

The choice of economic instruments is crucial for decarbonization, especially in developing countries. The support policy is the main driver of renewable resources diffusion in Europe. The effectiveness of the policy varies by region and by instrument (Bersalli et al., 2020). Some researchers indicate a greater but decreasing impact of price instruments on carbon intensity than renewable energy policies. There is also a visible and greater impact of indirect price signals than explicit ones (Mckibbin, 2017; Raveh, 2020). The analyzes emphasize that economic instruments provide continuous incentives to reduce pollution, even after reaching the normative emission limit.

3. The research methodology

This research aims to assess the impact of economic instruments and macroeconomic stabilization on decarbonization in the CEECs from 2005 to 2019. We analyzed the following economic instruments financial outlays on environmental protection, environmental taxes, outlays on renewable energy sources, prices of futures contracts for CO₂ emissions, outlays on R&D, EU Emissions Trading System. It is not a complete list of all instruments for environmental protection, but according to the literature on the subject and economic practice, they are crucial for decarbonization. We also determine the macroeconomic stabilization indicator based on the stabilization pentagon method. The research sample covers the Central and Eastern European Countries, including Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia. These countries are linked not only by their geographic location but also by history and a similar course of economic transformation. These countries are among the developing countries, with the great importance of fossil fuels for economic development.

The central research hypothesis (H) is "The impact of economic instruments and macroeconomic stabilization on decarbonization varies in the Central and Eastern European Countries in 2005-2019". We use the Ordinary Least Squares to verify our hypothesis. The justification for the research hypothesis is that countries use economic instruments to a different extent, have a different scale of problems related to compliance with nature protection standards, have a different energy balance and a different level of development of industry and new technologies. The research questions are as follows:

- Which of the economic instruments contributes most to decarbonization?
- Are economic instruments optimal, or do they require changes?
- In addition to economic instruments, does macroeconomic stabilization positively or negatively affect decarbonization?

To verify our research hypothesis, we use the Ordinary Least Squares. Our research consists of two stages:

1) Verification of the research hypothesis (H):

we create two types of models allowing for the assessment of relationships between variables (dependent variables are indicators of decarbonization):

Model 1:

$$De_{CO2i} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \varepsilon_i$$

Model 2:

$$De_{CO2i} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 MSP_t + \beta_8 t + \beta_9 De_{(t-1)} + \varepsilon_i$$

2) Conclusion and discussion.

We form the indicator of decarbonization. We use the following formula:

$$De_{CO2i} = \frac{minCO_2}{CO_{2i}},$$

where:

CO_{2i} – emission of carbon dioxide in the i – year,

$De_{CO_{2i}}$ – the indicator of decarbonization in the i -year,

$\min CO_2$ – minimum value of carbon emissions in 2008-2018.

Then we form the macroeconomic stabilization. We use the formula (Kołodko, 1993):

$$MSP = [(\Delta GDP * U) + (U * CPI) + (CPI * G) + (G * CA) + (CA * \Delta GDP)] * k$$

where:

$a = \Delta GDP * U * k$ - presents triangle area called the real sphere triangle and characterizes the relation between the rate of economic growth and unemployment rate;

$b = U * CPI * k$ - stands for the stagflation triangle which depends on the unemployment rate and inflation rate;

$c = CPI * G * k$ - is defined as the budget and inflation triangle;

$d = G * CA * k$ - is called the financial equilibrium triangle and depends on the budget and the current account balance;

$e = CA * \Delta GDP * k$ - means the external sector triangle and shows the variability of current account balance and rate of economic growth;

$k = 1/2 \sin 72 = 0.475$ - is a constant value.

4. The research results

Figure 1 presents the decarbonization indicator in the period from 2005 to 2019. In all countries (except Lithuania), De_{CO_2} characterizes an upward trend (parameters before the time variable are positive). The decarbonization process should be assessed positively, although it is necessary to take further actions aimed at reducing CO_2 emissions to the atmosphere. The decline in decarbonization in the period from 2017 to 2020 may result from the growing demand of economies for electricity (for example, in Poland, the production of electricity from hard coal and lignite increased by over 20% in the last year, and unfortunately, production from gas and wind decreased, as well as electricity imports). Moreover, the disturbance may result from the EU regulations forcing countries to reduce carbon dioxide emissions into the atmosphere. These countries slowly began to change their energy balance (e.g. Lithuania and Poland), which may increase decarbonization in the short term. The authorities should focus on shifting from hard coal and investing in renewable energy sources are a priority. All analysed countries should invest in renewable energy sources and implement innovations to increase energy efficiency.

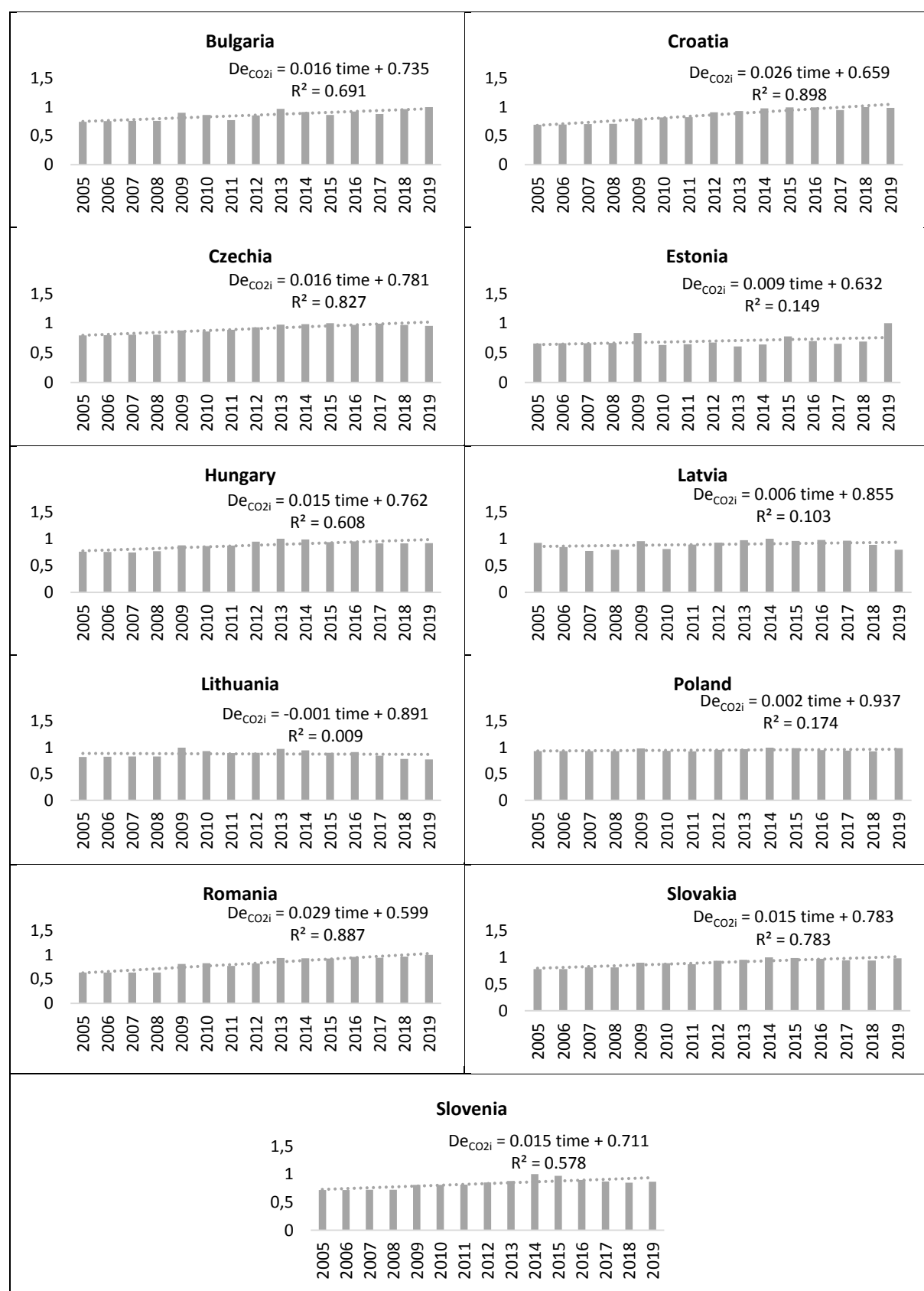


Figure 1. The indicator of decarbonization of CEECs in the period from 2005 to 2019.

Source: own study based on Eurostat [<https://ec.europa.eu/Eurostat>], 10.12.2020.

Table 1 presents the result of the OLS estimation of Model 1. In all countries, the impact of economic instruments on the indicator of decarbonization is statistically significant and diversified (in terms of strength and direction).

In Czechia, Hungary, and Slovenia, four economic instruments influence the indicator of decarbonization. In other countries, two/three economic instruments influence the indicator of decarbonization. The EU Emissions Trading System is the most common of all economic instruments (in nine countries). The least common economic instrument is outlaid on R&D (only in one country, which means that R&D expenditure is low). The coefficient of determination ranges from 0.669 (a satisfactory fit to the model's data) to 0.988 (a perfect fit to the model's data).

The estimation results show that the EU instruments are crucial for decarbonizing the countries in Eastern Europe. In the studied countries, we obtain different models, indicating that they vary in energy balance, R&D level, and industry structure. In most cases, there is a statistically significant influence of external economic tools on decarbonization. It is necessary to create restrictive legal, environmental regulations at the EU level, which affect decisions made in the Member States under the threat of financial penalties.

Table 1.

Results of Ordinary Least Squares regression method in the CEECs in the period from 2005 to 2019: $De_{CO2i} = \beta_0 + \beta_1x_i + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 + \varepsilon_i$

Country	Dependent variable	Independent variable	Coefficient	p - value	R ²
Bulgaria	De _{CO2i}	constant	0.551	2.09e-07 ***	0.809
		x ₁	0.001	0.0202 **	
		x ₃	0.024	0.0002 ***	
Croatia	De _{CO2i}	constant	1.444	3.52e-015 ***	0.972
		x ₄	-0.002	0.060 *	
		x ₆	-5.503e-08	1.15e-09 ***	
Czechia	De _{CO2i}	constant	1.204	<0.0001 ***	0.988
		x ₂	-3.027e-05	0.0324 **	
		x ₄	-0.004	<0.0001 ***	
		x ₅	0.001	0.0002 ***	
		x ₆	-3.807e-09	0.0031 ***	
Estonia	De _{CO2i}	constant	1.151	<0.0001 ***	0.907
		x ₂	0.001	0.0046 ***	
		x ₆	-4.084e-08	<0.0001 ***	
Hungary	De _{CO2i}	constant	1.296	<0.0001 ***	0.972
		x ₂	-5.819e-05	0.0374 **	
		x ₃	0.043	0.0588 *	
		x ₄	-0.003	0.0482 **	
		x ₆	-1.524e-08	0.0214 **	
Latvia	De _{CO2i}	constant	1.312	<0.0001 ***	0.789
		x ₁	-0.001	0.0686 *	
		x ₄	-0.007	0.0041 ***	
		x ₆	-9.868e-08	0.0344 **	
Lithuania	De _{CO2i}	constant	0.865	<0.0001 ***	0.669
		x ₁	0.001	0.0135 **	
		x ₄	-0.007	0.0016 ***	

Cont. table 1.

Poland	De _{CO2i}	constant	1.462	<0.0001 ***	0.689
		x ₂	-1.040e-05	0.0235 **	
		x ₃	0.013	0.0173 **	
		x ₆	-2.248e-09	0.0155 **	
Romania	De _{CO2i}	constant	1.130	<0.0001 ***	0.978
		x ₃	0.010	0.0029 ***	
		x ₆	-8.697e-09	<0.0001 ***	
Slovakia	De _{CO2i}	constant	0.887	<0.0001 ***	0.980
		x ₁	0.001	0.0531 *	
		x ₃	0.034	<0.0001 ***	
		x ₆	-1.387e-08	0.0039 ***	
Slovenia	De _{CO2i}	constant	1.065	<0.0001 ***	0.980
		x ₁	0.001	0.0011 ***	
		x ₃	0.005	0.0736 *	
		x ₄	-0.004	0.0003 ***	
		x ₆	-4.818e-08	<0.0001 ***	

Source: own study based on Eurostat [<https://ec.europa.eu/Eurostat>], Investing [<https://www.investing.com/>], IEA [<https://www.iea.org/>], Our World in Data [<https://ourworldindata.org/>], EEA [<https://www.eea.europa.eu/>], 9.04.2021.

Table 2 presents the results of the estimation of the Model 2. In each country, apart from Slovakia (problems with economic growth, unemployment, and foreign trade after the economic crisis), there is a statistically significant positive impact of macroeconomic stabilization on decarbonization. This result means that the existence of stable economic equilibrium is of key importance for environmental policy. The introduction of the macroeconomic stabilization indicator also influences the change of statistically significant economic instruments influencing decarbonization. Moreover, in Bulgaria, Czechia, Latvia, and Romania, the estimation results indicate the impact of decarbonization from the previous period on the current reduction of carbon dioxide emissions to the atmosphere. In other words, it means a certain continuity in the decarbonization of these countries.

Table 2.

Results of Ordinary Least Squares regression method in CEECs in the period from 2005 to 2019: $De_{CO2i} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 MSP_t + \beta_8 t + \beta_9 De_{(t-1)} + \varepsilon_i$

Country	Dependent variable	Independent variable	Coefficient	p - value	R ²
Bulgaria	De _{CO2i}	constant	2,288	0,0155 **	0,999
		x ₁	0,002	0,0252 **	
		x ₂	-0,002	0,0294 **	
		x ₃	-0,008	0,0748 *	
		x ₄	0,018	0,0317 **	
		x ₅	0,002	0,0327 **	
		x ₆	-2,4e-08	0,0131 **	
		MSP	1,490	0,0282 **	
		t	0,042	0,0332 **	
		De _(t-1)	-0,432	0,0438 **	
Croatia	De _{CO2i}	constant	1,493	<0,0001 ***	0,974
		x ₁	-0,001	0,0851 *	
		x ₆	-5,9e-08	<0,0001 ***	
		MSP	0,365	0,0046 ***	

Cont. table 2.

Czechia	De _{CO2i}	constant	1,717	<0,0001 ***	0,999
		X ₁	0,001	<0,0001 ***	
		X ₂	-0,001	<0,0001 ***	
		X ₃	0,012	0,0001 ***	
		X ₄	0,000	0,0013 ***	
		X ₆	-2,1E-09	0,0002 ***	
		MSP	0,213	<0,0001 ***	
		t	0,020	<0,0001 ***	
		De _(t-1)	-0,537	<0,0001 ***	
Estonia	De _{CO2i}	constant	1,274	<0,0001 ***	0,986
		X ₂	0,001	0,0117 **	
		X ₆	-4,7e-08	<0,0001 ***	
		MSP	0,210	<0,0001 ***	
Hungary	De _{CO2i}	constant	1,933	<0,0001 ***	0,959
		X ₃	-0,058	0,0046 ***	
		X ₆	-3,7e-08	<0,0001 ***	
		MSP	0,156	0,0041 ***	
Latvia	De _{CO2i}	constant	2,623	0,0039 ***	0,999
		X ₁	-0,001	0,0209 **	
		X ₂	0,001	0,067 *	
		X ₃	-0,009	0,0127 **	
		X ₄	-0,018	0,009 ***	
		X ₆	-1,1e-07	0,01 **	
		MSP	2,387	0,0149 **	
		t	0,045	0,0414 **	
		De _(t-1)	-0,332	0,0245 **	
Lithuania	De _{CO2i}	constant	1,026	<0,0001 ***	0,772
		X ₁	-0,030	0,0278 **	
		X ₄	-0,008	0,0029 ***	
		MSP	1,002	0,0380 ***	
Poland	De _{CO2i}	constant	1,521	<0,0001 ***	0,800
		X ₁	0,001	0,092 *	
		X ₂	-2,5e-05	0,0066 ***	
		X ₆	-2,9e-09	0,0089 ***	
		MSP	0,438	0,0089 ***	
Romania	De _{CO2i}	constant	1,545 ***	<0,0001	0,999
		X ₂	-1,9e-05 *	0,0647	
		X ₃	0,003 *	0,0819	
		X ₄	0,003 **	0,0159	
		X ₆	-1,e-08 ***	<0,0001	
		MSP	0,371 ***	0,0046	
		De _(t-1)	-0,146 **	0,0155	
Slovakia	De _{CO2i}	constant	2,241	<0,0001 ***	0,974
		X ₂	-0,001	0,0574 *	
		X ₄	-0,002	0,0337 **	
		X ₆	-1,2e-07	<0,0001 ***	
		MSP	-0,292	0,0262 **	
Slovenia	De _{CO2i}	constant	1,051	<0,0001 ***	0,974
		X ₃	0,022	0,0086 ***	
		X ₆	-1,8e-08	0,0008 ***	
		MSP	0,241	0,0164 **	

Source: own study based on Eurostat [<https://ec.europa.eu/Eurostat>], Investing [<https://www.investing.com/>], IEA [<https://www.iea.org/>], Our World in Data [<https://ourworldindata.org/>], EEA [<https://www.eea.europa.eu/>], 9.04.2021.

The OLS estimation results indicate that the impact of economic instruments and the macroeconomic situation on decarbonization is different in Eastern Europe. Decarbonization and macroeconomic situation are interrelated in developing economies. In addition, the EU instruments, including the EU Emission Trading System, are necessary for reducing emissions of harmful substances in the eastern EU countries. The European Union's regulations, rules and environmental protection plans are essential for the decarbonization of the member states. Therefore, the external impact, based on the polluter pays principle, brings the best results.

5. Discussion

Instruments of energy economy are important, although they are not the optimal solution. They allow only to reduce CO₂ emissions to the atmosphere and not eliminate the whole emission of harmful substances. These instruments should be considered in the context of the country. The impact of economic instruments on decarbonization varies across the countries studied, as these countries differ in size, level of development and economic structure and have different energy balances. Importantly, these countries have different possibilities of implementing eco-innovation, and their energy consumption is different.

The research results show that the economic instruments decreased the carbon dioxide emissions to the atmosphere. Thus, we confirm the previous research, highlighting the importance of energy economy instruments for decarbonizing developing countries (Mazzanti, Ugo Rizzo, 2017; Peñasco et al., 2021). Moreover, the impact of the instruments on decarbonization vary across the countries. The instrument that appears most frequently in the research results is the EU Emissions Trading System. These results confirm that the EU ETS is a crucial component of the EU's climate change policy and its primary tool to reduce greenhouse gas emissions cost-effectively.

We agree with other researchers who also point to the importance of the EU ETS (Naegele, Zaklan, 2019; Hintermayer, 2020; Pietzcker, 2021). However, we would like to point out that this instrument still needs to be reformed (the direction of the current reforms seems correct), and a more comprehensive approach to environmental protection among business managers is necessary. Entrepreneurs must develop strategies and business models that take environmental considerations into account. Otherwise, they will be forced to incur high financial expenses related to the functioning of the EU emissions trading system. In addition to the EU ETS, contracts for CO₂ emissions and environmental taxes are essential for decarbonization. Like other authors, we have noted their contribution to reducing carbon dioxide emissions (Catalano, 2020; Papadis, Tsatsaronis, 2020; Fajczak-Kowalska et al., 2021). However, it seems to us that these instruments are still not fully used.

Model shows the positive impact of macroeconomic stabilization on decarbonization in most emerging and developing economies in the eastern European Union (the exception here is Slovakia, where an increase in macroeconomic stabilization leads to a decrease in decarbonisation, it may result from macroeconomic problems in this country, especially with economic growth, unemployment rate, internal demand after the economic crisis) (Issah, Antwi, 2017; Pieloch-Babiarz et al., 2021).

Adding the decarbonization indicator, variable "time", and decarbonization from the previous period to the model slightly changes the results, but the general direction of the impact is like in the first two models. The research results indicate that it was possible to separate economic growth from decarbonization in the analyzed countries (Boța-Avram et al., 2018; Wang et al., 2019). Moreover, maintaining macroeconomic stabilization is essential for eco-investment and environmental activities (Owen et al., 2018; Wang, Zhang, 2018).

6. Conclusions

Economic instruments play an important role in decarbonization. We can distinguish financial outlays on environmental protection, environmental taxes, outlays on renewable energy sources, prices of futures contracts for CO₂ emissions, outlays on R&D, and the EU Emissions Trading System. This list is not exhaustive of all instruments and tools, but it seems that these play a fundamental role in reducing carbon dioxide emissions.

The research results indicate that countries manage in reducing carbon dioxide emissions. Statistical models indicate that the central research hypothesis is true because "The impact of economic instruments and macroeconomic stabilization on decarbonization varies in the Central and Eastern European Countries from 2005 to 2019".

The models show that the EU Emissions Trading System is important for decarbonization in nine of eleven countries (Croatia, Czechia, Estonia, Hungary, Latvia, Poland, Romania, Slovakia, Slovenia). In six countries, outlays on renewable energy sources (Bulgaria, Poland, Hungary, Romania, Slovenia, and Slovenia) and futures contracts for CO₂ emissions (Croatia, Czechia, Hungary, Latvia, Lithuania, Slovenia) are essential for decarbonization. The outlays on environmental protection are important for reducing the CO₂ in five countries (Bulgaria, Latvia, Lithuania, Slovakia, Slovenia) and environmental taxes in four countries (Czechia, Estonia, Hungary, and Poland). On the other hand, outlays on R&D have a statistically significant impact only in Czechia. Moreover, the strength and direction of the impact between the variables are different.

There is also a statistically significant impact of macroeconomic stabilization on decarbonization. Moreover, in most countries, this dependence is positive, which means that the macroeconomic policy goes hand in hand with decarbonization. Hence, a rational and stable

policy aimed at economic growth, a decline in unemployment, and maintaining inflation at an appropriate level is indispensable.

Economic instruments seem to have a positive effect on decarbonization, but they are not optimal. It seems necessary to take rational measures to rebuild the economics in hand with protecting the natural environment. In the short term, it is necessary to stimulate domestic demand and take radical political action. It also seems that the change in the approach to environmental taxes is justified. Taking measures to increase their share in total fiscal revenues is crucial for climate protection and sustainable development.

The EU Emissions Trading System stimulates investment into clean, low-carbon technologies. After recovering from the crisis caused by the covid pandemic, a principal challenge will be to increase prices to force companies to invest in new, environmentally friendly technologies. For example, launching financial programs encouraging investments in renewable energy sources. Decarbonization requires radical political decisions which should focus on the reorganization of industry and closing mines.

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INFLUENCE OF SELECTED ECONOMIC FACTORS ON THE AMOUNT OF GROSS SALARIES IN INDUSTRY

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Purpose: the aim of the work is to study the impact of selected economic factors on the level of gross salaries in the industry sector in Poland in the years 2005-2020.

Design/methodology/approach: in the first stage of the research, the Pearson linear correlation between the average gross salary in industry and the adopted variables was examined. Then, a multiple regression model was created, which aims to indicate which of the adopted variables best explain the development of the average gross salary in industry.

Findings: the construction of the econometric model allowed us to indicate that the factors that best explain the average gross salary in industry are the average gross salary in the economy and the volume of domestic demand.

Research limitations/implications: there are many alternative models that may lead to different results by subsequent authors of scientific papers. Therefore, it is recommended to conduct further research to identify the factors shaping gross salaries in industry.

Originality/value: the article raises an important topic regarding economic factors affecting the level of salaries in industry. The existing literature lacks research specifically focused on salaries in the industry.

Keywords: industry, salaries level, economic factors.

Category of the paper: Research paper.

JEL: C10, C51, J31, L60.

1. Introduction

Technological progress, resulting from globalization processes, changes the role of the labor force as a factor increasing the level of competitiveness (Ulbrych, 2015). At the same time, the increase in innovation has contributed to a reduction in the importance of the number of hands at work, and the role of acquired qualifications has increased, which is important in particular in modern industries, which is commonly understood as a branch of the national economy dealing with the exploitation and processing of natural resources in a mass manner, using machines and applying division of labor.

Issues related to employee salaries are among the basic issues in modern economics. On the one hand, they refer to the human factor and the work it performs, and on the other, to employees' expectations related to this work in the form of salary received. The literature defines salary as payment for work performed for the employer (Borkowska, 2014). In a broader sense, salary is understood as the sum of: salary including basic salary; employee allowances and salary received for time not worked; short and long-term stimuli; additional benefits (which are usually of a material nature).

The level of salary is often one of the significant problems related to the sense of security. This is due to the two functions of salary: maintenance and motivation (Bernatt et al., 2011). The alimony function is intended to provide the employee with a level of salary that allows him to function properly in society. According to the motivational function, the level of pay is a stimulator of effective action. As Gros (2012) points out, salary should be adequate to the degree of difficulty of the work performed. The amount of salaries is therefore one of the basic elements determining the economic and social conditions of a given country.

It should be noted that they are the basic source of household income, which in turn proves the wealth of a given individual. This may cause certain inequalities and divisions in society. Additionally, salaries indicate the ability to meet one's needs, as a result of which their level will affect domestic consumption, which in turn will affect the level of economic development. Therefore, it becomes important to find the determinants influencing the level of salary. The study of individual factors is particularly important after Poland's accession to the European Union, which resulted in intensified economic migration of the community and, consequently, an increase in the level of income inequality between individual regions of Poland.

Many important factors influence the overall salary level in a given country. In existing research, they most often include socio-economic factors at the micro and macroeconomic levels. Borkowska (1999) notes that various labor market institutions, such as employers, employees, trade unions and state institutions, contribute to shaping the level and differentiation of salaries. When explaining the impact of economic factors on the level of salaries, it is reasonable according to Sobczak (2000) is to refer to the real GDP growth rate, the inflation rate and the annual growth rate of the average monthly salary. The positive relationship between the level of average salaries and the economic effects of the enterprise, labor productivity, the level of inflation and the level of investment per employee was proven by Nyk (2007, 2013). The work of Ziemia and Świeszczak (2011) proved the statistical significance between the average level of salary and the value of the development index of entities from the SME sector and the value of revenues per 1 SME entity. Przekota (2016) considers the unemployment rate and industrial production sold to be the basic factors influencing the amount of salaries. In turn, Łopatka (2015) shows that the formation of salary levels is largely sanctioned by the autonomous functioning of the market, and therefore depends on the prevailing situation in the economy and the level of competitiveness of the regions.

In world literature you can also find issues examining the impact of individual factors on the level of salaries. The issue of salaries in the euro area economy in the 1980s and 1990s was discussed in depth in the work of Genre, Momferatou, Mourre (2005). The authors state that salaries in the long run are integrated with changes in labor productivity and there is a reverse causality between the increase in the average salary and the increase in the number of people employed in a given industry. Moreover, they prove that salary differences in the euro area are similar to those in the United States. In turn, the works of Leuven and Oosterbeek (2004) and Simón (2010) state that the level of salaries is influenced by both market forces and institutional factors. Interesting conclusions are reached by Magda, Rycx, Tojerow and Valsamis (2009), who compare salaries in Western and Eastern Europe. At the same time, they confirm that salary differences are more dispersed in countries where salary negotiations are poorly coordinated. Logeay, Stephan and Zwiener (2011) draw attention to macroeconomic factors affecting the level of salaries, pointing out the high importance of such determinants as: unemployment rate, minimum salary, state economic growth rate and domestic demand growth rate. Preston (2018) also comprehensively presents the determinants of salaries, emphasizing that both supply and demand factors play an important role.

However, these studies refer to the average level of salaries in a given country or group of countries. On the other hand, there is a lack of research specifically focused on salaries in industry. In recent years, the industry has been entering the path of dynamic development as a result of numerous transformations occurring both in enterprises and their surroundings. It is important to remember that industry continues to have a significant impact on the overall economy. This is determined by the fact that this sector is a producer of investment goods for all sectors of the economy. The global financial and economic crisis has revealed that the current economy cannot function properly without industry. It is an important workplace for society, innovation and productivity. Moreover, it meets the growing needs of material consumption. Therefore, the main aim of the work was to study the impact of selected economic factors on the level of gross salaries in the industry sector in Poland in the years 2005-2020.

For the purposes of the study, it was found that the industry, in accordance with the Regulation of the Council of Ministers of 24.12.2007 on the Polish Classification of Activities (PKD), includes: - section B - mining and quarrying; - section C – industrial processing; - section D - production and supply of electricity, gas, steam, hot water and air for air conditioning systems; - section E - water supply, sewerage and waste management and reclamation activities.

2. Introduction

In the first stage of the research, an analysis of the literature was carried out identifying factors that could potentially influence the average gross salary in industry. These included:

- X1 – average employment in industry (in persons),
- X2 – unemployed registered at the end of the year (in thousands of people),
- X3 – average monthly gross salary (in PLN),
- X4 – state budget revenues (in PLN million),
- X5 – state budget expenditure (in PLN million),
- X6 – domestic demand (in PLN million),
- X7 – price index of sold production in industry (in %),
- X8 – gross domestic product (in PLN million),
- X9 – average annual euro – Polish zloty exchange rate (in PLN),
- X10 – average annual exchange rate US dollar – Polish zloty (in PLN),
- X11 – average opening prices of Brent crude oil (in PLN),
- X12 – total capital expenditure (in PLN).

The next step of the analysis is to examine the Pearson's linear correlation between the average gross salary in industry and the adopted variables. This is intended to show the strength of the relationship between individual variables. Due to emerging doubts whether the relationship between the examined features is at least approximately linear, the natural logarithms of individual variables were examined. In addition, monetary data have been reduced to constant 2005 prices to eliminate the impact of inflation.

In the last stage, a multiple regression model was created, which aims to indicate which of the adopted variables best explain the formation of the average gross salary in industry. The model was constructed based on annual data. Hellwig's integral capacity method was used to select the explanatory variables. When building the model, assumptions were made that the explanatory variables were characterized by a correlation level of less than 0.5, and that the selected explanatory variables were at least significantly correlated (correlation level greater than or equal to 0.5) with the explained variable and that they were statistically significant at 5%.

3. Results

The average gross salary in industry in 2005-2020 varies. The lowest value was recorded in 2005 - PLN 2,361.61, and the highest in 2020 - PLN 3,866.23. The average gross salaries in industry was PLN 3,057.49.

A significant role in the methodology of examining the interdependence of time series is their stationarity. Therefore, the adopted variables were tested for stationarity through the KPSS test (with a test lag of 1). The results of the test for the variables are included in Table 1.

Table 1.

KPSS test results for potential variables explaining the average gross salary in industry and their first increases

Variable	p-value	p-value for first increments
Y - average gross salary in industry (in PLN)	0.038	p > .10
X1 - average employment in industry (in persons)	0.092	
X2 – unemployed registered at the end of the year (in thousands of people)	0.016	p > .10
X3 – average monthly gross salary (in PLN)	p < .01	p > .10
X4 – state budget revenues (in PLN million)	p < .01	p > .10
X5 – state budget expenditure (in PLN million)	p < .01	p > .10
X6 – domestic demand (in PLN million)	p < .01	p > .10
X7 – price index of sold production in industry (in %)	p > .10	
X8 – gross domestic product (in PLN million)	p < .01	p > .10
X9 – average annual euro – Polish zloty exchange rate (in PLN)	0.020	p > .10
X10 – average annual exchange rate US dollar – Polish zloty (in PLN)	p > .10	
X11 – average opening prices of Brent crude oil (in PLN)	0.067	
X12 – total capital expenditure (in PLN)	0.015	p > .10

Source: own study.

When analysing the results of the KPSS test, it should be noted that the following variables are characterized by non-stationarity: the average gross salary in industry, the unemployed registered at the end of the year, the average gross salary, state budget income, state budget expenditure, domestic demand, gross domestic product, average annual euro-Polish zloty exchange rate, total investment outlays. The remaining variables were found to be stationary (at a significance level of 5%). These include: average employment in industry, the price index of sold production in industry, the average annual US dollar-Polish zloty exchange rate, and average opening prices of Brent crude oil. In situations where the time series was non-stationary, first differences were calculated for it. After applying them to variables that showed non-stationarity in the time series, the KPSS test again showed their stationarity (Table 1). From this point on, the calculated first differences were used for further analyses.

In order to empirically verify the factors that shape the average gross salary in industry, in the first stage, a Pearson linear correlation analysis was performed between the average gross salary in industry and the adopted variables. The conducted research focuses on obtaining answers as to which of the potential variables are important in connection with the explained variable. The achieved results are presented in table 2.

Table 2.

Pearson's linear correlation coefficient between the average gross salary in industry and the adopted variables

Variable	r	Test statistics
X1 – average employment in industry (in persons)	0.46	0.084
X2 – unemployed registered at the end of the year (in thousands of people)	-0.82	0.000
X3 – average monthly gross salary (in PLN)	0.90	0.000
X4 – state budget revenues (in PLN million)	0.40	0.145
X5 – state budget expenditure (in PLN million)	0.27	0.323
X6 – domestic demand (in PLN million)	0.75	0.001
X7 – price index of sold production in industry (in %)	-0.17	0.552
X8 – gross domestic product (in PLN million)	0.68	0.005
X9 – average annual euro – Polish zloty exchange rate (in PLN)	-0.49	0.062
X10 – average annual exchange rate US dollar – Polish zloty (in PLN)	-0.01	0.979
X11 – average opening prices of Brent crude oil (in PLN)	-0.01	0.983
X12 – total capital expenditure (in PLN)	0.64	0.011

Source: own study.

The calculations of the correlation coefficient using the Pearson method indicate significant differences in the results achieved. The value of the average gross salary in industry is characterized by a very high degree of correlation with the average monthly gross salary ($r = 0.90$), and a high degree of correlation occurs with the variables: unemployed persons registered at the end of the year ($r = -0.82$) and domestic demand ($r = 0.75$). In turn, a significant degree of interdependence (statistically significant at the 5% level) was observed with the variables: gross domestic product ($r = 0.68$) and total investment outlays ($r = 0.64$). With the remaining variables, the size of the average gross salary in industry is not statistically significant at the 5% level.

Due to doubts as to the possibility of taking into account individual variables when building a model explaining the influence of factors on the average gross salary in industry, the selection of variables was verified based on Hellwig's integral capacity method. Five explanatory variables were taken into account (those characterized by statistical significance of the correlation with the average gross salary in industry). This method indicated that the variables: average gross salary (first increments) and domestic demand (first increments) should be taken into account when building the model.

The next step was to create models that explain the influence of factors on the average gross salary in industry. For the initially estimated model, the results of the Doornik-Hansen test for the normality of the distribution of residuals indicate that the empirical distribution function has a normal distribution (for the assumed significance level of 5%). The chi-square value was 1.649, with p-value = 0.438.

In order to check autocorrelation and possible modification of variables, the Breusch-Godfrey test based on Lagrange multipliers was performed. The lag order for the test was 1. For all test statistics, the p values are much greater than 5%, so the null hypothesis that the model does not contain autocorrelation should be accepted. Detailed results are presented in Table 3.

Table 3.

Results of the initial Breusch-Godfrey test for Lagrange multipliers for first-first autocorrelation

	Factor	Standard error	t-Student	p-value
Const	0.001	0.004	0.296	0.773
d_X3	-0.041	0.126	-0.328	0.750
d_X6	0.015	0.066	0.221	0.830
uhat_1	-0.423	0.310	-1.364	0.202
Coefficient of determination R-square = 0.157.				

Source: own study.

To check heteroscedasticity, White's test was performed. The null hypothesis in this test was the lack of heteroskedasticity. In the test, the p value was greater than the significance level of 0.05 (Table 4). Therefore, there are no grounds to reject the null hypothesis. Therefore, there is no heteroscedasticity in the model.

Table 4.

Results of White's test for heteroskedasticity of residuals

	Factor	Standard error	t-Student	p-value
Const	0.000	0.000	0.936	0.374
d_X3	0.003	0.003	0.829	0.428
d_X6	-0.001	0.001	-1.159	0.276
sq_d_X3	-0.054	0.073	-0.739	0.479
X2_X3	0.023	0.049	0.465	0.653
sq_d_X6	0.003	0.013	0.235	0.820
Coefficient of determination R-square = 0.303				
Test statistic: $TR^2 = 4.551$				
with p-value = $P(\text{Chi-square}(5) > 4.551) = 0.473$				

Source: own study.

The VIF test was used to check the multicollinearity of the variables. The test shows that there is no multicollinearity in the model because the factor value is less than 10 (the VIF value for both variables is equal to 1.625, with the minimum possible value equal to 1.0). In the next step, the Ramsey RESET test was performed. The null hypothesis of this test was that the given model was linear. The adopted version of the RESET test (square and cube of the variable) confirmed the functional correctness of the model (Test statistics: $F = 0.661365$, with p value = 0.537). Therefore, this model was adopted as the final one. At the same time, it should be noted that the phenomenon of coincidence occurs in the model. The most important results of the estimation of the model explaining the influence of factors on the explained variable are presented in Table 5.

Table 5.

Results of the estimated function of the model explaining the influence of factors on the average gross salary in industry

	factor	Standard error	t-Student	p-value
const	0.008	0.004	2.143	0.053
d_X3	0.639	0.123	5.192	0.000
d_X6	0,145	0,062	2,329	0,038
Arithmetic mean of dependent variable		0.033	Standard deviation of dependent variable	0.017
Determination coefficient R-square		0.865	Adjusted R-square	0.843
			The p-value for the F-test	0.000

Source: own study.

The final model indicates that the average gross salary and domestic demand have the relatively greatest positive impact on the average gross salary in industry. It is also worth noting that the estimated model has a very good fit, the R² value is 86.5%. This means that this model explains almost 87% of the variability of the phenomenon, i.e. the average gross salary in industry.

4. Conclusion

The added value is the quantification of factors influencing the average gross salary in industry. The obtained results allow us to indicate that the average gross salary in industry is related to: the average gross salary in the economy, the number of unemployed people registered at the end of the year, domestic demand, gross domestic product and total investment outlays. The construction of the econometric model made it possible to indicate that the factors that best explain the average gross salary in industry are the average gross salary in the economy and the volume of domestic demand. It should therefore be concluded that the average level of salaries in the economy exerts pressure on the level of salaries in industry. On the other hand, the volume of consumption and gross savings are becoming more important. The higher the values of the variables included in the model, the higher the level of gross salaries in the industry. The results achieved are important primarily for state authorities and production companies

The determined conditions therefore largely confirm the existing domestic and foreign research on the impact of factors on the overall level of salaries. At the same time, it is worth noting that despite the passage of time, similar factors still play a decisive role in shaping salaries.

At the same time, it should be remembered that the proposed equation is one of many possibilities to solve the problem. There are many alternative models that may lead to different results by subsequent authors of scientific works. Therefore, it is recommended to conduct further research to identify the factors shaping gross salaries in industry.

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TOWARDS A GREEN FUTURE: THE POLISH ENERGY MARKET AND THE POTENTIAL OF RENEWABLE ENERGY SOURCES

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Purpose: The purpose of the article is to present the current situation in the energy sector in Poland, with particular emphasis on the role of renewable energy sources (RES), and to assess the impact of these investments on the future of the energy sector in Poland.

Design/methodology/approach: Secondary research was conducted to characterize the energy market in Poland. Documents from four leading electric power producers in Poland were examined.

Findings: Despite the fact that Polish energy sector still heavily relies on coal, the future of the Polish energy sector appears to be closely linked to the development of RES. Leading companies operating in the Polish energy sector have adopted strategies involving significant investments in RES.

Research limitations/implications: This study focuses on the power sector and does not take into account investments in RES made by households. Therefore, future research could focus on the energy transition of households in particular, identifying the determinants and constraints of this transition.

Practical implications: This paper shows how legal regulations, including CO2 emission restrictions and international commitments, affect the current situation of the Polish energy market and shape its development. These regulations also point out the need to accelerate the country's energy transition in order to increase energy security through diversification of energy sources.

Social implications: Large-scale investments in renewable energy sources will contribute to reduction of greenhouse gas emissions, thus, they will have positive effect on the environment.

Originality/value: The issue of energy transition is addressed from both a practical and social point of view. The analysis conducted uses the most recent data, thereby providing up-to-date knowledge.

Keywords: renewable energy sources, energy transition, electricity generation, energy market, electricity.

Category of the paper: research paper.

1. Introduction

In the era of global pursuit of sustainable development, the importance of renewable energy sources (RES) in shaping the future of energy is undeniable. Poland, at the current stage of energy transformation, serves as a unique research subject due to its historical dependence on fossil fuels. The energy policy of Poland is conditioned by international commitments, including existing legal regulations established by the European Union (EU). Poland, as a member of the EU since 2004, is obligated to diversify its energy sources, including increasing the use of RES in the energy mix (Chodkowska-Miszczyk, Szymańska, 2012).

This issue becomes particularly significant in the context of the established air quality norms in Polish cities, that have been, for many years, exceeded. trend results in Poland being positioned at the bottom of the ranking of EU countries in terms of atmospheric quality, which underscores the urgent need for intervention in environmental and energy policy (Adamczyk, Graczyk, 2019). Increasing the share of RES does not only contribute to the improvement of the environment by reducing pollution, but also enhances the efficiency of use and conservation of energy resources, along with the reduction of waste production (Pultowicz, 2009). Furthermore, the increase in the use of RES contributes to the improvement of energy security (Sobolewski, 2010).

Energy security can be defined as "the ability to satisfy the market conditions demand for energy in terms of quantity and quality, at a price resulting from the equilibrium of demand and supply, while maintaining environmental protection conditions" (Borgosz-Koczwar, Herlender, 2008). Therefore, the inclusion of RES into the fuel and energy base contributes to increasing energy security, as it reduces the dependence degree of the availability of these resources on the market and it includes the possibility of them being imported.

Energy transition actions undertaken in the modern world are observable in both the social, economic, environmental and political spheres (Seroka, 2022). The policy of continuous tightening of emission standards is a result of processes occurring in the global economy and those of climate and technology (Kielierz, 2018). Plans to modernize Poland's electricity generation structure must take into account increasing the share of RES (Skoczkowski et al., 2016). Energy transition and ensuring energy security, especially in a coal-dependent economy such as the one in Poland, are activities with a long-term perspective. Yet, the energy transition process in Poland is progressing in an inefficient manner (Kubiczek et al., 2023).

Coal remains the most important resource when it comes to electricity generation in Poland (Ministerstwo Aktywów Państwowych, 2022, p. 14). Operating an energy market based largely on the use of a single energy source is risky. As recently as 2021, it was noted that Poland's continued reliance on coal threatens energy security (Pietrzak et al., 2021). This risk was materialized when, in 2022, Russia began its invasion of Ukraine, and the price of energy carriers and coal imports increased as a result. The war in Ukraine, according to experts,

may in the short term affect the pace of decarbonization of the energy sector (PKO, 2022), however, in the slightly longer term, it may significantly accelerate the energy transition (Polska Akademia Nauk, 2022). Nevertheless, the war resulted in the need to update Poland's Energy Policy to 2040 (PEP2040), noting the need to develop RES in Poland with an increased focus on coal (Ministerstwo Klimatu i Środowiska, 2022, pp. 1-3).

Increasing global energy demand further accelerates the depletion not only of fossil fuel (Sowa, 2018), but also energy security. It is worth noting that Poland, due to its geographical location, is a country with high RES potential (Seroka, 2022). Together with the possibility of obtaining subsidies for projects related to increasing the share of RES in the energy mix, especially infrastructure construction, it effectively encourages large companies to invest (Gouardères, 2023). This is reflected in the development strategies of leading Polish energy companies (Enea, 2024; Tauron, 2022a). Reports from these companies reveal investment strategies focused on the development of RES projects, with the aim of not only increasing the share of green energy in their portfolios, but also contributing to national and EU climate goals (Tomaszewski, Sekściński, 2020).

The purpose of the article is to present the current situation in the energy sector in Poland, with particular emphasis on the role of RES, and to assess the impact of these investments on the future of the energy sector in Poland. The article is structured as follows. The first part compares the use of RES in Poland and Europe, analyzing the share of RES in electricity generation and the structure of the market, including key power generation companies. This part focuses on discussing the main factors shaping the energy market in Poland, including historical conditions, the impact of CO₂ emission allowances and their prices, as well as aspects related to energy security. The second part presents the energy mixes of Poland's leading energy producers, with particular emphasis on the share of RES. In the third part, taking into account the regulations governing the development of the electricity market, a comparison of past and planned investments in RES by leading companies is presented, allowing one to understand the adaptation strategies and development directions of the RES sector in Poland.

2. Main factors shaping the situation of the electricity market

For decades, Poland's energy mix has been based on coal. Scenarios for shifting away from this energy carrier adopted by the Ministry of State Assets show a significant decline in coal's share of electricity generation between 2018 and 2050 (Figure 1). This suggests that the power sector is moving away from fossil fuels such as coal, toward more sustainable energy sources. Two scenarios show that CO₂ allowance prices have a significant impact on the rate of coal decline. In the high CO₂ allowance price scenario, the decline is much faster, proving that pricing policies can be an effective tool in accelerating the transition to cleaner energy.

In 2050, even in the scenario of a balanced increase in the price of CO₂ allowances, the share of coal drops to 28% from 77% in 2018. In the high price scenario, it drops to just 11%. As a result, it can be assumed that in the future, coal will have a much smaller role in electricity generation in Poland (Ministerstwo Aktywów Państwowych, 2022, p. 42; Ministerstwo Klimatu i Środowiska, 2021, pp. 99-100).

RES are the natural direction to move away from coal. According to Eurostat, in 2021, Poland had more than 17% share of RES for electricity generation, with the EU average at 37.5%. According to Eurostat (2023) in Europe, Scandinavian countries lead the way (especially Norway with 114% and Iceland 99%); among EU members, Austria has the most RES in the energy mix with 76%.

In less than a decade from 2012 to 2021, the share of renewable energy in Poland's electricity generation has steadily increased. This suggests that Poland is successfully increasing its use of RES. The most significant increase in the share of RES occurred between 2018 and 2021. It was an increase from 13% to 17%. In these 3 years, it was greater than in the 7 previous years (2012-2018 period), where there was a pattern of only 2.5 pp (Eurostat, 2023).

There is an increase in the penetration of RES in all sectors and technologies. According to the National Energy and Climate Plan for Poland, the share of RES in gross final energy consumption is expected to reach 21-23% by 2030 (Komisja Europejska, 2020, p. 2). In the electricity sector, the share of RES is to be no less than 32%, with wind and photovoltaic energy dominating (Ministerstwo Klimatu i Środowiska, 2021, p. 77). Nevertheless, Poland significantly lags behind most EU countries, highlighting the need to intensify efforts to increase RES use.

2.1. Energy market in Poland

In 2022, an increase was observed in the volume of gross domestic electricity generation to 175,157 GWh. This represented an increase of 0.9% compared to 2021. At the same time, gross domestic electricity consumption amounted to 173,479 GWh, a decrease of 0.5% compared to the previous year.

Polska Grupa Energetyczna (hereinafter: PGE) dominated the electricity market in 2022, as in previous years, both in terms of generation and sales to end users. In the same period, there was an increase in the importance of the PKN Orlen Group (hereinafter: Orlen) in terms of the amount of energy injected into the National Power System (NPS).

The market share ratio of the three largest producers, measured on the basis of the amount of energy put into the network (taking into account the amount of energy supplied by producers directly to end users), fell slightly to 66% in 2022 (down 1 pp compared to 2021). The ratio of the three largest producers' share of installed capacity continued a clear downward trend, declining by 6.2 pp. In 2022, the three largest groups, namely PGE, Enea and Tauron Polska Energia (hereinafter: Tauron), still had almost half of the installed capacity. However, in terms of the amount of energy put into the network, Tauron was replaced by Orlen in the group of the

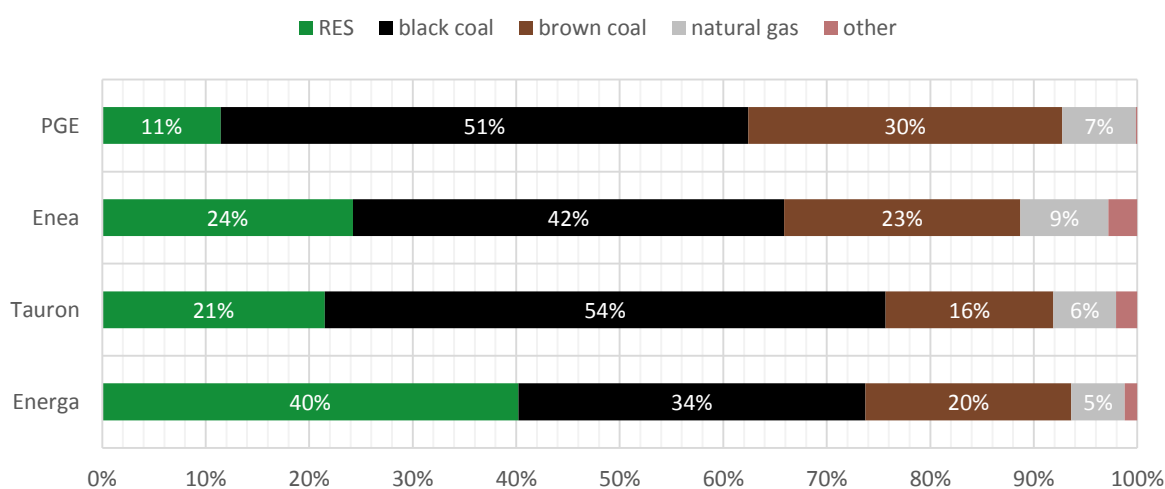
three largest producers. It is worth noting that these three companies account for more than two-thirds of Poland's electricity generation. In 2022, producers from Orlen significantly strengthened their position in the electricity generation market and a significant factor contributing to this was the acquisition of producers from the PGNiG into their structure (Urząd Regulacji Energetyki, 2023).

In 2022, total electricity consumption amounted to 163.5 TWh, not including direct consumption for heating and lighting in entities included in Section D (generation and supply of electricity, gas, steam, hot water and air for air conditioning systems). This represents a decrease of 0.3% compared to 2021. The highest consumption of electricity was recorded in the Mazowieckie (17% of the country's total consumption) and Silesian (16%) voivodeships, while the lowest consumption was recorded in the Podlaskie, Warmińsko-Mazurskie and Lubuskie voivodships. Electricity consumption in the industrial and construction sectors accounted for 42% of total consumption, while consumption by small consumers amounted to 46% of total consumption (Główny Urząd Statystyczny, 2023, p. 20).

2.2. Share of energy sources of power generation companies

In 2022, an increase was observed in the volume of gross domestic electricity generation to 175,157 GWh. This represented an increase of 0.9% compared to 2021. At the same time, gross domestic electricity consumption amounted to 173,479 GWh, a decrease of 0.5% compared to the previous year.

Conventional fuels, i.e. black coal (43% share in 2023) and brown coal (21%), continue to play a dominant role in electricity generation (Energy.intrastat.pl, 2024). However, a noticeable change is the increase in the share of electricity generation from RES. In wind sources, the share of electricity generation increased from 8% to 10%, and in other RES it increased from 3% to 5% compared to 2021 (Urząd Regulacji Energetyki, 2023). Figure 1 presents the energy mixes of the leading electricity producers.



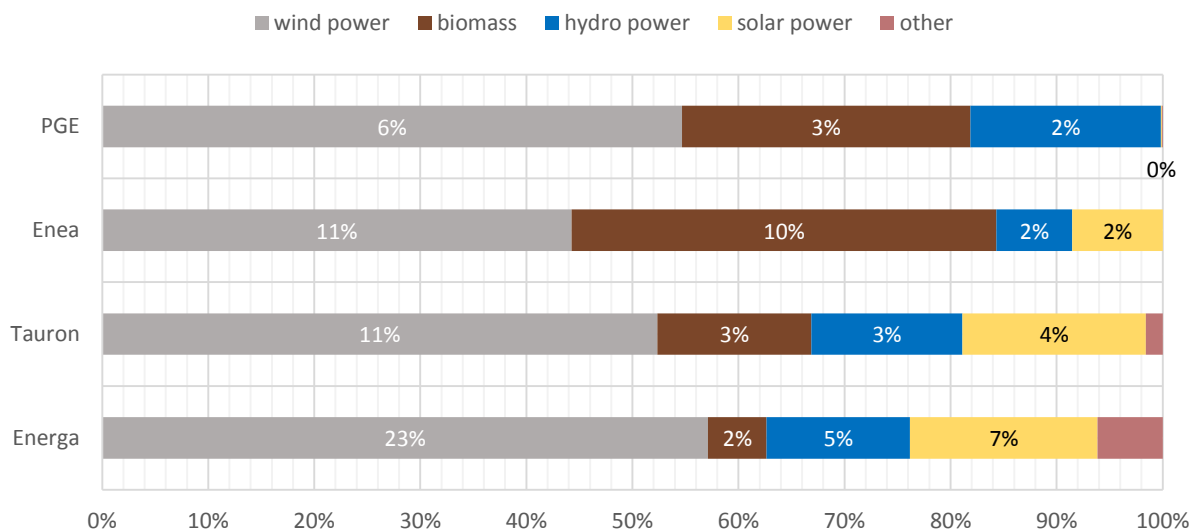
Note. None of companies use nuclear power.

Figure 1. Structure of fuels and other primary energy carriers used to generate electricity sold in 2022.

Source: own study based on (Enea, 2023a; Energa, 2023; PGE, 2022; Tauron, 2024b).

Energa stands out as having the highest use of RES, accounting for 40% of the company's energy mix. This is significantly higher than the other companies, demonstrating Energa's commitment to promoting sustainability. Tauron, on the other hand, relies heavily on black coal, which accounts for 54% of the company's energy mix. This is the largest share of this coal among all companies, which may indicate the need for further diversification of energy sources. PGE shows a balanced use of black coal (51%) and brown coal (30%), showing that the company is trying to maintain a balance between different energy carriers. Finally, Enea uses black coal (42%) as its main energy source, but it also uses RES, which accounts for 24% of the company's energy mix.

Analyzing Figure 2, which shows the structure of RES used by Poland's four major power companies (PGE, Enea, Tauron and Energa) in 2022, it can be seen that the wind power leads the way, accounting on average for half of the RES mix (from 44% at Enea, to 57% at Energa).



Note. Other includes biogas, geothermal.

Figure 2. Structure of RES used to generate electricity sold in 2022.

Source: own study based on (Enea, 2023a; Energa, 2023; PGE, 2022; Tauron, 2024b).

For PGE, wind power accounts for 55% of its RES mix and this is yielding 6% of its energy mix. The share of other RES in PGE's energy mix is relatively low. Enea shows a balanced use of various RES. Wind power and biomass account for 11% (44% of the RES mix) and 10% (40% of the RES mix) of the company's energy mix, respectively. Tauron also shows a balanced use of various RES, with wind power accounting for the largest share at 11% of the company's energy mix. Energa stands out with a significant share of wind power, which accounts for almost 23% of the company's energy mix. Energa also shows significant involvement in solar power, which accounts for more than 7% of the company's energy mix. None of the companies use geothermal energy.

These differences in energy strategies show that Polish energy companies are following different paths toward sustainability. However, attention should be paid to the need for further development and investment in RES to accelerate Poland's energy transition.

2.3. Regulations conditioning the development of the electricity market

In order to harmonize and liberalize the internal energy market, the EU has applied a series of measures to create an energy market that is competitive, customer-focused, adaptable and non-discriminatory, with supply prices based on market mechanisms. These measures include aspects such as market access, transparency and regulation, consumer protection, interconnection and security of supply. They have strengthened the rights of individual consumers, energy communities and vulnerable customers, while clarifying the roles and responsibilities of market participants and regulators, as well as promoting the development of trans-European energy networks. Against the context of the Russian invasion of Ukraine, the EU energy market is undergoing profound structural changes (Ciucci, 2023).

The invasion of Ukraine and the ensuing energy market situation, including the need to move away from fossil fuels imported from Russia, prompted the Council of Ministers to adopt, on March 29, 2022, the assumptions for updating PEP2040. The update aims to minimize or mitigate the risks of potential crises at home and abroad, while pursuing the main goal of the energy policy, namely "ensuring energy security while ensuring the competitiveness of the economy and reducing the environmental impact of the energy sector." A fourth pillar - energy sovereignty – has been added to the three pillars of PEP2040 which include a just transition, building a zero-emission system and improving air quality (Ministerstwo Klimatu i Środowiska, 2022, p. 1).

Therefore, Poland plans to increase technological diversification and expand capacity based on domestic sources. This could mean investing in new technologies and infrastructure to tap domestic energy sources. By 2040, about half of power generation is expected to come from renewable sources. Plans call for further development of wind and solar power capacity, while intensifying the use of weather-independent RES (hydropower, biomass, biogas, ground heat). Poland also plans to improve energy efficiency. This may involve investing in technologies that allow more efficient use of energy, such as smart grids and energy-saving technologies. Furthermore, diversifying energy supplies and providing alternatives to hydrocarbons will mean investing in new energy sources, such as nuclear power or natural gas, which can provide alternatives to coal. This shows that Poland is planning ambitious changes in its energy strategy to increase the share of RES, improve energy efficiency and diversify its energy supply. Still, a threat to the development of RES may be posed by the agreement to periodically increase the use of black coal, maintaining the readiness of coal units (Ministerstwo Klimatu i Środowiska, 2022, pp. 1-4). Nevertheless, studies have shown that the price of CO₂ emission allowances will have a significant impact on the rate of transition away from coal in Poland.

2.4. RES investment plans of the electricity market in Poland

Poland's leading electricity producers are committed to the country's energy transition. Table 1 shows both the current status and future plans of Poland's four major power companies - PGE, Enea, Energa and Tauron - with regard to the use of RES.

Table 1.

Selected RES investment of Poland's four major power companies

	Current	In the future
PGE	20 wind farms, 29 hydropower plants, 4 hydro-pumped power plants and 24 photovoltaic farms	23 photovoltaic installations, the company has about 3000 hectares of land secured for investment purposes. Target solar farms with a capacity of more than 2 GW
ENEA	26 RES installations including more than 20 hydropower plants, as well as wind farms	The Development Strategy envisions a "Green Change for Enea". It is a sustainable transformation of the Group building value growth, with the assumption of achieving climate neutrality by 2050. Plans for offshore wind farms, photovoltaic farms, onshore wind farms and energy storage facilities
ENERGA	The country's largest run-of-river hydroelectric power plant in Wloclawek, 44 small hydroelectric power plants, a hydropower pumped storage plant, 6 wind farms and 6 photovoltaic power plants	By the end of 2030, the corporation will reach an installed renewable capacity of more than 2.5 GW. Baltic Power's offshore wind farm of up to 1.2 GW with a completion date of the end of 2026
TAURON	11 wind farms, 2 photovoltaic farms and a microgrid in Bytom	The Group is building three photovoltaic farms with a total capacity of 200 MW and five wind farms with a capacity of over 160 MW. The strategy "TAURON's Green Turnaround. Energy Around the Clock" indicates the Group's priorities, the most important of which is to achieve climate neutrality by 2050

Source: (Enea, 2020, 2023b, 2024; Energa, 2022, 2024; PGE, 2023a, 2023b; Tauron, 2022b, 2024c, 2024a).

An investigation of the investment strategies of various energy companies in Poland, such as PGE, Energa, Enea and Tauron, shows a diverse approach to the use of RES. All of these entities are definitely committed to RES development, but at different levels and with different technologies.

PGE and Energa appear to be the most committed to a variety of RES technologies, which shows their desire to diversify their energy portfolios. On the other hand, Enea and Tauron seem to be focusing their efforts mainly on wind power, which may be due to their strategic approach to using available wind resources.

Nonetheless, all of these companies still have a long way to go, especially in terms of future plans for photovoltaics and other renewable technologies. The increased interest in these technologies indicates the need for further development and investment in these areas to meet the growing demands for sustainable electricity generation. In this context, the future strategies of these companies will be key to shaping the RES landscape in Poland.

3. Conclusions

Poland's geographic location creates many opportunities for RES exploitation. Furthermore, Poland, by becoming a member of the EU, received a number of funding and support opportunities for RES projects, which could significantly accelerate the process of decarbonization and modernization of the energy sector. Despite this potential, however, the Polish energy sector still relies heavily on coal. Although this situation is historically conditioned, the lack of decisive action within the energy transition has resulted in a threat to energy security.

The future of the Polish energy sector appears to be closely linked to the development of RES. Leading companies operating in the Polish energy sector have adopted strategies involving significant investments in RES. These investments are key to lowering the cost of electricity generation in the long term. By diversifying energy sources, it will be possible to achieve greater stability of energy prices in the domestic market. In addition, the development of RES is fundamental to increasing Poland's energy security. In the context of global geopolitical instability, especially in the face of Russia's invasion of Ukraine and the risks associated with fossil fuel supplies, having a diversified fuel and energy base is crucial. Furthermore, investment in RES contributes to Poland's environmental goals and international commitments, such as reducing greenhouse gas emissions. In the long term, the energy transition makes it possible to effectively pursue sustainable development in the face of growing demand for electricity.

The presented findings have numerous practical implications. They show how legal regulations, including CO₂ emission restrictions and international commitments, affect the current situation of the Polish energy market and shape its development. They also point to the need to accelerate the country's energy transition, in order to increase energy security through diversification of energy sources.

The analyses presented in this study have some limitations, as they mainly focus on the power sector and do not take into account investments in RES made by households, that are nowadays increasingly becoming prosumers of electricity. Therefore, future research could focus on the energy transition of households in particular, identifying the determinants and constraints of this transition.

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THE IMAGE OF A PUBLIC ORGANISATION AS AN ATTRACTIVE EMPLOYER – THE EXAMPLE OF THE POLISH ARMED FORCES

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Purpose: The main objective of the research conducted was to evaluate the image of the military as an employer in Poland.

Design/methodology/approach: The authors have identified shortcomings in the research results pertaining to the image of public organisations as employers. They have particularly noted the inadequacy of reports on the quality of the armed forces' image as an employer. In light of these observations, the authors have conducted a new research study to explore this issue in greater depth. With the use of the CATI and CAWI techniques, it was possible to identify the co-occurrence of psychological, economic and functional benefits resulting from possible entry into professional service, as well as to indicate the level of trust towards the military.

Findings: The survey revealed that the military enjoys a generally positive image in Poland and a positive image as an employer. This translates into considering the military as an attractive employer and a trustworthy institution. From a social perspective, the attractiveness of the military is fuelled primarily by the military's vital role in the state in terms of maintaining the security of citizens, the certainty of employment and the attractiveness of the pension system. The possibility of early retirement is especially appreciated by those who perceive the situation in the local labour market as difficult.

Research limitations/implications: The research was conducted among Poles, what means that only external image of the army as an employer was analysed. In the future studies it is worth to conduct research among employees, what gives an opportunity to compare those two perceptions (internal and external).

Practical implications: Revealing the results of the research connected with the image of a public employer – the image of the army, gives a possibility to plan and organize activities toward shaping the better image of the army, implement changes in the employer branding process, as well as understanding the opinion of the generations on the labor market.

Originality/value: The paper reveals the image of the army as an employer in the public opinion of Poles.

Keywords: Employer branding, public organisation, armed forces.

Category of the paper: research paper.

1. Introduction

The public sector is often known as bureaucratic, characterised by stalemate, red tape, and inertia (Osborne, Brown, 2011). This fact can negatively affect the perception of it in terms of being an attractive employer. Given that in many states, the public sector is a major employer in terms of its share of total employment (e.g. between 20% and 30% in the majority of EU states), the problem of the attractiveness of a public organisation's image in attracting talent is all the more pressing. It must therefore come as a surprise that there is a rather limited amount of literature in this field, not to mention the rare studies on a specific public employer such as the armed forces of individual countries. Consequently, in order to fill this gap, the main objective of the research presented in this article was to determine the image of the military as an employer in Poland. The research analysed both the attractiveness of the military and the general image of the institution. Additionally, answers were sought to the following questions: *What factors might determine the decision to join the military?* and *Is the military perceived as a trustworthy public institution?* Providing answers to the research questions so posed, including the achievement of the research objective, entailed conducting empirical research.

The study presented herein is structured as follows. The first part addresses the functioning of public organisations in the labour market. It presents the role and importance of a public organisation in its capacity as an employer. The second part deals specifically with the issue of the employer's image as an important prerequisite for attracting and retaining competent and talented employees. The next part of the article identifies the factors of the attractiveness of an organisation as an employer. The next part of the paper discusses the results of the empirical research. This part begins with a presentation of the research methodology and characterisation of the research sample. The article is based on the results of two survey rounds: the first survey was carried out in February and March 2022 (CATI, N = 537; The research was realised by a team composed of Marzena Piotrowska-Trybull, Ph.D., Prof. Stanisław Sirko, Ph.D., under the task included in the task and financing plan of scientific activity of the War Studies University for the year 2021, entitled "Efficiency of acquiring candidates for military service in the Polish Armed Forces in the light of contemporary management concepts and methods", task no. II.2.3.), and the other one in June 2022 (CAWI, N = 384; The research was carried out by Dorota Kurek, Ph.D., under the research task included in the task and financing plan of scientific activity of the War Studies University for the year 2021, entitled "Methods and techniques of shaping the image of employers", task no. II.2.1.). This section includes conclusions along with limitations and directions for future research.

2. Theoretical framework

2.1. The public sector as an employer

The role of the public sector is not just about providing socially useful goods. “Public sector labour markets have attracted over the decades a great deal of attention from economists” (Gregory, Borland, 1999, p. 3574). Economists have emphasised the impact of public sector employment on the national (Assaad, 1997) and local levels (Faggio, Overman, 2014). The discussion concerning the volume of employment in the public sector revolves around a broader issue relating to the role of the state in shaping the socio-economic reality of individual economies. Proponents of the state's proactive role in the economy acknowledge the possibility of greater relative employment in the public sector and see nothing wrong with the state being a direct employer for many people (in administration, state-owned enterprises and other public sector units). In contrast, advocates of far-reaching economic liberalism and the minimal role played by the state in a country's socio-economic life will consider the high proportion of employment in the public sector to be dysfunctional. In general, in so-called market economies with the dominance of private ownership, it may be as low as a few per cent. The size of public sector employment varies significantly among different OECD countries; for example, Scandinavian countries (Denmark, Norway, Sweden) report the highest levels of general government employment, reaching close to 30% of total employment. On the contrary, some developed Asian countries like Japan and South Korea report the lowest levels among OECD countries, with general government employment making up only 6% of total employment in Japan and 8% in Korea (OECD, 2021).

However, regardless of the size of the public sector in a country's overall economy (measured in various ways, e.g. the ratio of government expenditures to the total output of the economy or the number of public sector employees as a percentage of the total workforce), considering a public organisation as an employer also involves considering the qualitative characteristics of the people employed in the public sector. Indeed, public organisations compete in the market for the best possible employees. Many factors determine whether a person opts for public or private sector employment. Salary is one of the more frequently mentioned determinants, though it is not the only factor.

Clearly, the intense competition to secure a workforce between the public and the private sector is dependent on the level of unemployment prevailing in a particular area at a particular time. The lower the unemployment rate, the more intense this competition becomes. Undoubtedly, it is more difficult for the public sector to attract skilled and qualified employees in that situation (if only for the reason that in conditions of low unemployment, employees value employment stability less, knowing that they can find another job quite easily). Such conditions have been present in Poland in recent years. Among other European Union (EU) states, Poland has been characterised by a very low level of unemployment. According to

data published by the Statistical Office of the European Union, the unemployment rate in Poland in 2021 was 3.4% (comparable to Malta, only the Czech Republic reached a lower unemployment rate of 2.8%) (Eurostat, 2023). Similar figures were recorded in 2022, e.g. in November 2022, the unemployment rate in the euro area amounted to 6.5% and in the EU countries to 6%. The lowest levels of unemployment were in the Czech Republic (2.2%), and Germany (3.1%). It can therefore be observed that, despite the economic slowdown in Poland, unemployment remains at a very low level - especially considering Poland's more than 30-year history of a free market economy (which began with the changes in 1989). Thus, the intense rivalry to recruit employees that has occurred in recent years has come as a shock to a number of employers representing both the private sector (e.g. the need to raise salaries) and the public sector (e.g. no candidates for a given job position). This makes the ability to create an image of an attractive employer all the more important. When it comes to the Polish armed forces, this issue is all the more important, as the war in Ukraine (the country being Poland's direct neighbour) raises numerous fears and concerns about professional military service as a potentially dangerous career prospect. This factor also reinforces the need to professionally manage the image of the military as an attractive employer.

2.2. Employer image

A key non-material resource (Szczygielska, Kurek, 2021), having a significant impact on an organisation's ability to attract competent employees, reduce turnover rates and consequently increase retention rates is the organisation's attractiveness as an employer. Every organisation, regardless of whether it belongs to the private or public sector, pays attention to how it is perceived by its stakeholders, including efforts aimed at protecting its image. As far as the public sector is concerned, where the military belongs, the organisation strives to achieve success, viewed not so much in the category of the financial result it has achieved but in the context of assessing the usefulness of its activities for society (Piotrowska-Trybull, Jabłońska-Wołoszyn, 2020). As emphasised by Kotas (2014), the key to public organisations' success is to satisfy individual stakeholder groups, which depends, among other things, on the efficiency of the communication system, which, on the one hand, enables the collection of information on stakeholders' needs and expectations, as well as the evaluation of previous activities, and, on the other hand, serves to provide information on: changes introduced in response to customers' needs, procedures that guarantee the quality of the service, and the outcome of work. When addressing the concept of employer image, it is important to understand its nature, diversity and perspectives in order to correctly interpret the potential benefits of taking proactive measures and the consequences of failing to do so.

One category closely related to the issue of the image of public organisations is the public goods they provide. As regards the military – national defence is being provided on the basis of universal accessibility. Individual enjoyment of this good does not prevent other members of society from accessing it. As a matter of principle, the production and consumption of public

goods are regulated in such a way so as to ensure that regardless of their different purchasing power, individuals have access to them, as it is an expression of social inclusion and serves the interests of the public (Matysiak, Brol, 2010; Kozuch, 2004).

The image of public organisations is one of the ingredients used to gain public acceptance of their activities and a positive assessment of their usefulness. Creating a favourable image of an organisation such as the military in the public's consciousness results in increased trust towards this organisation and translates into longer-lasting relations with the community and, consequently, leads to the higher efficiency of security activities. That is why there is a need for systematic and long-term actions in the sphere of image building due to its "ephemeral" nature, as it is not given to an organisation once and for all but is constructed on an ongoing basis in relations with stakeholders. The key question is: In what direction and in what way should the image be changed so that it meets social expectations?

The term image is derived from the Latin word *imago* meaning reflection, likeness, or image. It is commonly defined as an opinion, a view, or an image that appears in people's minds about another person, organisation or thing. In turn, literature offers definitions derived from psychology, management theory and marketing. Boulding emphasises that image is the result of all of one's past experiences (1956), while Miller, Galanter and Pribram point out that it can be freely shaped by providing an individual with relevant, carefully selected information, which allows an image to be formed in accordance with expectations (1980). It is therefore considered that the image is both of a subjective and active nature, as it undergoes changes under the influence of a new pool of information, while the value of the incoming information depends on the credibility of the source, also assessed subjectively.

The multifaceted character of an image is evident in its varieties. The image of an organisation, perceived as an image existing in stakeholders' opinion, can be analysed in relation to the views of all stakeholders – the so-called actual image, and internal stakeholders (employees) – the so-called mirror image. The said image can also be classified using the criterion of the reality of the image, in which case the desired image (the way in which the organisation would like to be perceived) and the target image (representing a compromise between the desired image and the organisation's actual potential, limited by competition, the company's reputation, as well as financial and personal resources) can be indicated (Budzyński, 2002).

Bearing in mind the scope of ongoing research concerning image, increasing attention is being paid by researchers to the issue of employer branding (EB). Ambler and Barrow (1996) are credited with coining the term employer branding. They define EB as "the package of functional, economic and psychological benefits provided by employment, and identified with the employing company" (Ambler, Barrow, 1996, p. 187). Furthermore, the authors draw attention to the importance of communication and organisational culture throughout the process. Minchington's work shows a different approach to this definition since, according to the researcher, EB is the image of an organisation perceived as an amazing working

environment (2005). Barrow and Mosley, on the other hand, describe EB as an emotional relationship between employer and employee built on communicated information about the company's personality as an employer of choice and shaped through the use of tools and techniques to develop employee engagement and motivation (2005). Meanwhile, Burke emphasises that EB is simply the manner in which stakeholders evaluate the promise made by an employer (2007). The significance of a bilateral agreement between an organisation and employees is captured in Rosethorn's (2016) definition, demonstrating at the same time that it is the quality of this agreement that determines the willingness to work for the organisation. A different way of defining EB can be seen in the work of Sullivan (2004). Indeed, the author points out that it is a long-term strategy aimed at managing the awareness and perception of both employees and job applicants, aiming at retention, recruitment and productivity management. Its main objective is to portray the organisation as a good place to work. Backhaus and Tikoo (2004), on the other hand, point out that EB is the process of building a unique corporate identity easily identifiable by the public.

In conclusion, EB is both a way in which an organisation is perceived by its stakeholders and the result and, at the same time, the objective of a long-term strategy of the organisation, which seeks to communicate its unique identity to the public, as well as to point out the promise that the organisation is able to fulfil when engaging with an employee. The overall activities undertaken as part of employer branding highlight the importance of the issue analysed mainly in terms of the perception of the organisation, i.e. how it is perceived on the market.

When exploring the issue of employer branding, researchers are increasingly considering the impact of these activities on recruitment effectiveness (Kumari, Dutta, Bhagat, 2020; Wilden, Gudergan, Lings, 2010), improvement of communication within the organisation (Ćorić et al., 2022), development of the GHRM concept (Muisyo et al., 2023), implementation and development of CSR concepts (Szegedi, Németh, Körtvési, 2023), employee commitment (Ashariana, 2022; Agarwal, Arya, Bhasin, 2021; Staniec, Kalińska-Kula, 2021; Hanin, 2013), employee performance (Ha, Luan, Khoa, 2021), the link between EB and the development of virtual reality (Najam et al., 2022), the importance of digital EB (Kurek, 2021) and employee retention (Thalgaspitiya, 2020; Bayarsaikhan, Sain-Od, 2017; Gilani and Cunningham, 2017). The analysis also addresses the impact of internal communication on creating internal EB (Vokić, Verčič, Ćorić, 2023), the use of gamification (Kaoud, ElBolok, 2023) and PR in shaping the image of the employer (Olariu, 2017) or managing the employer's reputation to enhance its attractiveness (Šontaitė-Petkevičienė, 2022).

The image of organisations operating within the business landscape, with a particular focus on the IT industry, has been widely explored (Suruchi et al., 2017; Kucherov, Zamulin, 2016). On the other hand, as regards public institutions, the research focuses, among others, on the image of universities (Ryńca, Miško, 2016; Dejnaka, 2012; Alves, Raposo, 2010; Palacio, Meneses, Perez, 2002), as well as public service/public administration institutions (Weske et al., 2019; Korac, Saliterer, Weigand, 2018; Kotas, 2014; Wæraas, Byrkjeflot, 2012).

Meanwhile, the issue of the military's image has been analysed by scholars from India (Kaur, Shah, 2019; Kaur, Pingle, 2018), the Philippines (Sabado, 2016), Belgium (Lievens, 2007; Lievens et al., 2005), Sweden (Jorlöv, Venngren, 2014), and Poland (Kurek, 2022; Klein, 2019), among others. The image of the military in the role of the employer can be analysed when considering two perspectives: internal and external. Central to both are the factors that make the military an attractive employer for both current employees (both civilian employees and professional soldiers) and potential candidates to serve and work in the military (Piotrowska-Trybull, 2018; Piotrowska-Trybull, Sirko, 2023).

2.3. Factors determining an organisation's attractiveness as an employer – distinctive features of the attractiveness of public organisations

The attractiveness of an organisation in its capacity as an employer can be conceptualised differently by employees, job applicants and the organisation itself. According to Berthon, Ewing and Hah (2005), from an employee's perspective, attractiveness is the result of the benefits the employee attributes to the job. Conversely, from an organisational perspective, it is captured as the power an organisation has to motivate a candidate to consider a particular employer brand as an entity of value in the labour market (Bakanauskiene, Bendaravičienė, Barkauskė, 2017). In turn, if we turn our attention to job candidates, attractiveness can be defined by them as the degree of interest in a given organisation resulting from potential job benefits (Ray, 2006). Attractiveness can therefore be considered the strength of an organisation both in attracting job applicants and retaining employees. There is an increasing awareness of the importance of the process of building the so-called psychological contract between the organisation and employees. The change in mindset regarding the establishment of relationships with employees – moving away from the employment contract towards relationship building, including emotional attachment has a significant impact on organisational culture, productivity and engagement (Chhabra, Sharma, 2014). The two dimensions of attractiveness identified – intrinsic and extrinsic attractiveness – should be analysed in detail, as a general identification of employer attractiveness factors can distort the correct understanding of the values that stakeholders believe are of key importance for a given organisation.

There are a number of different classifications of attractiveness factors to be found in the literature:

- two types of benefits: instrumental and symbolic (Lievens, Highhouse, 2003), hard and soft (Baum, Kabst, 2013) and monetary and non-monetary (Ray, 2006);
- the three types of benefits referred to as functional, economic and psychological, originally identified by Ambler and Barrow (1996) and taken into account in research conducted by Berthon, Ewing, Hah (2005) and Reis, Braga, Trullen (2017), among others;

- five categories of factors determining the attractiveness of an organisation, including social, economic, developmental, application and attribute aspects (Jiang, Iles, 2011; Alniacik, Alniacik, 2012; Thiranagama, Dileesha, 2020).

Employer attractiveness is determined by a number of factors, and attractiveness alone does not necessarily mean that a stakeholder will decide to actively apply for a job with that organisation. An additional factor influencing the final decision is the reason for choosing a particular job or employer, sometimes at odds with the perceived level of attractiveness. One excellent example of such a situation is the way in which the attractiveness of public institutions as employers is assessed. In the public's opinion, these entities enjoy a high level of attractiveness, which is attributable to several factors. Each of these factors can be interpreted differently and thus given an individual value (factor weighting), which means that public institutions are regarded as stable employers, but, for instance, they are not able to compete in terms of remuneration with organisations from the business sector. When it comes to this type of institution, there is a clash between so-called theoretical values and ideological values (Van Der Wal, de Graaf, Lasthuizen, 2008), with the indicated values perfectly manifested in the Employee Value Proposition. Eisenberg et al. viewed that "first, a firm develops the value proposition that is to be embodied in the brand. Intended to be a true representation of what the firm offers to its employees, the value proposition provides the central message that is conveyed by the brand" (Chhabra, Sharma, 2014, p. 50).

The phenomenon of the dominance of ideological values over theoretical values in relation to work in public institutions has already been described by scholars and falls under the term PSM – Public Service Motivation. PSM is defined as "the belief, values and attitudes that go beyond self-interest and organisational interest, that concern the interest of a larger political entity and that motivate individuals to act accordingly whenever appropriate" (Vandenabeele, 2007, p. 547).

A sense of mission, and therefore an innate urge to serve society, can have a significant impact on the way an organisation is assessed as an employer. A special sense of mission, values and attitudes are evident in those who apply for jobs in the uniformed services, including the military.

In order to reflect the value of the image of a public institution, of which the military is an example, it is appropriate to quote Hope and Dubick, according to whom "(...) the difference between public service institutions and other organisations supplying any "good" to the market is the fact of their potential existence or non-existence on the market. While the absence from the market of the latter or their failure from the point of view of society as a whole is of little importance, the bankruptcy or even poor financial condition and especially the negative reputation of the activities of public utilities can have far-reaching consequences for society as a whole" (Kotas, 2014, p. 135). With regard to public institutions, the negative image of these entities as employers may be due to the different values held by potential candidates in relation to the values offered by the organisation, among other things. On top of that, the attractiveness

of the indicated entity is also conditioned by the market situation and the attractiveness of other organisations that compete for employees. In order to attract suitable candidates for service, the military competes for them with other employers, representing the public, private and social sectors. Accordingly, when compared to other employers, the attributes possessed by the military and their attractiveness in the assessment of candidates may be particularly important in the recruitment process, as well as in career development.

3. Description of the research and structure of the survey sample

Two rounds of empirical research were conducted to provide answers to the main research question and specific problems. The first round of research took place in February and March 2022. The research, with the use of the diagnostic survey method with the CATI technique and based on the original tool in task no. II.2.3. was conducted by the IPC Research Institute Sp. z o.o. The research involved people aged between 18 and 44 (those who are of working age and mobile, a category in public statistics). Drawing on data available from the Central Statistical Office (for 2019), it was determined that the population of Poland in the specified range reached 14,461,300 people. The size of the survey sample was determined accordingly. The study involved 537 respondents selected randomly and proportionally by gender and taking into account the provinces (voivodeships) where they live. After the completeness and correctness of the input were analysed, data from 530 respondents were accepted for further analysis (Table 1). Seven questionnaires were rejected due to errors that occurred during the entry of data into the database.

Table 1.

Distribution of survey respondents by province, 02.2022-03.2022

Voivodeship	%
Lower Silesia	7,36
Kuyavian-Pomeranian	6,04
Lublin	5,85
Lubusz	2,45
Lodzkie	6,04
Lesser Poland	9,25
Masovian	13,21
Opole	3,02
Subcarpathian	5,66
Podlaskie	3,21
Pomeranian	6,60
Silesia	10,57
Holy Cross	3,21
Warmian-Masurian	3,77
Greater Poland	9,25
West Pomeranian	4,53
Total	100,00

Source: own research results (research task no. II.2.3, N = 537).

The survey involved 273 men (51.51%) and 253 women (48.49%). Taking into account the economic activity of respondents – 13.2% were students or learners, 79.6% were working, and 7.2% were unemployed. In turn, regarding the education of respondents – 53.02% had secondary education, 26.79% had higher education, basic vocational education – 13.58%, post-secondary and post-secondary education – 5.47% and 1.13% had lower secondary education. Respondents lived in localities with varying population potential. Thus, rural areas were represented by 14.15%, towns with up to 20 thousand inhabitants – 5.85%, towns with more than 20 thousand to 50 thousand inhabitants – 16.6%, towns with more than 50 thousand to 100 thousand inhabitants – 30.19%, towns with more than 100 thousand to 200 thousand inhabitants – 19.62%, and 13.58% were from towns with more than 200 thousand inhabitants.

The second survey was carried out in June 2022 on a sample of 384 Polish residents. The survey was conducted using the CAWI technique. The structure of the survey sample was determined with three key criteria in mind: gender, generational affiliation and voivodeship. The study involved 178 women (46.4%) and 206 men (53.6%). Respondents aged between 18 and 60 for women and 65 for men participated in the research (table 2).

Table 2.

Research sample structure

Voivodeship	Generation Z		Generation Y		Generation X		Total
	Men	Women	Men	Women	Men	Women	
Lower Silesia	4	4	6	6	5	4	29
Kuyavian-Pomeranian	3	3	4	4	4	3	21
Lublin	3	3	4	4	4	3	21
Lubusz	1	1	2	2	2	2	10
Lodzkie	4	3	5	4	4	4	24
Lesser Poland	5	6	7	6	6	5	35
Masovian	8	7	11	10	9	8	53
Opole	2	1	2	2	2	1	10
Subcarpathian	4	3	4	4	4	3	22
Podlaskie	2	2	2	2	2	2	12
Pomeranian	4	3	5	4	4	3	23
Silesia	6	6	9	8	9	7	45
Holy Cross	2	1	3	2	2	2	12
Warmian-Masurian	3	2	3	2	3	2	15
Greater Poland	6	5	7	6	6	5	35
West Pomeranian	3	2	3	3	3	3	17
Total	112		146		126		384

Source: own research results (research task no. II.2.1, N = 384).

In order to fully characterise the survey sample, respondents were also asked about their level of education, expected salary and place of residence. The survey included 7.29% of respondents with education below secondary level, 48.44% with secondary education and 44.27% with university education. The group of respondents included 11.98% of persons expecting to be paid up to PLN 3000, 32.55% would like to be paid between PLN 3001 and 4000, 23.96% expected to be paid between PLN 4001 and 5000, 17.19% would like to be paid between PLN 5001 and 6000, while remuneration of over PLN 6000 was expected by 14.32%

of the surveyed Poles. Meanwhile, in terms of place of residence, 17.45% of respondents resided in rural areas and 18.75% in cities with more than half a million inhabitants. The remaining respondents were residents of cities with up to half a million inhabitants. The purposefulness of the selection of the survey sample resulted from the desire to reflect the structure of the general population in Poland in the structure of the respondents of working age.

As part of the conducted research, an analysis of the reliability and relevance of measurements was also undertaken. Cronbach's alpha was used to estimate the reliability of a set of items comprising a Likert scale. The analyses revealed that the level of reliability in surveys conducted on the sample of 384 people was Cronbach's $\alpha = 0.864$, while in the survey conducted on the sample of 537 people, Cronbach's α was $= 0.918$.

The change in Cronbach's α was checked if an item was deleted. The results revealed no significant change in the scale. In order to ensure the right level of validity of the research tool, the authors asked for the opinion of a group of competent people. The group consisted of university professors – experts who are involved in research on the issue under consideration.

4. Results

Being an employer of major importance on the market, employing not only soldiers but also a large number of civilian employees, the Polish Army undertakes a wide range of activities aimed at shaping its image. Numerous campaigns promoting military service, the implementation of solutions accelerating the process of recruitment to the army, the promotion of service in mass media, as well as an active online presence, especially through social networking profiles, all translate into the social perception of the army not only as an institution that guarantees security, but also an institution that provides jobs for more than 46,500 civilian employees and more than 110,000 soldiers.

When asked in the course of the survey about the overall image of the military, the respondents indicated that it was rather or definitely positive – 61.19%. 12.25% of respondents expressed the opposite opinion, while 26.56% found it difficult to indicate the quality of the military's image. When asked to assess the image of the military as an employer, the same respondents expressed a similar opinion, with almost two percentage points more respondents stating that it was difficult to say (Table 3).

Table 3.

Respondents' opinions on the general image of the military and the image of the military as an employer

Answers	Image of the military as an employer in Poland	General image of the military
Very positive	20,31%	21,09%
Rather positive	41,67%	40,1%
Difficult to say	28,65%	26,56%
Rather negative	7,29%	9,38%
Very negative	2,08%	2,87%

Source: own research results (research task no. II.2.1, N = 384).

Taking into account the prevalence of information about the military as a state institution, the percentage of respondents having difficulty giving definite answers may be due to the fact that the research was conducted more than four months after the war in Ukraine had begun. The outbreak of armed conflict in a neighbouring country may have significantly affected respondents' opinions on the quality of the military's image, especially as an employer. The stability guaranteed by the military, due to the specifics of its functioning, may partly cease being considered an advantage.

The respondents were also asked to indicate the level of attractiveness of the Polish Army as an employer. High and very high attractiveness levels were indicated by a total of 60.39% of respondents. A medium level of attractiveness was indicated by 30.47% of respondents, while opinions of low and definitely low attractiveness were expressed by 9.11% of respondents (Figure 1).

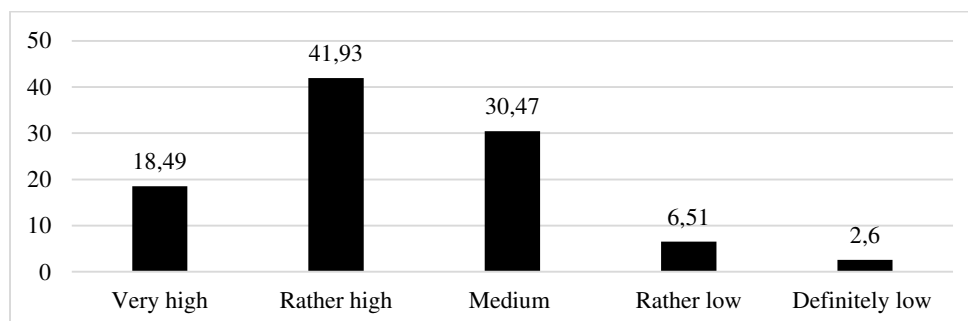


Figure 1. Attractiveness of the army as an employer – research findings.

Source: own research results (research task no. II.2.1, N = 384).

The analysis of the conducted research shows that the Polish Army enjoys a positive opinion as an employer. Almost every third respondent assesses the attractiveness of the army as average, while the indicated level results from a subjective assessment of factors shaping – increasing and decreasing – the level of attractiveness. The assessment of the level of attractiveness does not necessarily translate directly into the employees' decision to take up a job in the army, as some of the surveyed employees, when making their assessment, tend to compare the working conditions in the army with the conditions offered to them by their current employer. The result of such a comparison, especially with regard to the stability of employment, the openness of salaries, additional benefits and the social prestige of the profession, may determine the attractiveness of the military.

When studying the image of a public institution, it is reasonable to analyse not only the subjective feelings of the respondents concerning the quality of the image but also opinions relating to trust in a given institution because, as indicated in the paper, the level of trust is important in the perception and social assessment of a given entity. The research carried out shows that trust in the Polish Army was declared by a total of 71.18% of respondents (I trust the army: 36.46% and I rather trust: 36.72%). Lack of trust was indicated by 8.59% of the respondents, and 18.23% found it difficult to give a definite answer. When comparing the results of the research in terms of trust and the general image of the army, as well as the image of the army as an employer, it was revealed that more respondents (by almost 10%) declare trust in the indicated institution, in relation to those who consider the image of the army as positive – both overall and the image of the army as an employer. Therefore, it can be concluded that trust in a given institution does not necessarily correlate with a positive assessment of its image, both overall and of the organisation as an employer.

Trust in the military is conditioned by a number of factors, which include the military's actions and their effects, the legitimacy and predictability of these actions and communication with stakeholders. In terms of the implementation of statutory tasks, the apolitical nature of the military should be considered another important category, for it strengthens the conviction of the permanence of values and principles that serve society as a whole, affecting people's trust in this institution. When asked whether the apolitical nature of the military matters, 66.03% of respondents answered in the affirmative, while 33.96% gave a negative answer. Regarding the results presented above on trust in the military, it needs to be emphasised that the survey conducted in February and March 2022 also produced a very high proportion of respondents who affirmed trust in the military (83.7%), and the rest answered negatively. These findings corresponded with the CBOS [Public Opinion Research Center] results on citizens' trust in public institutions. Between 1995 and 2021, declarations of trust in the military were expressed each year by at least 74% of survey participants (Omyła-Rudzka, 2020). Trust in the military is based on the characteristics associated by respondents with military service. In the conducted surveys, the highest levels were attributed to, among others: readiness to sacrifice for the Homeland (83.4% of respondents), compliance of the military's actions with procedures (80% of respondents), assistance to the local community in emergency situations (79.43%), and physical fitness (75.28%). It can be assumed that the attributes associated with the military confirm its servant role towards society and allow for a certain degree of explanation for the trust in this institution.

As has been emphasised previously, developing the military's image in public opinion is determined by communicating it to its stakeholders. The military uses a variety of information sources for this very purpose. Accordingly, the respondents were asked about the sources of information about the military and military affairs that, in their opinion, are useful in this regard. Respondents considered information from friends (76.79%) who serve or work in the military and family members (75.65%) professionally related to the military to be useful and very useful

sources. In addition, respondents gave high ratings to information: obtained from military websites (66.6%), from participation in open days at the unit (62.63%), from the recruitment portal of the Polish army (59.42%), and from social media (58.1%). On the other hand, the lowest level of indications of useful and very useful sources concerned television programmes (38.1%), articles in the press (33.39%), advertising on radio and television (27.13%), and popular science books (26.9%).

Based on the results obtained, it can be assumed that face-to-face contacts still play a vital role in conveying information about the military, in particular about serving and working in this organisation. During face-to-face meetings, the opinions and behaviours of people associated with the military, to some extent, reflect the way they perceive the attractiveness of the military as an employer and may also influence their decisions about a career path. In addition, during open days at military units, meetings with soldiers make it possible for those interested to get a first-hand opinion and look at the organisation "from the inside", so to speak. At the same time, direct contacts are crucial in the context of building the image of the military as an organisation that can be trusted with responsibility for the security of the state and citizens.

In order to find out the respondents' opinions on the motivations, understood as internal states with an impetus to actions leading to the satisfaction of needs (Koziański, 2003), which may determine the decision to join the army, they were asked to evaluate a dozen or so categories. Some of the categories listed had attributes that made it possible to describe the military from the perspective of an attractive employer that offers certain benefits to its employees. Others corresponded to the impact of those associated with the military on the respondents and their clearly defined interests. Viewing the military through the prism of particular attributes may provide an incentive to serve and work in the military as it relates to the possible benefits to be gained from this employer. The categories that respondents evaluated can be divided into three groups following the division of benefits presented in the literature (Ambler, Barrow 1996), namely:

- functional – the military: cares for the professional development of soldiers, provides opportunities to prove oneself in situations under the pressure of time, develops teamwork skills, creates equal development opportunities for women and men, is helpful during crisis situations in local communities, is an important partner in NATO structures;
- economic – military: provides job security, offers high pay in comparison to other employers, provides an attractive pension scheme;
- psychological – the military: plays an important role in the state, ensuring the security of citizens, enjoys public trust and gives a sense of pride in belonging to the organisation.

As signalled above, the motivation for joining the service may come from interests in the military and military affairs and contacts with family members and friends who are or have been associated with this organisation. In the case of personal contacts and relationships

regarding the military, it can be assumed that respondents have a specific perception of the attributes of this organisation thanks to such contacts.

Among the factors that respondents believe may have the greatest impact on their decision to join the military (answers to a great and very great extent), we can point to the military fulfilling an important role in the state in the context of taking care of the security of citizens – 84.7% of respondents answered this way, and the military providing job security – 81.89%. A slightly lower percentage of indications related to the military offering an attractive pension scheme – 66.42%, the development of teamwork skills – 64.91% and a sense of pride in belonging to the organisation and being able to serve – 63.96%. Two motivations received the lowest percentage of indications to a high and very high degree, namely the Polish military being an important partner in NATO structures – 48.49% and the military creating equal development opportunities for men and women – 38.68% (Figure 2). The last two motivations also received the highest mid-point ratings, respectively: 39.81% and 39.43%.

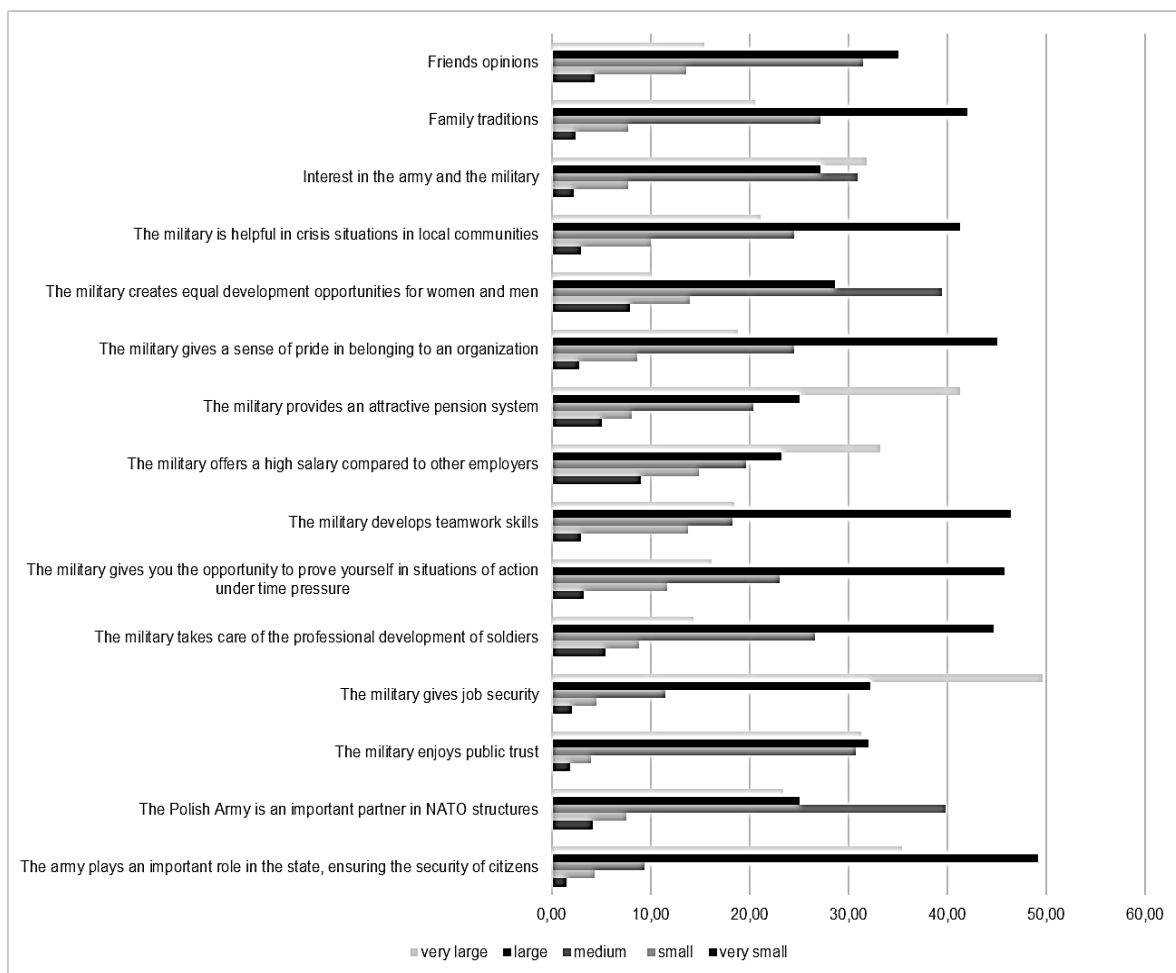


Figure 2. Degree of influence of individual motives behind the decision to join the army

Source: own research results (research task no. II.2.3, N = 537).

When analysing the distribution of opinions expressed by respondents regarding the motives for joining the service, the relatively high ratings of the individual categories are worth highlighting. At the same time, it is possible to identify two motives, which were accompanied

more often than others by opinions that they could influence the decision to join the army to a very small and small degree, namely: the army offers high remuneration in relation to other employers – 23.96% and the army creates equal development opportunities for men and women – 21.89%. Respondents' opinions on equal development opportunities for both sexes in the military may indicate certain doubts in this respect, conditioned both by stereotypical perceptions of the occupations and their division into masculine and feminine, as well as by media reports on irregularities in this respect.

The respondents' answers show the co-occurrence of benefits of a psychological, economic and functional nature resulting from possible entry into professional service. In the context of benefits associated with certainty of employment in the army, no significant link to the labour market situation in the respondents' place of residence was observed. In contrast, such a relationship was found in relation to the variable: attractive pension scheme. Respondents rating the labour market situation as average and good were also more likely to perceive the attractiveness of this system ($r = 0.25$).

5. Conclusions

Conducting research dedicated to the issue of the image and attractiveness of the military as an employer is an important activity, especially when considering the social importance of the indicated institution, the size of the workforce (soldiers and civilian employees of the military) and the importance of this employer in the local labour markets in particular. The survey led to the conclusion that the military enjoys both a positive overall image (61.19%) and a positive image as an employer (61.98%) and is considered an attractive employer (60.39%). A total of 71.18% of respondents declared trust in the Polish Army. Persons who serve or work in the army (76.79%), family members professionally connected with the army (75.65%) and websites dedicated to military matters (66.6%) were indicated as the main sources of information about the army. The information obtained from the said sources of information allowed a positive assessment of the military as an employer, as well as an indication of the main motives for choosing a military career (aspects related to functional, economic and psychological benefits). The opportunity to serve in an institution with an important social role, job security and an attractive pension scheme are the most frequently indicated motives for choosing a military career. The opportunity to develop teamwork skills and pride in fulfilling an important social role are also deemed significant.

Given the considerations as well as the results obtained concerning the image of an organisation such as the military, it can be concluded that it carries out activities that have a positive impact on its image. It is noteworthy that, in the opinion of the respondents, the military plays an important role in the state security system, its assistance to the community

in emergency situations is perceived to strengthen trust in this institution, and it has been emphasised that belonging to this organisation can be something to be proud of. In this respect, the military is successful in image-building efforts as its activities are assessed as being useful to society. Meanwhile, in the context of creating a positive image of the military, the material conditions (financial and non-financial) offered to candidates for service and their verification expressed in the assessments of those who function in military structures are complementary to the aforementioned activities. As the results of the survey have shown, the opinions of soldiers and military employees about this employer are important, determining the public's perception of it, as well as potentially influencing the influx of candidates for service. Not only are the opinions of those directly associated with the military considered to be a reliable source of information about the military as an employer, but they also have a significant impact on the overall assessment of the military's image and trust in this institution, which is connected to Poles' sense of security.

The research included an analysis of Polish society to examine the general public perception of the military, as well as an assessment of the military's external image and attractiveness as an employer. Internal image and attractiveness were not analysed, which limits the possibility of inference. The authors plan to conduct research on internal image and attractiveness in the future. The spatial scope of the research will also be extended to include other states in order to identify similarities and differences in this area. The authors also plan to carry out an analysis of the conditions for shaping the image of the military among the public and in the labour market.

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CONFLICT MANAGEMENT IN AN EMPLOYEE TEAM IN MANUFACTURING ENTERPRISES IN THE BESKIDS REGION

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Purpose: The study addresses an important and topical issue of conflict in work teams. Reviewing the available literature and research in this area, no research was found on the impact of conflict on the work team in manufacturing enterprises. The article attempts to analyze and evaluate the impact of conflicts on the management of the work team in manufacturing enterprises in the Beskids Region. Conflict management is playing an increasingly important role in modern companies and is very important for the entire organization. Unfortunately, not all companies share this opinion. Traditional views, lack of knowledge or reluctance to change means that conflict is often a taboo subject. Companies waste time and money on hiding conflicts while focusing on achieving financial results, increasing production or introducing modern technology. Therefore, this study attempts to draw attention to the issue of conflict and to examine whether, with the development of theories, methods and tools of conflict management, the awareness of company employees in this regard in selected manufacturing companies in Beskids Region is increasing. The following research questions were defined: What types of conflicts are most common in a company? How are conflicts most often resolved in a company?

Against this background, the main hypothesis was formulated, which was that responsible conflict management has a positive impact on the realization of potential projects in companies.

Design/methodology/approach: The purpose of the study was to attempt to analyze and evaluate the significant impact of conflict on the work team and to characterize the main sources of conflict in manufacturing companies located in the Beskids Region. A diagnostic survey method was used for the study. A survey questionnaire was used as a tool.

Findings: The collected empirical material confirm the established hypothesis, which was that responsible conflict management has positively influences the utilization of the potential of the employee team in the surveyed companies.

Research limitations/implications: This research should be treated as pilot research. It is proposed to increase the number of surveyed manufacturing enterprises in the Beskids Region.

Practical implications: It is proposed to introduce systematic training of employees on perception and conflict resolution in the manufacturing companies in Beskids Region. It is necessary to conduct continuous observation and control of the results of conflict management.

It is suggested that the research be expanded to include interviews with executives in order to learn about their attitudes and approaches to conflict situations occurring in the surveyed companies.

Originality/value: New in the paper is a characteristic the main sources of conflict in manufacturing companies located in the Beskids Region.

Keywords: conflict, conflict management, work team, manufacturing enterprise.

Category of the paper: empirical researches.

1. Introduction

The study addresses an important and topical issue of conflict in work teams. Reviewing the available literature and research in this area, no research was found on the impact of conflict on the work team in manufacturing enterprises. The article attempts to analyze and evaluate the impact of conflicts on the management of the work team in manufacturing enterprises in the Beskids Region.

The study presents the sources and types of conflicts in enterprises and the issue of conflict management in the context of the impact on the work of the staff team.

The purpose of the study was to attempt to analyze and evaluate the significant impact of conflict on the work team and to characterize the main sources of conflict in manufacturing companies located in the Beskids Region.

The main objective is to study the relationship between conflict management and group work in selected enterprises in the Beskids Region. The following research questions were posed: "What type of conflicts are most common in the studied enterprises?" "How are conflicts most often resolved in the studied enterprises?".

2. The essence of conflict

An indispensable element of human relations is conflict. At its root, there is always a divergence of interests of the subjects in question (Ciekanowski, Nowicka, Załoga, 2019, p. 39).

Conflict is an ambiguous concept, different scientific disciplines are interested in its subject, so there are many different definitions.

In psychological terms, conflict is a contradiction of attitudes and interests, i.e. a situation in which an individual is subjected to the action of forces of similar power, but of opposite directions. In sociological terms, it is the same situation, only that a certain group is subjected to these processes. It pursues its own interests even by destroying the individual or eliminating him (Šmid, 2015, p. 142).

In management literature, conflict is a social process that occurs between individuals, groups, states or organizations, resulting from conflicting interests, goals, views or duties, causing hostility between them. Conflict is any manifestation of struggles or fights between people, the purpose of which is not only to gain possession of the means of production, a given social position, power, etc. (Kozlowski, 2017, p. 172).

Conflict in an organization refers to a dispute between two or more members of an organization arising from the need to share limited resources or work, or to take different positions on an issue, pursuing different goals. Conflict can arise from different value systems of the participants or divergent points of view. The phenomenon can also be described by the characteristics of conflict:

- is a situation in which there are, at least, two parties,
- the parties to the conflict are dependent on each other,
- conflict triggers specific behaviors toward the other party,
- the other party usually reciprocates the reactions,
- the conflict is generally accompanied by strong emotions,
- conflict begins when at least one party perceives that its goals, tasks, values or behaviors are in conflict with the goals and/or actions of the other party and the other party blocks, hinders their implementation (Kuc, Moczydlowska, 2009, pp. 216-217).

According to J. Koziński, conflicts arise when external obstacles stand in the way leading to the satisfaction of needs, when there is a contradiction of interests between the goals of the individual and those of the social group (Lewicka, 2010, p. 214).

The essence of conflict is the lack of agreement between two or more individuals, groups or organizations. This disagreement can be relatively superficial or very strong. It can be short-lived or persist for months or even years, and it can be work-related or personal (Griffin, 2017, p. 639).

Underlying most definitions of conflict are several common ingredients. Conflict must be perceived by the parties involved. The existence of conflict is a matter of human perception. It can be said that conflict is always a relationship between two independent parties who harbor feelings of hostility toward each other and blame each other for the situation. In other words, by conflict is meant a situation in which there is a contradiction of interests, views or attitudes of individuals or groups coexisting and interacting at a certain time and place (Lewicka, 2010, p. 214).

3. Types of conflicts in the organization

Due to the multiplicity of conflict situations that have occurred in practice, their proper classification is much more difficult. This paper presents typologies of conflicts depending on the criteria adopted.

Taking the subject criterion, we can distinguish conflicts: political, cultural, social, economic, class, stratum, values and goals.

With regard to the subjective criterion, we can distinguish between individual and collective conflicts.

Individual conflicts (internal, intrapersonal conflict), that is, the parties are mutually exclusive needs felt by the same person at the same time. The individual is in specific conflict with himself. He is internally "torn", feels dilemmas, dilemmas. And although the place where the internal struggle is played out is a person's mind, this conflict negatively affects his behavior in the work environment (Kuc, Moczydlowska, 2009, pp. 219-220). We can classify collective conflicts as interpersonal, intragroup, intergroup and interorganizational conflicts. Interpersonal conflicts are tensions between two or more individuals or groups who have conflicting goals. This type of conflict can be divided into zero-sum conflict (conflict in which one party's win is always equal to the other party's loss) and mixed motive conflict, (in which both parties can gain by interacting, and an individual can gain even more by competing with his or her partner) (Aronson, Wilson, Akert, 1997, pp. 387-388). In the workplace, this type of conflict is usually played out on three levels:

- between a superior and a subordinate,
- between supervisor and superior (conflict between equal managers),
- between subordinate and subordinate (they have a variety of sources, often mundane, and usually expire quickly) (Kuc, Moczydlowska, 2009, p. 220).

Intragroup (in-group) conflicts occur between an individual and a group. Often caused by the way in which individuals respond to pressures exerted by the group to enforce conformity (Penc, 2001, p.127). Intergroup (intergroup) conflicts conflict occurring between two or more groups in an organization. In the case of this conflict, the causes lie more in the organization itself than in contradictions between people. Often they arise from differences in views, goals and also competition for too few resources. This is a conflict of great importance to the organization. Inter-organizational (inter-organizational) conflicts, that is, conflict between an organization and its environment. The conflict may involve different organizations or other elements of the environment such as, consumer groups or suppliers. Conflict of moderate intensity, resulting from competition, is normal, but sometimes it takes on more drastic forms and greater scope (Griffin, 2017, pp. 641-642).

Taking the effects of conflicts as a criterion, they can be put into two categories: constructive (functional) and destructive (dysfunctional) conflicts. Constructive conflicts support the goals of the group or organization, increase its efficiency, prevent stagnation, stimulate development, but this depends largely on three factors. These are the level of conflict, the structure and the culture of the organization (Stoner, Wankel, 1994, p. 336). If the conflict is potentially costly for all parties and these costs may prove to be greater than the gains, if the conflict drags on before any kind of agreement is reached and if all participants are dissatisfied with the results of the conflict and believe that they have lost as a result we are dealing with a destructive conflict. This conflict destroys the parties and the relationship (Wilmot, Hocker, 2011, pp. 42-57). From the point of view of the level of intensity, we can distinguish between weak and acute conflicts. While the dynamics of intensity (the course of changes in the emotions of the people involved in the conflict) allows us to distinguish three types of conflict. Progressive conflict, in which the level of intensity of emotions is initially low, but gradually increases. Degressive conflict, in which the level of intensity of emotions, after quickly reaching a climactic state, slowly and steadily descends. Wavy conflict is characterized by a high variability of intensity (Pawlak, Antoszkiewicz, 2000, p. 312).

4. Sources of conflicts in the organization

The conflict resolution strategy must be diverse and multilayered, it must include the entire enterprise and its various parts, both individual employees and their teams, enterprise goals and strategies, departmental tasks and their substantive problems. In resolving conflicts, a manager can use various techniques:

- extinguishing the conflict - alleviation through appropriate persuasion, non-reaction to the conflict,
- settlement of a dispute (coercion) - forcing one of the parties to surrender as a result of force, threat, pressure or the formation of a coalition or the mediator's judgment,
- compromise - resolving the conflict rather than resolving it, no winning or losing side,
- integration (consensus) - a solution that satisfies both sides, a technique in which both sides win, but the agreement does not have to be unanimous (Penc, 2001, p. 143).

According to J. Barton, the first method of resolving conflict is to prevent it from erupting, that is, to avoid it. In this regard, there are several ways, such as suppression, shifting interests to another object, bypassing the object of conflict, dismissing the resolution of the conflict. A method that, as a consequence, can aggravate the causes of conflict. The second method is to start an informal discussion on conflict resolution to clarify the differences between the parties. This is one of the more commonly used methods in resolving everyday difficulties. It may yield a more or less satisfactory solution for the parties to the dispute, or due to lack of interest or

skill, it may not even yield the least satisfactory solution. The third method is negotiation, understood as the arrangement of relations between parties who are in a state of conflict. The participants establish, by mutual consent, short-term contacts to give both parties to the conflict an opportunity to get to know each other, learn about each other's needs and interests, exchange comments, determine the nature of potential contacts or agree on the procedure they will take to resolve the problem. Negotiation is an intentional with a specific structure, a process of discussing conflict resolution (Adamus-Muszyńska, 1998, p. 61).

Another of the methods used in conflict resolution is mediation. That is, resolving disputes with the participation of a third party. Mediation is most effective when the participants care about finding a solution, the dispute concerns specific issues and there is a relative balance of power between the parties. The mediator's assistance is most needed during acute clashes accompanied by high levels of conflict and hostility (Stephan, W.G., Stephan, C.W., 1999, pp. 168-169).

We can still mention the strategy of conciliation, which involves using an outside expert in the conflict. The expert's task is to analyze and propose potential solutions to the conflict. The solution proposals are non-binding, the expert has no authority and his attitude remains passive towards the conflicting parties.

The last of the strategies is external arbitration. The method involves appealing to the verdict of a third party so-called arbitrator. This can be a person, a commission or a court. The verdict of the arbitrator is binding on the parties to the conflict, and the condition for successful arbitration is the voluntary recognition of this opinion.

5. The role of the staff team

In everyday life, the terms team and group are often used interchangeably, however, in the literature we can see a clear distinction between these categories. In this paper, the concepts of group and team are used interchangeably.

Some authors equate a team with a group and treat it as a collection of more than two people, subject to the same interactions, aware of the interactions taking place between them, perceiving themselves as members of the group and identifying with it, and having a common goal, common norms and forming a specific peculiar structure.

James A.F. Stoner, Edward Freeman and Daniel R. Gilbert also use the term team and work group interchangeably, where a team is two or more people interacting and interacting with each other in pursuit of a common goal (Stoner, Wankel, 1994, p. 481).

According to Griffin (Griffin, 2017, p. 627), a team is a group of employees functioning as a separate unit, often with little or no supervision, to perform work-related tasks, functions and activities.

According to Susan Cohen and Diane Bailey, a team is a group of individuals who are interdependent on each other when performing their assigned tasks, who are jointly responsible for the results of their work, who perceive themselves, and are perceived by others, as a distinct social unit, embedded within another, larger social system, or several such systems (for example, a company or corporation), and who, by forming relationships with each other, cross structural boundaries within the organization (Kohn, O'Connell, 2008, p. 38).

B. Kożusznik defines a team as a specific social group, linked by formal and informal "ties", performing specific tasks in order to obtain specific material and non-material gratification.

However, it should be noted that many phenomena characteristic of a social group also characterize an employee team - group norms, cohesion or group roles. To date, a complete and unambiguous definition of an employee team has not been established (Kożusznik, 2007, pp. 97-98).

Positive relationships not only increase employee satisfaction, but also stimulate their higher efficiency, creativity and loyalty to the organization; negative relationships are destructive and bring the opposite effect (Szostek, Glińska-Neweś, 2017, p. 11).

6. The impact of conflict on the work team in manufacturing enterprises in the Beskids Region

The purpose of the study was to attempt to analyze and evaluate the significant impact of conflict on the work team and to characterize the main sources of conflict in manufacturing companies located in the Beskids Region. The following research questions were defined:

1. What types of conflicts are most common in a company?
2. How are conflicts most often resolved in a company?

Against this background, the main hypothesis was formulated, which was that responsible conflict management has a positive impact on the realization of potential projects in companies.

A diagnostic survey method was used for the study. A survey questionnaire was used as a tool, which consisted of 16 factual questions and 5 metric questions that allowed characterization of the subjects. The questionnaire used 1 filter question, which avoided the logical and factual errors associated with asking questions of people to whom they do not apply. And, 8 closed-ended questions, which greatly helped to standardize and unify the survey material, and 7 semi-open-ended questions. The survey was conducted in 5 manufacturing companies operating in the Beskids Region in 2023. 254 employees participated in the survey. Verification of the correctness of the questionnaires allowed 250 questionnaires to be used, 4 questionnaires were rejected.

Based on the survey results obtained, it was found that employees' awareness of the existence of conflicts in companies is high (90% of respondents recognized that there are conflicts in the company).

The most common reasons for conflicts in the surveyed manufacturing companies were "incompatibility in perceptions of roles," 64%, and "difference of views regarding the goals that should be achieved." - 56%. 38% received the answer "differences in people's personality traits", 31% received the answer "incompatibility regarding the perception of facts by both sides", 29% indicated "transferring their frustrations resulting from family or health problems to the group forum", and 27% for the answer "intrigue and gossip". And the answers "Using the same resources" and "differences in worldview or adherence to different values, views and attitudes" were given by 20% of respondents. And the answer "promotion system that promotes excessive competition" was indicated by 18% of respondents. One person (0.4%) gave the answer "management's misunderstanding of the actual tasks to be performed by the employee".

Some conflicts in the company arise due to differences based on the type of job (physical and mental division). The reasons for conflict situations in the surveyed companies are presented in Figure 1.



Figure 1. The reasons for conflict situations in surveyed companies.

Source: own research.

Analyzing the results of the survey, it can be noted that people in physical positions most often, as a cause of conflict in indicated "difference of views regarding the goals that should be achieved" 61% of indications, followed by "incompatibility in perception of roles" and "differences in human personality traits" 35%. In contrast, those in white-collar positions chose "incompatibility in perception of roles" (57%), "dissimilarity of views regarding the goals that should be achieved" 43% and "differences in human personality traits" 39% as sources of conflict. The other sources of conflict obtain a similar percentage pattern in relation to the position held.

The predominant attitude during conflict situations was "striving to clarify the situation" so indicated 80% of respondents. According to a small group of respondents, 9% mentioned "ignoring the problem". 7% of respondents indicated "waiting for help from managers or someone unrelated to the conflict". And 4% of responses referred to "an aggressive attitude towards the participants in the conflict". Attitude of respondents in conflict situations in the surveyed companies are included in Figure 2.

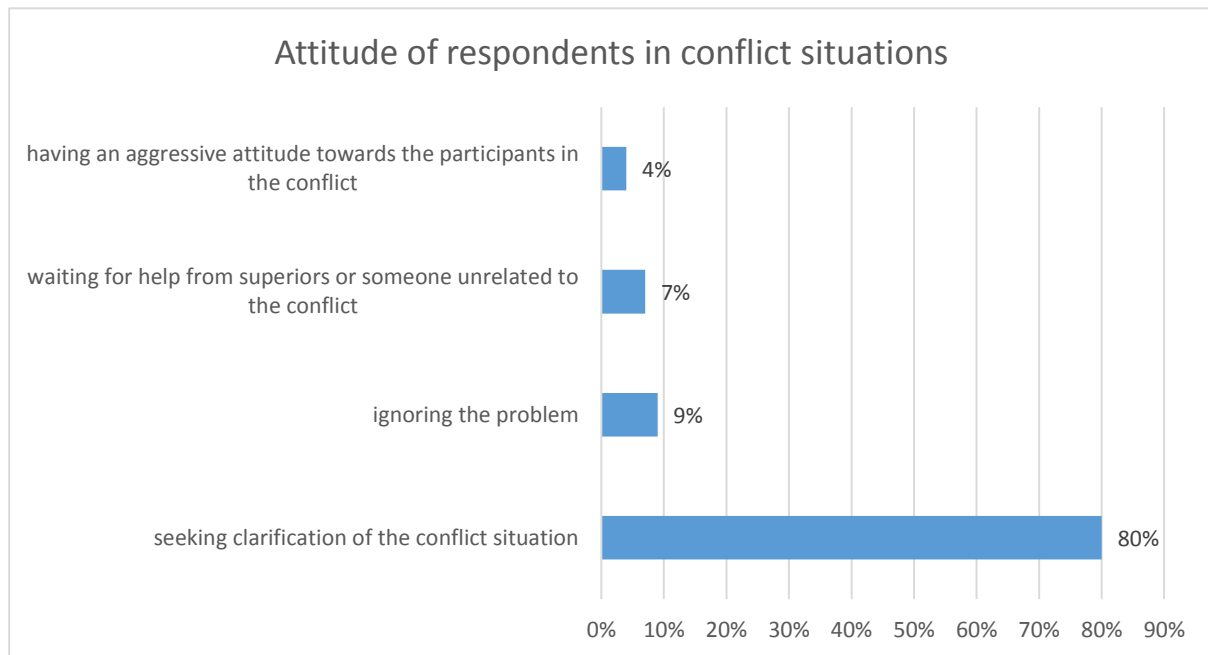


Figure 2. Attitude of respondents in conflict situations in the surveyed companies.

Source: own research.

The most common type of conflict occurring in the company was found to be conflict between groups 56% of respondents indicated this answer. Conflict between a supervisor and a group of employees was indicated by 20% of respondents, while 18% of respondents stated conflict between a subordinate and a supervisor. Only 7% of respondents indicated conflicts between an employee and a group.

The question of whether company managers adequately respond to conflicts that arise was answered in the negative by 53%, 31% of those surveyed said "yes", while 16% answered "don't know".

Conflict resolution methods are presented in Figure 3.

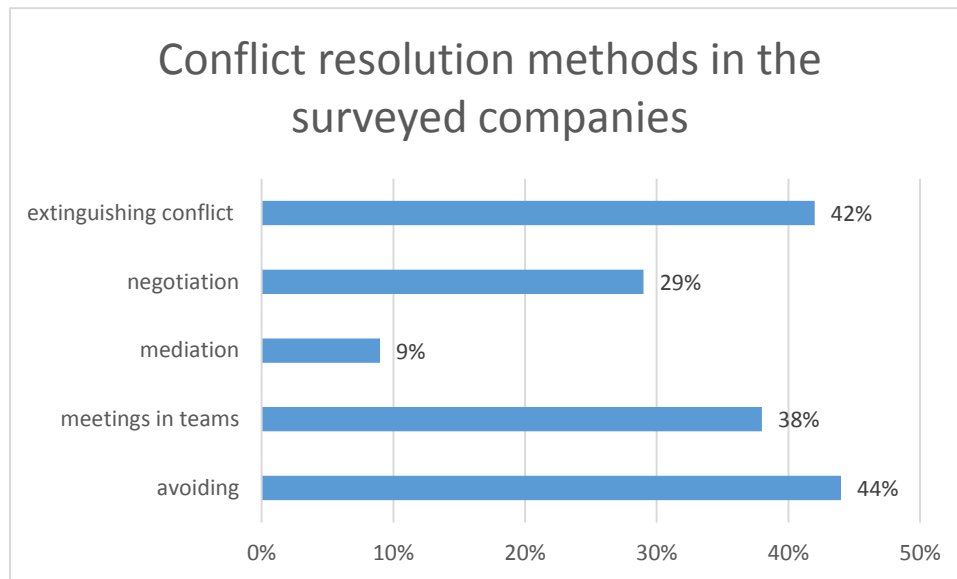


Figure 3. Conflict resolution methods in the surveyed companies.

Source: own research.

The survey showed that the preferred method of conflict management in the company is conflict avoidance, as indicated by 44% of respondents. Numerous respondents also mentioned: extinguishing - 42% of indications, discussing problems at departmental meetings - 38% of indications, and negotiation - 29% of indications. Mediation was indicated by only 9% of respondents. In an open question in which respondents could list other methods of conflict management, none of the respondents answered. Since the method of avoiding and extinguishing conflicts in the surveyed company are not among the responsible methods of conflict management, the main hypothesis was disproved.

It is not possible to clearly state how the company's management reacts when an employee is in a conflict situation, as 56% of respondents indicated that the supervisor ignores the conflict and waits for the conflict to resolve itself. In contrast, 40% of respondents said that the supervisor reacts immediately and seeks to resolve the conflict. Respondents were also allowed to give other ways of reacting two survey participants indicated that the supervisor's reaction "depends on the problem" and "if the problem directly concerns the supervisor, in other cases it varies".

Building a good atmosphere in the workplace is the type of support most needed by respondents 82% of indications. In second place, respondents marked integrating employees 48%. Slightly less 44% received the answer conflict resolution and substantive support 38% of indications. Next, respondents indicated conducting training 28% and emotional support 16% of indications.

Half of the respondents (50%) felt that those in management positions lacked adequate competence in the area of conflict resolution and prevention.

Respondents identified cooperation 66% of responses and compromise 58% of responses as the most effective method. 44% of respondents indicated negotiation and 32% of respondents indicated mediation. The least responses of only 4% were given to such methods as conflict avoidance and competition. In an open-ended question in which respondents could name other methods of conflict resolution, none of the of the respondents gave no answer.

7. Conclusions and recommendations for the studied manufacturing enterprises of the Beskids Region

Surveys conducted in manufacturing companies in the Beskids Region confirmed that there is a very high awareness among employees of the occurrence of conflicts, as many as 90% of respondents admitted that conflicts occur in manufacturing companies. Only 25 people (representing 10% of respondents) said that such situations do not occur in their company.

Employees in white-collar jobs most often chose incompatibility in role perceptions (57%) as the main source of conflicts, while blue-collar workers explicitly chose dissimilarity of views regarding the goals that should be achieved (61%). Relating the respondents' answers to one of the tools used to analyze the causes and sources of conflict, the conflict wheel of Ch.W. Moore's wheel, based on the results obtained, it can be seen that in the group of blue-collar workers there is mainly conflict of interest. In contrast, structural conflict is the main cause of conflict in the group of white-collar workers.

The thesis of the occurrence of interest and structural conflict is confirmed, as more than half of the surveyed employees identified intergroup conflict (56%) as the most common, and 20% of respondents believed that conflict occurs between a supervisor and a group of employees. Conflict between a subordinate and a supervisor was indicated in third place (18%). As the least frequent, respondents considered conflict between an employee and a group (7%).

More than half of employees (53%) were rather unfavorable about the company's response, while a third (31%) said that the conflict response was appropriate. 16% of respondents answered "I don't know," which may be due to employees' lack of knowledge about appropriate ways to resolve conflict. The most common methods used in the surveyed manufacturing companies are avoiding (44%) and extinguishing (42%) conflict in companies. 38% of employees said that problems are discussed in meetings. However, it is difficult to determine whether the problems are only discussed or whether an attempt is made to solve them.

Of the modern methods of conflict resolution, employees indicated negotiation (29%), mediation only 9% of indications, other ways were not given. Thus, it can be assumed that the ways of managing conflict in the surveyed manufacturing companies belong to the group of traditional views on conflict. Traditional approaches to conflict recognize that conflict hinders optimal efficiency, can be avoided, and management should eliminate conflict situations.

The level of knowledge that company employees have about conflict is similar to the knowledge that exists in organizations regarding conflict resolution and perception. Only 36% of respondents felt that conflict can increase the efficiency of the organization, while 14% of employees agreed that conflict can serve the organization in effective operation. In contrast, 56% of company employees believe that conflict always harms the organization.

56% of employees can count on the help of their supervisor if they are in a conflict situation, while 40% of those surveyed do not feel support from their supervisor are ignored and have to solve the conflict themselves.

Half of the employees (50%) felt that the supervisor should be responsible for resolving disputes, while 36% of the respondents do not see their supervisor in the role of conflict resolution. 14% of employees expressed no opinion on the subject.

Employees of manufacturing companies identified the following as the most effective methods of conflict resolution: cooperation (66%), compromise (58%), negotiation (44%) and mediation (32%). Avoidance and rivalry are not considered by company employees as effective ways to resolve conflicts.

The collected empirical material confirm the established hypothesis, which was that responsible conflict management positively influences the utilization of the potential of the employee team in the surveyed companies.

The conducted research and its analysis made it possible to formulate recommendations for the surveyed manufacturing enterprises of the Beskids Region.

It is proposed to introduce systematic training of employees on perception and conflict resolution in the workplace. To begin with, it is recommended to train managers in this area and organize a series of trainings for lower-level employees. In terms of information and education activities, all kinds of e-learning, team-building trips and the introduction of conflict management procedures are proposed - which will raise employee awareness, ensure transparency in the company's operations and also improve the conflict management process.

It is recommended that companies analyze the company's organizational structure and key processes to find out why intergroup conflict is the most common conflict in companies.

It is necessary to conduct continuous observation and control of the results of conflict management. Improvements should be made on an ongoing basis, as conflicts are a dynamic phenomenon and change frequently.

It is suggested that the research be expanded to include interviews with executives in order to learn about their attitudes and approaches to conflict situations occurring in the surveyed companies.

8. Summary

Modern manufacturing companies in Poland face intense economic development, competitive pressures, dynamic changes in the business environment, difficulties in attracting and retaining qualified employees and, above all, functioning in an environment characterized by high volatility and uncertainty. Therefore, it is reasonable for companies to constantly take care of improving the abilities of managers in business management. In the context of this study, conflict management should be a key skill of a manager. The ability and skillful resolution of conflicts open up new ways of thinking that can lead to new innovative solutions and healthy team performance, and thus efficient and effective business operations. The way conflict is handled often determines whether it works in favor of the team or will contribute to its downfall. Thus, understanding and appreciating the different viewpoints associated with conflict is a key factor in conflict resolution. It should also be remembered that effective methods of resolving disputes, bring significant financial benefits to the company by eliminating the waste of time that employees spend on conflict situations.

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EMBRACING THE FOURTH INDUSTRIAL REVOLUTION: NAVIGATING CHALLENGES AND LEVERAGING OPPORTUNITIES IN MARKETING AND MANAGEMENT – CASE STUDY NOKIA POLAND

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Purpose: The primary objective of this paper is to examine the transformative effects of the Fourth Industrial Revolution (Industry 4.0) on marketing and management practices, using Nokia Poland as a case study. The research aims to understand how Industry 4.0 technologies can be leveraged to navigate challenges and capitalize on new opportunities within the telecommunications sector and beyond.

Design/methodology/approach: The research adopts a qualitative case study approach, focusing on Nokia Poland to explore the application and impact of Industry 4.0 technologies in a real-world corporate setting. Data collection methods include semi-structured interviews with key Nokia Poland executives, analysis of company documents, and review of relevant literature on Industry 4.0. The study is framed within the broader theoretical context of digital transformation and innovation management.

Findings: The results show that Nokia Poland has effectively incorporated Industry 4.0 technologies to boost effectiveness introduce product solutions and enhance customer interaction. Essential technologies such as the Internet of Things (IoT) artificial intelligence (AI), and digital twins have enabled faster. The study emphasizes the role of embracing a strategy for digital transformation that involves cultural shifts, skill enhancement, and collaboration, within the ecosystem.

Research limitations/implications: The study scope is restricted to examining a telecommunications company potentially overlooking the experiences and approaches prevalent in other sectors. To gain an understanding of Industry 4.0 adoption future research should explore comparative analyses spanning various industries and regions. Additionally, the study highlights the importance of exploration in the changing landscape of technologies and their impact on businesses.

Practical implications: The findings of this research provide advice for businesses starting their Industry 4.0 transformation. Suggestions involve creating a defined plan allocating resources to skills and technology and fostering collaborations in the innovation network. Additionally, the paper explores the business and marketing framework of Industry 4.0, highlighting opportunities for increased competitiveness and expansion in the market.

Social implications: The research suggests that Industry 4.0 has significant implications for workforce development, requiring upskilling and reskilling initiatives to prepare employees for new digital roles. Additionally, the paper considers the potential of Industry 4.0 technologies to drive sustainable business practices and contribute to societal well-being through improved product quality and accessibility.

Originality/value: This paper contributes to the existing literature by providing an in-depth case study of Industry 4.0 implementation in a leading multinational company. It offers practical insights and strategies for managing digital transformation, with a particular emphasis on the value of integrating advanced technologies in marketing and management.

Keywords: Industry 4.0, Marketing and management practices, Technology Nokia.

1. Introduction

The concept of Industry 4.0 or the fourth industrial revolution (4IR) is attracting significant attention, particularly regarding its potential effects on humanity (Schwab, 2015). According to Schwab (2015), 4IR will bring about fundamental changes in various aspects of human life, work, economies, and governance. The industrial revolutions trace back to the 17th century, with Britain leading the way in what is now referred to as the first industrial revolution (Blinov, 2014; Dunga, 2019). The term "industrial revolution" is a significant economic transformation that shifted people's livelihoods from bucolic rural settings to urban areas (Dunga, 2019). Before the first industrial revolution, economic activities were limited, resulting in widespread poverty. People relied on small farms for their sustenance, making life challenging for the average person (Allen, 2006). Moreover, production during that time was primarily for personal use, and people used basic hand tools for production, mostly within their homes (Dunga, 2019, Allen, 2006). The advent of the first industrial revolution marked the replacement of animal power with the steam engine, leading to a shift from agrarian livelihoods to industrialization with the use of specialized machinery (Crafts, 1996). Britain initiated the first industrial revolution, followed by other countries like America (Crafts, 1996). The development of the steam engine around the early 18th century marked the beginning of the first industrial revolution, enabling mechanized production and societal changes as urbanization increased (Schwab, 2017). This revolution brought about the rise of coal, textiles, iron, and railroad industries, while the second industrial revolution saw the extensive expansion of electricity, petroleum, steel, and other scientific advancements that facilitated mass production (Ooi et al., 2018). In the 1950s, the third industrial revolution commenced with the inventions of computers and digital technology. This revolution led to automation in the manufacturing sector and caused disruptions in industries such as banking, energy, and communications (Ooi et al., 2018). However, it also opened doors to advancements in space research and biotechnology. Currently, we find ourselves in the era of the fourth industrial revolution, also known as Industry 4.0 (Ooi et al., 2018). Schwab's scholarly work from 2017 indicates that Industry 4.0 is built upon prior advancements made during previous revolutions including first-hand accounts from

various sectors within society itself. Key components integral to Industry 4.0 include cutting-edge computer science applications such as artificial intelligence and machine learning algorithms together with emerging innovations that hyperlink multiple domains including biological realms in medical breakthroughs or even automotive driving features based on GPS directions using advanced AI algorithms (Schwab, 2017). As a result of this integration across industries, we are seeing unparalleled availability not only today but, in many cases, predictive needs influencing product design. Countries, development organizations, and businesses worldwide are actively planning and preparing for the impact of the fourth industrial revolution on humanity and business. However, the societal impact of this revolution, particularly regarding AI's influence on poverty, remains relatively unexplored in-depth (Mhlanga, 2020; Dunga, 2019; Deloitte, 2018). Each industrial revolution has necessitated society to undergo challenging processes of adaptation, transitioning from predominantly rural, agricultural societies to urban, industrial societies, and eventually to post-industrial societies coping with the loss of traditional industries and employment sources (Blinov, 2014). The impact of the fourth industrial revolution on society will not only involve job losses but also a significant one on the logistics and Marketing of services and goods.

Therefore, this study is investigating the impact of industry 4.0, its challenges and solutions in the marketing and management area of a global company like Nokia Poland.

2. Industry 4.0: Impacts and Challenges

Industry 4.0 also known as the fourth industrial revolution merges digital technologies including artificial intelligence big data analytics to enhance industrial processes. These technologies boost productivity, flexibility, and decision making in industries resulting in intelligent factories (Schwab, 2016). Industry 4.0 is characterized by the integration of the physical and digital realms creating 'smart factories' in which cyber physical systems closely monitor physical processes and communicate with each other and humans in real time (Kagermann, Wahlster, 2022). Industry 4.0 traces its roots back to the German strategic initiative "Industry 4.0", which was introduced in 2011 at the Hannover Fair. Various papers have identified several critical technologies that are the pillars of Industry 4.0, including IoT, AI, big data analytics, and cloud computing. Each technology plays a crucial role in transforming traditional industries into smart industries (Lu, 2017).

Various papers have identified several critical technologies that are the pillars of Industry 4.0, including IoT, AI, and cloud computing (Lee et al., 2014; Hermann et al., 2016; Xu et al., 2018). Each technology plays a crucial role in transforming traditional industries into smart industries. The principles of Industry 4.0 quickly spread beyond Germany, influencing industrial strategies worldwide (Lasi et al., 2014).

In 2012 a similar initiative called the "Advanced Manufacturing Partnership" (AMP) was launched by the U.S while China initiated "Made in China 2025" in 2015. Both these initiatives emphasized the importance of intelligent manufacturing and integration of digital technologies (Zhou et al., 2015).

The development of digital technologies has played a crucial role in driving Industry 4.0 forward. The introduction of new technologies has led to the emergence of cyber physical systems where digital and physical systems interact seamlessly (Zhou et al., 2015; Xu et al., 2018). Today Industry 4.0 is widely recognized as a transformative paradigm for industries across the globe. The integration of physical production and digital technologies has given rise to smart factories that are characterized by adaptability, resource efficiency, and ergonomic design (Geissbauer et al., 2016). The future of Industry 4.0 holds enormous potential with the evolution of technologies such as 5G, quantum computing, and blockchain (Marr, 2018).

The adoption of Industry 4.0 technologies can lead to substantial increases in efficiency and productivity. By harnessing IoT, AI, and big data analytics, companies can automate various processes, thereby reducing operational costs and increasing output (Zhong et al., 2017). Industry 4.0 also facilitates mass customization of products. Advanced technologies like additive manufacturing (3D printing) allow companies to manufacture products according to individual customer preferences at scale (Tao et al., 2018). The ability to analyze large quantities of real-time data significantly improves decision-making processes. This capability can lead to improved demand forecasting, inventory management, and predictive maintenance (Lu, 2017).

The increased interconnectivity of systems in Industry 4.0 raises significant cybersecurity risks. Protecting sensitive data and maintaining system integrity are paramount as cyber-attacks can have devastating impacts (Romanosky, 2016). Industry 4.0 demands a workforce with new skills, particularly in areas such as data analysis, programming, and systems integration. A significant challenge is the existing skill gap, requiring substantial effort in education and training (Maqbool et al., 2023). The transition to Industry 4.0 requires substantial upfront investment. This can be particularly challenging for small and medium-sized enterprises (SMEs) that lack the necessary financial resources (Frank et al., 2019). With the rise of AI and machine learning, several regulatory and ethical issues have emerged. Concerns about data privacy, transparency, and AI bias require careful consideration and regulatory interventions (Dignum, 2018). The implementation of Industry 4.0 holds enormous potential for transforming industrial operations. However, it is essential to address the associated challenges, including cybersecurity, skill gaps, investment requirements, and regulatory and ethical issues, to fully reap the benefits.

3. Embracing 4IR in Marketing and Management

The use of big data analytics and artificial intelligence has revolutionized the field of marketing. Making it more focused on data and insights. This allows marketers to deeply understand customer behaviors and preferences allowing for personalized marketing strategies that result in better engagement and conversion rates (Kumar, Reinartz, 2018). Furthermore, the combination of the Internet of Things (IoT) and advanced analytics has made real time marketing possible. Companies can now interact with their customers immediately. Providing offers, services, and support whenever needed. Thereby enhancing the overall customer experience (Rogers, 2016). The rise of social media platforms has also had a profound impact on marketing practices. By leveraging social media marketing techniques along with data analytics businesses can reach a wider audience. Additionally direct engagement with customers becomes possible leading to real time feedback that can be used to improve products or services (Tuten, Solomon, 2017). Industry 4.0 technologies have given rise to "smart factories", which have transformed operations management. The implementation of IoT technology allows for real time monitoring and control of operations within these factories. As a result. Efficiency is improved while errors are reduced (Liao et al., 2017). AI algorithms and machine learning have shown their immense value in examining intricate datasets. Offering crucial insights that assist in the decision making process. The implementation of automated decision making has paved the way for expedited and enhanced decision making capabilities in fields like supply chain management and financial management (Wuest et al., 2016).

In addition to these advancements in technology remote work has become more feasible thanks to cloud computing and advanced communication tools. This shift has significant implications for human resource management practices such as recruitment, employee engagement, and performance management (Bloom et al., 2015).

Undoubtedly Industry 4.0 has brought about profound changes across various aspects of business including marketing approaches as well as operational efficiency improvement methods like real time monitoring and control. The impact also extends to decision making processes aided by AI algorithms. And the transformation of human resource management practices due to the rise in remote work opportunities. In order to remain competitive. It is crucial for companies to adapt to these changes and capitalize on the opportunities that Industry 4.0 presents.

4. Case study: Nokia Poland

Nokia Poland, specifically the branch in Wroclaw, can indeed serve as an interesting case study for Industry 4.0 due to several reasons. Over the past ten years Nokia's operations in Poland have undergone significant changes. As a leading global telecommunications company Nokia has played a vital role in shaping the development of the telecom industry from second generation (2G) to fifth generation (5G) (Mlot, 2016). In 2000 Nokia established its manufacturing plant in Wroclaw, which primarily caters to the European market. In the years since, Nokia has embraced Industry 4.0 technologies and transformed the Wroclaw factory into a model of smart manufacturing. This transformation journey provides valuable insights into the challenges and successes of integrating Industry 4.0 technologies. Nokia's Wroclaw plant is considered one of the most advanced factories in Europe. It was among the first to implement and showcase the principles of Industry 4.0. The factory has successfully harnessed digital technologies like the Internet of Things (IoT) robotics, artificial intelligence (AI) and machine learning demonstrating their effective deployment and management within a manufacturing context. Nokia's involvement in Wroclaw plays an essential role as a global pioneer in 5G technology propelling the future of connectivity forward. With the rapid advancement and implementation of 5G comes substantial ramifications for Industry 4.0 because its ability to enable fast paced communication with low latency is critical for numerous applications within this field. Studying Nokia's Wroclaw branch can offer insights into the integration of 5G technology within industrial applications. Wroclaw, as a city. Is renowned for being one of Poland's leading tech hubs. It proudly hosts numerous IT companies and startups showcasing its vibrant ecosystem of technology and innovation. Additionally, the city is blessed with a pool of skilled talent. Further enhancing its appeal. Academic institutions and government bodies provide robust support to this flourishing hub. Making it an exciting place to explore the influence and application of Industry 4.0 principles. In recent years, Nokia has shown commitment to environmental sustainability, and the Wroclaw factory is part of these efforts. The company's endeavors to balance the demands of digital transformation with sustainable practices provide another compelling aspect to examine in the context of Industry 4.0.

Comparative Analysis with Industry 4.0 Leaders (Johnson, Jan. 2024)

As the Fourth Industrial Revolution (Industry 4.0) continues to reshape the landscape of manufacturing and operations, companies across various sectors are adopting innovative strategies to harness its potential. This section compares Nokia Poland's approach to Industry 4.0 with those of Siemens, General Electric (GE), and Boeing, providing insights into diverse strategies and the outcomes of their digital transformation efforts. Siemens demonstrates a thinking approach, to Industry 4.0 focusing on the development of business models and their

extensive integration within their facilities. Siemens's strategy centers around fostering innovation and harnessing technologies like the Internet of Things (IoT) intelligence (AI) and digital twins, throughout their operations. This strategic approach improves effectiveness and exemplifies the industry's digital transformation journey (Ohr, 2020). General Electric's approach to Industry 4.0 is focused on their thought-out Digital Twin strategy. This demonstrates their ability to integrate replicas of assets to optimize performance and predict maintenance needs. GE emphasizes the importance of innovation and the implementation of cutting-edge solutions such as leveraging digital products and incorporating new technologies in their factories. Their goal is to improve manufacturing processes and enhance product quality (Daecher, Jan. 2024). Boeing stands out for its implementation of Digital Twins as well as its pioneering work in areas like 3D printing and augmented reality (AR). Their strategy highlights the potential of twins in improving the efficiency and effectiveness of manufacturing operations. By exploring and adopting technologies Boeing takes a proactive approach to navigate the challenges and opportunities presented by Industry 4.0 (Boeing, 2018). While Nokia Poland is focusing on leveraging Industry 4.0 to enhance their marketing and management strategies, Siemens, GE and Boeing are demonstrating an application of these technologies, throughout their operations. They emphasize innovation and digital transformation as elements of their business strategies. Siemens and GEs emphasis on twins and AI showcases their shared understanding of the value that these technologies bring. Boeings investigation, into the utilization of 3D printing and augmented reality underscores the applications of Industry 4.0 technologies, within the manufacturing industry. The effective integration of these technologies has enabled these companies to make advancements in their operations resulting in heightened efficiency, waste and improved product and service excellence. These accomplishments underscore the possibilities that Industry 4.0 offers when aligned with business objectives (Nokia, 16.11.2021; Ohr, 2020; Boeing, 2018).

Industry 4.0 adoption 2020 by region

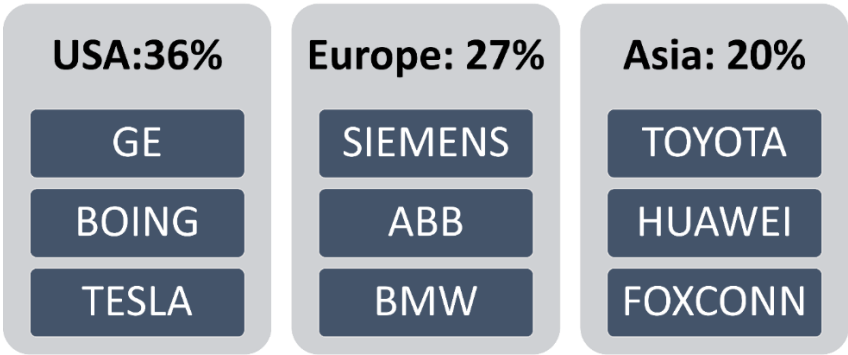


Figure 1. Industry 4.0 technology adoption by region.

Source: (Wopata, 2020).

It appears that North America is at the forefront of Industry 4.0 integration, with a significant 36% of surveyed entities reporting that these technologies have been "extensively" or "fully" implemented within their operational frameworks (Wopata, 2020). In the context of Industry 4.0 adoption, where North America is seen as leading the charge ahead of Europe and Asia, Nokia Poland's role and comparison with giants like Siemens and Boeing offer a unique perspective on how different regions and companies adapt to the digital transformation. Despite the apparent dominance of North America in adopting Industry 4.0 technologies, Nokia Poland's inclusion in this comparison underscores the nuanced and strategic approaches to digital transformation beyond mere geographical or size-based categorizations. In comparing Nokia Poland with Siemens and Boeing, the aim is to illuminate the diverse paths companies can take towards Industry 4.0, influenced by their industry sector, regional context, and strategic priorities. Nokia Poland's place in this comparison highlights the company's role as a key player in the digital revolution, demonstrating that success in Industry 4.0 is not just about the scale of adoption but also about the strategic alignment of technology with business objectives and regional opportunities (Bumgardner, 2022; Knell, 2021; Nokia, 2020).

5. Methodology

This research adopts a qualitative approach to explore the impact of the Fourth Industrial Revolution on marketing and management strategies at Nokia Poland. The study aims to get insight about adoptable marketing framework, focusing on the in-depth analysis of subjective experiences and perspectives.

Research Design

The study will adopt a qualitative research approach, suitable for exploring the nuanced challenges and opportunities related to Industry 4.0, particularly in the context of marketing and management at Nokia Poland. The purpose is to gain insights from key stakeholders at Nokia Poland, such as executives, managers, engineers, and marketing professionals, regarding their experiences, perceptions, and strategies in embracing Industry 4.0.

Purposeful sampling will be used to select participants who have direct knowledge and experience related to the topic and semi-structured interviews will be conducted, allowing for guided yet flexible conversations. An interview has been designed that includes ended questions to delve into topics such, as how individuals have adapted to advancements the strategies, they have implemented the challenges they have encountered success stories they can share and their thoughts, on prospects.

Prioritizing considerations throughout this study is seen as crucial. It was established that the purpose of the study and their rights were fully understood by all participants. Furthermore, confidentiality will be upheld by us to protect their privacy and sensitive information. Also, in this research document analysis is used to analyze documents relevant to Nokia Poland's marketing and management strategies in embracing Industry 4.0. Sources will include company reports, strategic plans, marketing materials, press releases, and publicly available internal documents and content analysis will be employed to identify recurring themes, strategies, milestones, and evidence of challenges and opportunities in implementing Industry 4.0.

Data Collection

The study involved conducting a series of interviews with selected participants from Nokia Poland. The criteria for participant selection included senior managers in R&D and Marketing. The interviews, which were unstructured, covered key topics such as Marketing process and the impact of industry 4.0. These interviews were instrumental in providing valuable perspectives on understanding the impact of technology and challenges in general in the field of marketing. Alongside the interviews, the research also included an analysis of various documents pertinent to Nokia Poland, such as Nokia embraces the industry 4.0 revolution with its new 'Future X for industries' strategy (Johnson, 8.11.2018; Nokia, 14.10.2020; Johnson, 16.11.2021; Matits, 16.03.2021; Apel, 14.02.2023; Kent, 27.09.2022; website 7.12.2021). These documents were examined to complement and corroborate the findings from the interviews, offering a more comprehensive understanding of Industry 4.0 and its impact.

Data Analysis

The analysis of the data, in relation to the impact of the Fourth Industrial Revolution on marketing and management practices at Nokia Poland was conducted in a comprehensive manner. To begin with, the interview transcripts have been read carefully and relevant documents have been familiarized with the data. This initial stage was crucial as it provided an understanding of the perspectives of the participants and the context within which these documents were produced.

Following this, a coding process has been proceeded. The data was broken down into manageable segments and each segment was labeled with concise codes that captured its essence effectively. This coding process was both inductive allowing themes to emerge naturally from the data itself and deductive, guided by research questions and a theoretical framework focused on how the Fourth Industrial Revolution influences business practices.

Once coding was complete, categorizing these codes into themes has been started. This categorization process involved grouping codes together based on their underlying meanings and connections. These themes were then carefully. Refined to ensure they accurately represented the data while remaining relevant to the research objectives. The topics covered aspects, including the adoption of technologies, in marketing and management the changes that organizations face due to digital transformation the challenges encountered by Nokia Poland in

adapting to the Fourth Industrial Revolution and the strategies implemented to take advantage of new opportunities.

Finally, these themes in light of existing literature on the Fourth Industrial Revolution, marketing and management have been interpreted. This interpretation aimed to provide an understanding of the research findings and their implications, for both theory and practice.

5.1. Result

The result highlights the potential for productivity and value creation in Industry 4.0 for industries that heavily rely on assets. Nokia's concentration on thought leadership campaign aligns with industry trends aiming to engage a customer base through a combination of technological advancements and strategic marketing efforts. The campaign focuses attention on the importance of sustainability and efficiency by showcasing how Industry 4.0 can reduce impacts while also improving worker safety and productivity.

Market projections indicate growth in the industry 4.0 market with an increase in revenues from private wireless solutions expected. This growth is supported by drivers such as hybrid cloud, IoT, edge computing, AI, AR/VR/MR and robotics that collectively create an ideal ecosystem for Industry 4.0.

However, transitioning to Industry 4.0 comes with its set of challenges. The information identifies obstacles including network connectivity issues, data fragmentation, cybersecurity concerns organizational readiness hurdles and difficulties in coordinating suppliers. To address these challenges effectively specific solutions are proposed such as evaluating connectivity options (build vs buy) implementing practices in network design and prioritizing change management initiatives.

Nokia plays a role in overcoming these challenges by offering end-to end solutions including modular private wireless solutions and digital automation cloud platforms. The company places importance on building partnerships and fostering the growth of its ecosystem. This approach aims to enhance Nokia's existing portfolio and open ways for generating revenue by implementing go, to market strategies and collaborating on marketing initiatives.

5.2. Discussion

Based on the information provided, a suggested marketing framework for Nokia and also other similar companies could focus on:

1. Customer Centric Approach: the main goal would be to provide tailored solutions that meet the needs of customers during their transition to Industry 4.0.
2. Thought Leadership; companies should strengthen the campaign to establish the organization as a leading provider of Industry 4.0 solutions showcasing our expertise and innovative approach.

3. Ecosystem Development; Building partnerships will enable the companies to enhance our product offering and address the entire value chain effectively.
4. Digital. Outreach: It is crucial to leverage channels to effectively communicate the benefits of Industry 4.0 and highlight how company's solutions can make a difference.
5. Data Driven Decision Making; By leveraging data and analytics we can tailor our marketing strategies, measure their effectiveness, and make decisions accordingly.

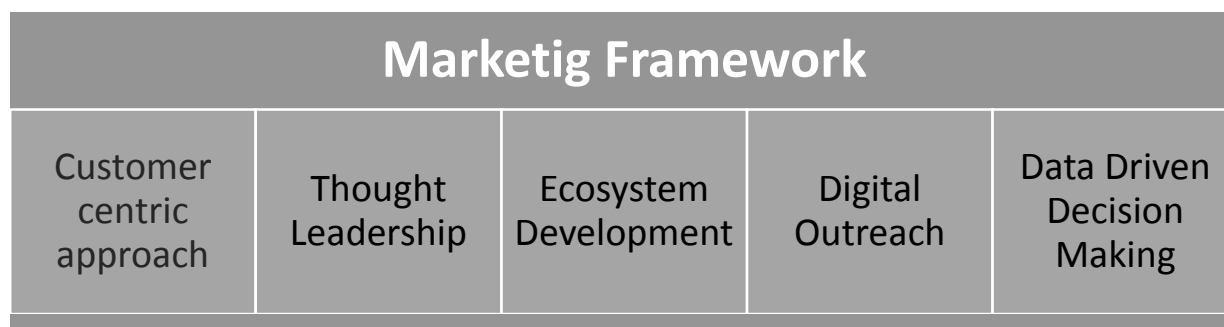


Figure 2. Suggested Marketing Framework.

Source: Own elaboration.

Implementing this marketing framework may pose challenges such as aligning with evolving technology trends overcoming market resistance towards technologies maintaining a consistent brand message across different channels and accurately measuring the return, on investment (ROI) of our marketing initiatives.

The proposed marketing framework, for embracing the Fourth Industrial Revolution as demonstrated by Nokia Poland involves an approach that can have an impact on marketing strategies and potentially serve as a universal model in similar situations. This framework revolves around prioritizing the needs of customers being at the forefront of industry knowledge building partnerships and ecosystems utilizing marketing and outreach techniques and making data driven decisions. It offers a dimensional strategy for navigating the challenges and capitalizing on the opportunities brought about by the Fourth Industrial Revolution.

By focusing on customers' evolving needs and expectations in an Industry 4.0 environment a customer centric approach ensures that marketing efforts are directly aligned with their demands. This approach not only leads to higher customer satisfaction and loyalty but also ensures that products and services evolve to meet market demands. This principle is universally applicable since prioritizing customer needs is fundamental to marketing across all industries and markets.

Establishing thought leadership in Industry 4.0 positions a company as an expert in this era enhancing its brand credibility while attracting potential customers and partners alike. By sharing insights and forward thinking perspectives a company can set itself apart in a market. This strategy is particularly powerful in industries experiencing advancements but can be adapted to various market contexts.

Partnerships and the establishment of ecosystems expand a company's capabilities and market reach enabling it to provide integrated solutions. In the context of Industry 4.0 where technologies and expertise are often highly specialized, collaborating with others can give an advantage. This approach is becoming increasingly important in today's interconnected business world. Applies to industries as a means to foster innovation and tackle complex challenges.

Digital marketing and outreach utilize the power of channels to communicate with a wide audience allowing for more targeted and engaging marketing campaigns. This aspect of the framework recognizes the role of having a presence in modern marketing efforts. It is relevant across sectors offering measurable ways to connect with customers.

Lastly making data driven decisions is crucial for optimizing marketing strategies and assessing their effectiveness. In the era of Industry 4.0 where vast amounts of data can be collected and analyzed, using this information to make informed choices can significantly enhance marketing endeavors. This approach holds relevance as it provides a method for tailoring marketing strategies precisely while also enabling real time evaluation of their impact.

The marketing framework suggested for Nokia Poland, which emphasizes customer-centricity, thought leadership, partnership development, digital marketing, and data-driven decision-making, can indeed be adapted for use by other global companies like Nokia. However, implementing this framework universally presents several challenges.

One major challenge is the cultural and regional differences across markets. Different regions have consumer behaviors, cultural differences, and regulatory landscapes. This means that marketing strategies need to be customized. Moreover, the extent to which Industry 4.0 has been embraced can differ greatly depending on the level of market development in each region. Some regions might be more advanced, necessitating different strategies compared to areas where these technologies are still emerging.

Resource allocation and prioritization also pose a challenge. Global companies often operate across multiple sectors with diverse product lines, and effectively allocating resources and prioritizing marketing efforts across these varied sectors is a complex task. This challenge is heightened by the need to synchronize marketing strategies with the company's existing capabilities and future plans considering the rate at which technology evolves and integrates.

The implementation of a data driven marketing strategy becomes more complex due to regulations surrounding data privacy and security. With regulations varying across regions, companies must navigate these complexities to effectively use data in their marketing efforts without breaching legal requirements.

Furthermore, intense competition and market saturation in some regions make it difficult to stand out and capture consumer attention. In such environments, differentiating a brand and its message becomes increasingly challenging. Measuring the success of marketing strategies and evaluating their return on investment (ROI) can be quite challenging, in the changing landscape of Industry 4.0. It is essential to create metrics and analytical tools that can effectively gauge

the influence of marketing initiatives. It is not an easy task.

Finally, implementing a new marketing framework involves substantial change management and requires buy-in from various stakeholders across the organization. Ensuring alignment across different departments and regions while managing this organizational change is a significant challenge.

To navigate these challenges, global companies need to adopt a flexible approach, adapting the framework to local contexts and continuously monitoring market trends and consumer behaviors. Investing in understanding regional differences and maintaining a balance between global consistency and local relevance are key to successfully implementing this marketing framework in a global context.

6. Conclusion

The research aimed to explore how Nokia Poland is navigating the challenges and leveraging the opportunities presented by Industry 4.0, particularly in the fields of marketing and management. It involved a qualitative analysis, utilizing data from interviews and document analysis, including a detailed PowerPoint presentation titled "Industry V4.0". The methodology employed thematic analysis to identify key themes and insights related to Industry 4.0's impact on business practices, challenges faced, and strategies implemented by Nokia Poland. The study was conducted to gain an understanding of the changing landscape of Industry 4.0 and its impact, on global companies like Nokia. Its purpose was to offer insights into how these companies can adjust their marketing and management strategies in response to the evolving environment thus ensuring their competitiveness and fostering innovation. The study employed methods, analyzing interview data and company documents. Through analysis meaningful insights and themes were extracted from the data, which were then examined within the context of existing literature, on Industry 4.0 marketing and management.

A significant outcome of the study was the development of a suggested marketing framework for Nokia Poland. This framework is designed to be flexible and adaptable to the demands and opportunities presented by Industry 4.0. It focuses on areas including prioritizing customer needs establishing thought leadership implementing digital marketing strategies and utilizing data driven decision making. The aim of this marketing framework is to assist Nokia Poland in addressing the challenges that arise from marketing in an Industry 4.0 setting enabling the company to maintain its competitive advantage and achieve sustainable growth.

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UTILIZATION OF SPORTS INFRASTRUCTURE IN POLAND

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Purpose: Analysis of changes in the level of utilization of sports facilities in Poland in 2010, 2014, 2018. The study of the relationship between the degree of use of sports facilities and their number, the number of inhabitants, as well as expenditure on sports and income from this division according to budget classification. Discussion of selected issues related to the degree of utilization of sports facilities in Poland. Drawing attention to the problem of underutilization of sports facilities.

Design/methodology/approach: The level of sports facilities utilization was presented using data from the Central Statistical Office. The canonical analysis method was used to develop detailed analyses.

Findings: The use of canonical analysis allowed for determining the relationship between the level of utilization of sports facilities and selected variables.

Research limitations/implications: The analysis covered the years 2010, 2014 and 2018 due to the availability of information published by the Central Statistical Office. The level of utilization applies to certain types of objects. Further analyses should include the issue of using outdoor gyms or cycle paths, which are not addressed in this paper. This is not possible from the point of view of the definition of the level of utilization of sports facilities, which cannot be applied to the above-mentioned facilities.

Practical implications: Drawing attention to the underutilization of facilities is aimed to optimize their use. Addressing the issues should also stimulate interest in physical activity and raise awareness of deficits in occupancy of sports facilities.

Social implications: A higher level of utilization of sports facilities can have a positive impact on the quality of life of inhabitants. Presented considerations may increase the awareness of the underutilization of specific types of facilities. The conclusions from the research may be used in practice and have an impact on increasing the accessibility to sports facilities for the society.

Originality/value: The added value of the paper results from the specificity of the research topic it raises. Scientific publications seldom refer to the issue of the use of sports infrastructure. It is a rarely discussed topic. Its universality can be analysed in two aspects. The first concerns the recipients. They can be representatives of Local Government Units who face the problem of the functioning of sports facilities, managers of facilities and everyone from the circle of the broadly perceived sports labor market, but also ordinary users of this type of infrastructure. The second aspect concerns the applied research method, i.e., canonical analysis, which is used in many fields, as indicated in the content of the study. Conclusions from the results of the presented research can be used by all people who have impact on decision-making in the sphere of sports facilities management and the promotion of an active lifestyle.

Keywords: canonical analysis, sports facilities.

Category of the paper: Research paper, case study.

1. Introduction

Sports infrastructure should serve a diverse group of recipients. Expectations related to the way it functions and develops are changing. It is similar with the awareness of their potential and actual users. The pressure exerted on the promotion of an active lifestyle means that increasingly often we hear about the need to undertake physical activity and its positive impact on health, as well as on the comfort of human life. Appropriate sports infrastructure should be the element encouraging to do so. It ought to be available and adapted to the needs of different age or social groups. In addition to sports values, modern sports facilities can be an attractive tourist product of the region, which is indicated by Cieřlikowski (2018).

The issue of modern sports facilities is a subject area relatively poorly recognized by social sciences. Demographic and health changes accompanying not only Polish society are the reason for analyzing the topic. The need for more frequent use of sports infrastructure arose especially after the pandemic, when there was an increase in doubts among various stakeholders about the usefulness of further sports facilities.

The study compares the level of utilization of sports facilities in Poland in 2010, 2014, and 2018, and evaluates the relationship between the degree of utilization of sports facilities and their number, the number of inhabitants, expenditure on sports as well as income from this division according to budget classification.

The research methods included a review of available data from Central Statistical Office (GUS) and canonical analysis, which enables the study of possible relationships between groups of variables. Statistical calculations were conducted using the Statistica software. A summary with the most important results is presented for each pair of groups. Those for which p (confidence level) < 0.05 are interesting.

Critical analysis of the literature related to the subject is the research method in the review part.

2. Literature review

The literature emphasizes that doing sport brings with it multi-faceted economic and social benefits. Improving the physical and mental well-being of the society contributes to a better quality of life. Active people are more efficient at work, perform better and take sick leaves less frequently. Keeping your workforce healthy can be an investment in the future. It is important

not only to shape social awareness of the role played by physical activity, but also to act to increase motivation to undertake it.

Caring for the shape and appearance is attributed mainly to young people. However, it must be admitted that this stereotype is slowly being changed. Elderly people walking with poles (Nordic walking), women at the swimming pool practicing aqua aerobics or using sports equipment in nearby parks are increasingly common. However, there is still much to be done in this sphere. The availability of sports infrastructure, regardless of individual socio-economic conditions, significantly affects the patterns of sports activity. However, the impact of certain types of sports infrastructure differs by age group. Research results presented by Wicker et al. (2009) are important not only in the context of the approach of the elderly to sport, but also in the management decisions made by managers. Sports infrastructure should be managed in such a way as to contribute to making sport accessible to people of all ages.

Physical activation of seniors is a task that is difficult to implement in practice, but extremely important. Seniors need to understand that regular exercise will improve their physical and mental condition, or independence in everyday life (Marchewka, 2013). For this reason, any programs promoting physical activity among all age groups of the society are important not only from the social point of view (building and strengthening relationships) but also from the economic point of view (lower costs of health and social care).

Sports stadiums are a specific type of sports infrastructure. They perceived in the context of a place where numerous sporting events take place. Several of them are presented in the publication entitled *The Stadium: Architecture for the New Global Culture* (Sheard et al., 2005). Many of the stadiums presented in this book have hosted some of the most successful sporting events of the last decade, including the Sydney Olympics, the Rugby World Cup, the Superbowl, the FA Cup Final, the Asian Games and the Euro 2004 Football Championship.

Sports facilities are not only an area of competition for players, but also a meeting place for families with children, as well as social and intercultural integration. The subject of changes in the stadium infrastructure is referred to by e.g., T. Szlendak, D. Antonowicz et al. (2014). They indicate the increasing commercialization of the space, where the pitch is the most important, yet it is surrounded by an extensive commercial zone. The implementation of innovative solutions, also in terms of energy consumption in sports facilities (Revel, Arnesano, 2014), is especially important as it supports long-term development and is a source of competitive advantage (Firlej, 2015). The role of local or regional authorities that support physical activity in various forms, cannot be disregarded. Much depends on the decisions of these authorities. It should be remembered that "properly designed and implemented regional policy, the appropriate perception of its mechanisms, the ability to use aid provided by the EU structural funds are a significant challenge and a huge development opportunity for Polish regions" (Firlej, 2016).

The effectiveness of sports facilities is the subject of considerations by Haydarov, N.H., Azimov, B.F., & Halimov, F.E. (2020). Sports facilities also occur in the context of the possibility of using them by people with disabilities (Ping Kung, Taylor, 2014). Kokot (2021) dealt with the accessibility of indoor swimming pools in Poland. Access to sports infrastructure near the workplace increases the likelihood that it will be used by working adults than the infrastructure located close to home (Zasimova, 2020). Müller-Frączek (2021) writes about the correlation between the development of sport and the resources of sports infrastructure. The results of her research showed that a higher number of sports facilities was accompanied by a higher average level of sport development in each year and in each variant considered. The strength of this correlation was at least moderate, but never very strong. It was indicated, however, that further research is needed to find an answer to the question of the impact of the increase in the number of sports facilities on the increase in the level of sports development (Müller-Frączek, 2021).

Emerging economies are increasingly recognizing the importance of the sports industry. As a result, there are growing expenses for building sports infrastructure, creating teams or acquiring new investments (Kutwa, Rafał, 2019). Actions taken in India (Singh, 2018) or China (Yongqi, 2018) can be an example here.

3. Utilization of sports facilities

In order to evaluate a text correctly and fully, intuitive understanding should be supported by scientific explanation, complemented by the point of view of other authors dealing with the subject. Therefore, the meaning of these concepts should be explained. Sport is considered to be any form of physical activity that, through casual or organized participation, affects expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels. Sport is also competition based on intellectual activity, whose aim is to achieve a sports result. Sport together with physical education and motor rehabilitation form physical culture (Act on Sport, 2010). Information on sports clubs and people exercising in individual sports sections can be found in the Local Data Bank of the Central Statistical Office. Since 2002, this data has been collected every 2 years. On the other hand, information on sports facilities is presented every 4 years. However, it does not include school facilities (BDL-Local Data Bank). The diagram shown in Fig. 1 allows for placing sports facilities among other public facilities.

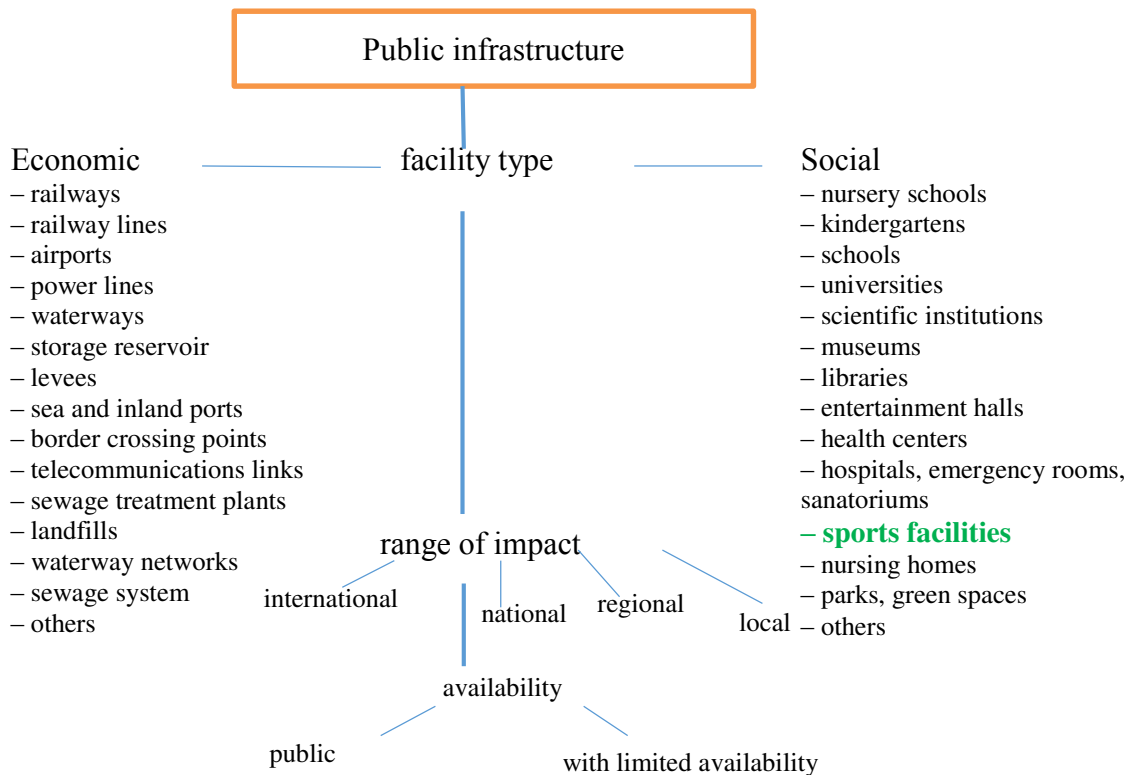


Figure 1. Division of public infrastructure by the type, range and availability of facilities. Adapted from: “Finansowanie inwestycji infrastrukturalnych przez kapitał prywatny na zasadach Project Finance” [“Financing infrastructure investments by private capital on the basis of Project Finance”] by K. Brzozowska. Copyright 2005 by Publisher.

As shown in Figure 1, sports facilities are part of the social public infrastructure. When completing the presented classification, it should be noted that a sports facility is considered to be an independent compact set of field facilities and buildings intended for sports purposes (GUS, 2017; Glossary of terms). Therefore, sports infrastructure performs tasks aimed at serving the local, regional, national or international community. It can be available to everyone. Limited access to certain facilities may result, for example, from their use during special events or being intended for specific groups of users (e.g., the facility is closed to the general public while athletes are preparing for an event). Social reception affects the level of utilization of facilities. The degree of occupancy of the facility for sports and recreation purposes results from comparing the number of days in a year when the facility was used for sport and recreation purposes to the number of days in a year when the facility was open. It is expressed as a percentage (Kultura fizyczna w Polsce w latach 2008-2010 [Physical culture in Poland in 2008-2010], p. 24).

Table 1.

Occupancy Rate of Facilities for the Purpose of Sport and Recreation in 2010, 2014, 2018 (in %)

Facility	Year	Total Poland	Facility	Year	Total Poland
Stadiums	2010	72	Tracks	2010	78
	2014	74		2014	82
	2018	75.5		2018	84.1
Sports fields for big games ¹	2010	65	Ice rinks	2010	94
	2014	67		2014	95
	2018	71		2018	93.6
Sports fields for small games ²	2010	71	Ski jumps	2010	68
	2014	73		2014	79
	2018	75.3		2018	45.8
Universal and multi-purpose sports fields	2010	77	Shooting range	2010	74
	2014	83		2014	78
	2018	84.3		2018	81.4
Tennis courts	2010	87	Golf courses	2010	93
	2014	88		2014	94
	2018	88		2018	90.4
Sports halls and gyms ³	2010	91	Water parks	2010	87
	2014	92		2014	94
	2018	90.6		2018	94.4
Indoor swimming pools	2010	96	Skateparks	2010	90
	2014	96		2014	91
	2018	96.8		2018	90.1
Outdoor swimming pools	2010	89			
	2014	91			
	2018	91.6			

Adapted from: Kultura fizyczna w Polsce w latach 2008-2010 [*Physical education in Poland in the years 2008-2010*], by Główny Urząd Statystyczny (GUS), Statistical Office in Rzeszów, Warszawa-Rzeszów, 2011, p. 208; Kultura fizyczna w Polsce w latach 2013-2014 [*Physical education in Poland in the years 2013-2014*], by Główny Urząd Statystyczny (GUS), Statistical Office in Rzeszów, Warszawa-Rzeszów, 2015, p. 171; Kultura fizyczna w Polsce w latach 2017-2018 [*Physical education in Poland in the years 2017-2018*], by Główny Urząd Statystyczny (GUS), Statistical Office in Rzeszów, Warszawa-Rzeszów 2019, tab. 49.

We should also mention outdoor gyms and bicycle paths, which, together with shooting ranges, golf courses, aqua parks and skate parks, are found in the lists of sports facilities among other facilities (GUS, 2019, table 49). Due to the specificity of these facilities, it is not possible to compare the number of days in a year when they were used for sports and recreation purposes to the number of days in a year when they were open. These facilities are open to the public and can be used at any time. Information on the level of use of outdoor gyms and bicycle paths is not available, therefore they are not included in Table 1.

¹ The fields for big games include: football + rugby + field hockey + baseball and softball.

² The fields for small games include: basketball, volleyball, handball (2010) + beach volleyball (2014) + beach handball (2018).

³ Sports halls and gyms include: Multifunctional sports halls with dimensions 44x22 m and larger + Sports halls with dimensions from 36x19m to 44x22m + gyms with dimensions from 24x12m to 36x19m + auxiliary rooms with dimensions under 24x12m.

Presented data indicate that none of the types of facilities from Table 1 was fully used in 2010, 2014, 2018. It should be clear that many factors could have influenced this situation. Certainly, the approach of the local community to the use of facilities, time and financial possibilities of using them is an important determinant. Attention should also be paid to the specificity of the objects. Not every person can use ski jumps. In this case, the question of proper management of facilities arises. The same situation applies to stadiums and all types of pitches, which are often used by sports clubs or national teams in various disciplines.

An interesting observation is the one concerning golf courses. Despite the prevailing opinion that golf is not a cheap sport, which proves to be not entirely true (BogiGolf; Magazyn Golfowy), the degree of utilization of these facilities is at a prominent level. A comparable situation applies to skate parks. Indoor swimming pools, outdoor swimming pools and water parks enjoy the highest level of use. They are places suitable for users of all age groups, as well as with various diseases.

4. Canonical analysis

Canonical analysis is applied to estimate the relationship between two sets of variables (TIBCO Statistica, 2022; UCLA). It is used in pedagogical research, for example, in assessing the simultaneous relationship between three measures of learning ability and five measures of success in learning. In sociology, it can help to identify relationships between two predictors of social mobility obtained in interviews and actual subsequent social mobility. Canonical analysis is also useful in medical science, for example, when looking for relationships between various risk factors and the formation of a certain group of symptoms. All these examples have one common feature. It concerns the interest in the relationship between two sets of variables, for which the appropriate method of analysis is the canonical correlation (Statsoft.pl).

In the literature there are examples of the use of canonical analysis, for example in economics, e.g., Deręgowski, Krzyśko et al. (2017), Malinowski (2016). The research on the impact of a set of variables characterizing households on the consumption of food, beverages and tobacco is also interesting. It has proved that expenditure on food, income per person in the household and the place of its location perform the leading role in food consumption (Piekut, 2006).

Formulating research hypotheses regarding the relationship between two sets of variables is popular in psychology (Prusiński, 2017). Canonical analysis is also applied in the studies of relationships between the ways of coping with stress and disturbed attitudes towards eating (Pawłowska, 2011).

The application of this method already appeared in papers from the 1970s and 1980s Kettenring, 1971; Kuylen, Verhallen, 1981. Examples of studies using canonical analysis, e.g., in biology (Howard, 1992 – soil-biology?), or in hotel tourism (Narangajavana, Hu, 2008) can also be indicated.

In the conducted empirical study on the use of sports infrastructure, the data set (Central Statistical Office) consists of 109 variables, 16 cases each (voivodeship):

- 42 variables - utilization of sports facilities: 14 types of facilities x 3 years (2010, 2014, 2018);
- 42 variables - number of sports facilities: 14 types of facilities x 3 years (2010, 2014, 2018);
- 3 variables - population in voivodeships for 2010, 2014 and 2018;
- 11 variables - expenditure of voivodeships on physical culture and sport (2008-2018);
- 11 variables - income of voivodeships from physical culture and sport for 2008-2018.

First, the data was standardized so that it could be compared, e.g., the use of facilities in % with population (different measurement units). Data transformation consisted in subtracting a certain value from the original data (usually the sample mean) and dividing it by the standard deviation (usually also determined from the sample). As a result of standardization, the transformed values have a distribution with a mean of 0 and a standard deviation of 1 (pogotowiestatyczny.pl). This transformation has many applications, because it allows for comparing the distribution of values for many variables and many groups. In addition, the standardization of input data makes the results of statistical analyzes completely independent of the units of measurement of individual variables. In addition, standardization highlights outliers.

Then it has been checked in which cases p is below 0.05. P represents the probability of making a type I error, i.e., rejecting the true H_0 , which says that there is a relationship between the degree of utilization of facilities and the number of people; $N = 16$ represents voivodships. They are cases, not variables, so they do not occur.

In view of the above, four research hypotheses were formulated:

- H_0 : there is a significant relationship between the degree of utilization of sports facilities and the number of people;
- H_1 : there is a significant relationship between the degree of utilization of sports facilities and their number;
- H_2 : there is a significant relationship between the degree of utilization of sports facilities and expenditure on physical culture and sport;
- H_3 : there is a significant relationship between the degree of utilization of sports facilities and the income generated from physical culture and sport.

The research results show that p is always above 0.005, so the probability of making a type I error, i.e., rejecting the true H_0 , stating that there is a relationship between the degree of utilization of facilities and selected variables, is below 5% for each hypothesis. High canonical R proves a strong correlation between the degree of utilization of sports facilities and selected variables.

Table 2.

Degree of utilization of sports facilities and the number of people⁴

N = 16	Canonical R: .86389; p = .02806	
	Left set	Right set
Number of variables	3	3
Variables: 1	S.W. Indoor swimming pools 2010	Population 2010
2	S.W. Indoor swimming pools 2014	Population 2014
3	S.W. Indoor swimming pools 2018	Population 2018
N = 16	Canonical R: .77151 ; p = .04885	
	Left set	Right set
Variables: 1	S.W. Water parks 2010	Population 2010
2	S.W. Water parks 2014	Population 2014
3	S.W. Water parks 2018	Population 2018

Adapted from: own study.

In the study of the relationship between the degree of utilization of sports facilities and the population (Table 2), a significant relationship was found between the degree of utilization of indoor swimming pools and the population ($p = .02806$) and between the degree of utilization of water parks and the population ($p = .04885$). The number of indoor swimming pools was increasing from 433 in 2010, through 521 in 2014 to 579 in 2018. The number of water parks changed from 43 facilities to 83 and 82 in 2018. The population in the studied years decreased from 38,529,866 through 38,478,602 and reached 38,411,148 in 2018 (Demography Database). The degree of utilization of both swimming pools and water parks is high, with a growing trend in the case of the latter. The conducted analyzes show that there is a significant relationship between the variables.

Thus, the H_0 hypothesis was partially confirmed, although it must be clearly stated that not for all types of facilities. The confirmation applies to water parks and indoor swimming pools. On the other hand, lack of confirmation is observed in the case of stadiums, all types of pitches, tennis courts, sports halls and gyms, outdoor swimming pools, tracks, ice rinks, ski jumps, shooting ranges, golf courses and skate parks.

⁴ S.W. - degree of utilization.

Table 3.*The degree of utilization of sports facilities and their number⁵*

N=16	Canonical R: .87546; p=.03823	
	Left set	Right set
Number of variables	3	3
Variables: 1	S.W. Indoor swimming pools 2010	L.O. Indoor swimming pools 2010
2	S.W. Indoor swimming pools 2014	L.O. Indoor swimming pools 2014
3	S.W. Indoor swimming pools 2018	L.O. Indoor swimming pools 2018

Adapted from: own study.

In the study of the relationship between the degree of utilization of sports facilities and the number of facilities (Table 3), a significant relationship was found between the degree of utilization of indoor swimming pools and their number ($p = .03823$). High canonical R proves a strong correlation between the degree of utilization of sports facilities and the number of facilities. Thus, H1 was partially confirmed, although it must be clearly stated that only in the case of indoor swimming pools. In the case of other objects, it was not confirmed. On the one hand, the increasing number of indoor swimming pools from 433 in 2010, through 521 in 2014 to 579 facilities of this type in 2018, may cause the decline in the utilization of the facilities. The greater availability of facilities/a bigger number of them leading to the scattering of potential customers may be the reason for that. On the other hand, greater accessibility of the facilities increases social awareness of the beneficial effects of swimming on physical and mental health. Pęczak-Graczyk, Skalski et al. draw attention to the non-recreational and non-rehabilitative role of swimming, as well as the growing number of swimming pools and increasingly frequent activity in the form of exercising in the swimming pool (2017).

Table 4.*The degree of utilization of sports facilities and expenditure on physical culture and sport in 2008-2018*

N=16	Canonical R: .97998; p = .04336	
	Left set	Right set
Number of variables	3	3
Variables: 1	S.W. Universal and multi-purpose sports fields 2010	Expenditure 2008
2	S.W. Universal and multi-purpose sports fields 2014	Expenditure 2009
3	S.W. Universal and multi-purpose sports fields 2018	Expenditure 2010
4		Expenditure 2011
5		Expenditure 2012
6		Expenditure 2013
7		Expenditure 2014
8		Expenditure 2015
9		Expenditure 2016
10		Expenditure 2017
11		Expenditure 2018

Adapted from: own study.

⁵ L.O. - number of facilities.

Next, the relationship between the degree of utilization of sports facilities and expenditure on physical culture and sport was studied (Table 4). Despite the fact that data on the degree of utilization of facilities concern only the years 2010, 2014 and 2018, a decision was made to extend the set of information to include annual spending. Every year, steps are taken to finance or subsidize the construction or modernization of sports facilities. Appropriate quality and availability of sports infrastructure may encourage potential users to use it. High canonical R proves a strong correlation between the degree of utilization of sports facilities and expenditure on physical culture and sport in 2008-2018.

The results of the research indicate that there is a significant relationship not only between multi-purpose sports fields and expenditure on physical culture and sport ($p = .04336$). It should be remembered that expenditure on physical culture, or income generated in this field, concern not only sports facilities. Within Section 926 of the budget classification, physical culture institutions, tasks in the field of physical culture, or removing the effects of natural disasters among others, are also distinguished (Regulation of the Minister of Finance, 2020). In addition, a significant relationship was observed between expenditure and the degree of occupancy of shooting ranges (Canonical R: .99650; $p = .00219$), and expenditure and the degree of occupancy of water parks (Canonical R: .99858; $p = .00003$).

Thus, the H2 hypothesis was partially confirmed, although it must be clearly indicated that not for all types of facilities. Confirmation of relationships applies only to universal-multi-purpose pitches, shooting ranges and water parks.

The situation is similar with regards to hypothesis H3. High canonical R proves a strong correlation between the degree of utilization of sports facilities and income from physical culture and sport in 2008-2018. A significant relationship was found between the degree of utilization of:

- playing fields for big games and income from physical culture in 2008-2018 ($p = .00010$, Canonical R: .99925),
- pitches for small games and income ($p = .00018$, Canonical R: .99692),
- universal-multi-purpose pitches and income; ($p = .00001$, Canonical R: .99945), tennis courts and income ($p = .00047$, Canonical R: .99818),
- outdoor swimming pools and income ($p = .04845$, Canonical R: .98356),
- shooting ranges and income ($p = .00305$, R: .99582),
- water parks and income ($p = .00003$, R: .99954).

Thus, hypothesis H3 was also partially confirmed. At this point, a question of the reason for such a result can be raised. This time, the relationship was not confirmed only in the case of stadiums, sports halls and gyms, indoor swimming pools, tracks, ice rinks, ski jumps, golf courses and skate parks. One can wonder about the influence of local government policy and actions taken in the field of functioning of sports facilities. Following the European Commission (2018), the Polish Economic Institute (Kutwa, Rafał, 2019) publishes information

about the views of Europeans on the availability of sports infrastructure. Three in four Europeans believe that there are numerous opportunities for physical activity where they live (74%). In Poland, 68 percent of people are of the same opinion. Views on the opportunities to engage in physical activity are most positive in the Netherlands, Denmark, Sweden and Germany, and least positive in Bulgaria, Romania, Croatia and Italy. A similar percentage (73%) believe that local sports clubs and other institutions offer such opportunities (63% in Poland). According to Poles (53%), local authorities do not do enough to provide their citizens with opportunities for physical activity. The opinion of Poles is shared by 39% of the surveyed EU citizens.

5. Conclusions

At the time of preparation of this publication, the Central Statistical Office has not yet provided information on the degree of utilization of sports facilities for 2022. The data is expected all the more that it will cover the time of the pandemic. A lot changed between 2018 and 2022. It should be remembered that the pandemic had impact on all people and all areas of socio-economic life. The introduction of lockdowns resulted in the closure of many clubs, and thus the loss of opportunities for spending time in an active way for people of all ages and with various diseases. The increase in the possibility of using various forms of physical activity through remote programs and applications promoting movement cannot be disregarded. However, sports activity at home is something completely different from the activity in the open air or indoor but with other exercisers.

The four-year cycle of publishing data on the degree of utilization of facilities is a bit of a problem when developing analyses. It seems a good practice to publish this data every 2 years, as is the case with sports clubs and the number of exercising people. The use of such a solution would make it possible to link the degree of utilization of sports facilities with the changing number of sports clubs or exercising people.

The applied research method is used in many fields of science, which proves its universality. High canonical R indicates a strong correlation between the degree of utilization of sports facilities and selected variables. At a further stage of research, these relationships should be explored in detail. Deeper analyzes should also cover the situation in individual voivodeships. It could explain a lot. The national situation is one thing. However, it consists of conditions/circumstances/events taking place in all voivodeships separately.

Effective use is noticed, but there are types of facilities whose utilization requires improvement. Paying attention to the underutilization of facilities should help optimize their use. Addressing these issues aims to stimulate interest in physical activity and to increase awareness of deficits in the occupancy of sports facilities.

The added value of the paper results from the specificity of the research topic it raises. Scientific publications seldom refer to the problem of the utilization of sports infrastructure as generally, it is a rarely discussed topic. Its universality can be considered in two aspects. The first concerns the recipients. They can be representatives of Local Government Units who face the problem of the functioning of sports facilities, managers of facilities and everyone from the circle of the broadly understood sports labor market, but also ordinary users of this type of infrastructure. The second aspect concerns the used research method, i.e., canonical analysis, which is applicable in many fields, as indicated in the content of the study. Conclusions from the results of the presented research can be used by all people who influence decision-making in the field of management of sports facilities and the promotion of an active lifestyle. Appropriate management of sports facilities can be one of the elements stimulating a healthy lifestyle, eliminating social exclusion, or developing the region. Understanding the problem should be the answer to the statement "If the world's population were more active, four to five million deaths could be avoided each year" (WHO, 2021).

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DOCTORS FROM UKRAINE AS STAKEHOLDERS IN THE HEALTHCARE SYSTEM IN POLAND

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Purpose: This article aims to outline the issue of doctors from Ukraine who provide medical services to the healthcare system in Poland. The distinguished research subject was treated in terms of stakeholders of the healthcare system.

Design/methodology/approach: The article analysed the solutions introduced based on applicable legal acts. For this purpose, the guidelines of the Ministry of Health were referred to. The secondary data comes from the Supreme Medical Chamber.

Findings: The management of the healthcare system in Poland is the responsibility of the Ministry of Health. Still, the role of the medical professional self-government must be considered in this process. In solving systemic problems, a dialogue with medical community representatives contributes to implementing transparent solutions in business practice. Based on the considerations, the authors show that the current challenges of the national healthcare system concern doctors from Ukraine. The introduction into the Polish healthcare system of people educated in a different education system and with professional experience already gained outside the European Union implies problems concerning the quality of the services provided. Entry into the health care system must be carried out transparently so that it does not raise objections from all stakeholders.

Research limitations/implications: The article contains a preliminary study. In the future it is planned to conduct additional quantitative and qualitative research.

Practical implications: The conclusions proposed as an outcome of the research can have an impact on the formulation of an activity aiming at managing relations in the healthcare system in Poland.

Social implications: The article demonstrates the selected positions and problems functioning in the healthcare system in Poland.

Originality/value: The article concerns the current scientific problems and business practice.

Keywords: stakeholders, doctors from Ukraine, medical education systems, healthcare system in Poland, desk research method.

Category of the paper: The article uses a research approach based on the existing legal frameworks and guidelines formulated by professional medical organizations.

1. Introduction

The healthcare system and its environment are formed by different stakeholder groups: government structures, local government, medical resources, and patients (Wu et al., 2018; Kaur, Victoria, 2017). Its fundamental objective remains protecting citizens' health (Jasinska, 2020). The definition adopted by WHO (2008) assumes that the concept of a health system encompasses all organizations, inputs, and institutions whose premise is to undertake activities aimed at improving health. There is a belief that its shape is also determined by the adopted organization and professed values (Borkowska, 2018). The analyzed system functions according to the so-called „triangle”, it consists of three essential elements: patients, providers, and the payer (Paszowska, 2017).

The Constitution of the Republic of Poland (1997) guarantees citizens equal access to publicly funded health care services, regardless of their material situation. In recent years, the national healthcare system has been financed by 69.4 % from public sources (INNOWO, 2020). However, Poland is ranked among countries with low public expenditure in the area in question (Frąckiewicz-Wronka et al., 2021). Estimates by the Central Statistical Office (GUS, 2023) show that in 2022, current expenditure on the health care accounted for 6.7% of GDP.

The healthcare system in Poland still needs to improve, including in the area of human resources management (NIK, 2018). These problems relate to aspects such as aging medical staff, graduates of medical schools taking up jobs outside the country, or failure to increase enrolment limits for medical studies. The phenomena highlighted result in citizens' limited access to essential medical services. Over the years, public policy has been ineffective in addressing the issues analysed and has yet to respond to the changes taking place. The COVID-19 pandemic has bluntly demonstrated the health system elements that require remedial action to maintain the continuity of medical services (Haileamlak, 2021; Filip et al., 2022). In 2020, the inclusion of non-EU nationals in the medical, dental, nursing, midwifery, and paramedic professions was allowed in the Polish healthcare system through simplified access (Rozporządzenie Ministra...; Ojczyk, 2021). Subsequently, following the escalation of hostilities in Ukraine in February, the legislation was maintained in 2022. For the conducted analyses, doctors from Ukraine providing medical services in the healthcare system in Poland were selected. The indicated object of the research is an example of a stakeholder group that appeared in the national healthcare system due to the introduced solutions. Its inclusion in the system in question was preceded by solutions introduced by the Ministry of Health.

This article outlines the issue of doctors from Ukraine as stakeholders in Poland's healthcare system. Several research questions were adopted for this discussion, which made it possible to detail the issues covered in the analysis.

2. Purpose and the research method used

The presented considerations aim to identify issues related to integrating doctors¹ from Ukraine into the healthcare system in Poland. According to the adopted research approach, the analyzed professional group includes persons who have undergone training and obtained specialization in Ukraine. The distinguished research subjects were treated as stakeholders of the analyzed system. The issue of stakeholder theory continues to be a key research area in the social sciences (Nartney et al., 2023). Its relevance can be argued by its multifacetedness from the point of view of the development of the activities of contemporary organizations. Their functioning is often determined by the expectations of different stakeholder groups (Markee et al., 2021) with whom relationships have been built (Fares et al., 2021).

The desk research method was applied within the developed research methodology framework. Its selection was dictated by the complexity of the issue under discussion and an attempt to fill a research gap in the national literature on the subject. Basic desk research was used. It was decided to discern selected aspects covered by the analysis to formulate answers to the research questions posed earlier (Bednarowska, 2015).

The article adopted the following research questions:

- what differences exist between the training systems for doctors in Poland and Ukraine?
- under what conditions can doctors from Ukraine be integrated into the Polish healthcare system?
- what legal arrangements have been developed to enable the sample group to apply for a conditional license to practice?
- under what conditions are persons employed with a conditional license to practice?

To realise the adopted research assumptions, the existing solutions based on the guidelines of the Ministry of Health and allowing doctors from Ukraine to practice their profession in Poland were analysed. In light of the considerations, an attempt was made to diagnose their impact on the Polish healthcare system.

3. Comparison of medical training systems in Poland and Ukraine

For this research, it was decided to compare the medical education systems in Poland and Ukraine (Table 1). In Poland, the right to practice medicine is regulated by law (Ustawa z dnia 5 grudnia...). The main aspects of handling the right to practice medicine include medical education, medical internship, state examination, professional registration and specialization.

¹ According to the current legal order, the professional group under study includes doctors and doctors-dentists. In the following discussion, this group is referred to as doctors.

A person interested in practising as a doctor in Poland must complete a six-year summer medical study or a five-year course in medicine and dentistry at a medical university and obtain the relevant diploma. Training in these faculties includes an annual, one-month internship and intensive practical training during the final year of study. Medical faculty graduates are awarded the title of doctor, doctor of dentistry and the so-called limited right to practise their profession. After graduating from medical school, doctors must complete a postgraduate internship, part of the medical training process, which lasts 13 months and is not oriented towards a chosen specialisation (Tyminski, 2019). By rotating between hospital departments according to the internship programme, the doctor has the opportunity to become familiar with almost every medical speciality².

At the end of their postgraduate internship, doctors take a state examination, which is required to obtain a licence to practise. These are the Medical Final Examination and the Medical and Dental Final Examination, respectively (Stryjski, Stryjski, 2016). The professional registration procedure is part of the scope of activity of the professional self-government of doctors and dentists. According to Matyja (2021, p. 7), this self-government „combines environmental concern for professional standards with respect for knowledge in serving the patient by ethical principles”. The right to practice medicine is granted by the district medical council in whose area the profession will be practised. If a doctor wishes to specialise in a particular field of medicine, they must start specialisation training in a residency or non-residency mode (Tyminski, 2019). After completing the specialisation and passing the specialisation examination, the doctor is awarded the title specialist in the field.

Training and obtaining specialization in medical faculties is different in Ukraine. Its main characteristics include medical education, state examination, medical internship, and professional registration. Medical studies in Ukraine last six years (Gorobeiko, Dinets, 2022). They are divided into a three-year pre-clinical phase (propaedeutics in paediatrics, internal medicine and surgery from the fourth semester) and a clinical phase, which lasts three years. Upon completion of the third year, the student can enter employment as a nurse, pharmacist, or paramedic on the same basis as someone with a degree in this field. Completing three years of medical studies corresponds to obtaining a diploma in nursing. Importantly, paediatrics is treated as a separate field of study, so recruitment is carried out independently of recruitment for medical studies. On the other hand, the medical-dental studies last five years. The study program may vary depending on the particular university where the medical and dental faculties operate.

² Postgraduate training for dentists lasts 12 months.

Table 1.*Comparison of medical education systems in Poland and Ukraine*

Specification	Duration of studies	Specialisation internship
Poland	<ul style="list-style-type: none"> • Medical studies last six years, medical and dental studies five years, • Unified training programme, • The graduate is awarded a medical degree, • The so-called limited right to practise medicine and dentistry is granted. 	<ul style="list-style-type: none"> • A 13-month postgraduate internship completed by the Medical Final Examination, • 12-month postgraduate internship completed by the Medical and Dental Final Examination, • Once you have passed the LEK examination, you are granted a licence to practise, • Specialisation training consists of uniform modules (lasting from 4 to 6 years) and basic modules with specialisation modules (from 4 to 7 years).
Ukraine	<ul style="list-style-type: none"> • The study of medicine lasts six years and is divided into two parts: the pre-clinical part of 3 years and the clinical part of 3 years. Medical and dental studies last five years, • The graduate is awarded the title of doctor and dentist, • separate recruitment for the paediatrics faculty, • during the course of study, the "STEP-1" exam (after year 3) and the "STEP-2" exam (after year 6) are passed. 	<ul style="list-style-type: none"> • The so-called internship (traineeship) lasts from 1-3 years and starts after passing the "STEP-2" examination, • At the end of the internship, one passes the STEP-3 exam and obtains a licence to practise with specialisation.

Source: own compilation based on (Remez, 2022; Medical education...; MedMobilityPoland 2022).

There are three state examinations in the Ukrainian medical training system. The first exam is conducted after the third year of study (KROK-1), the second exam after the sixth year of study (KROK-2), and the third exam after internship (KROK-3). A functioning examination system was introduced in 2017 (Holomb et al., 2022). The KROK-1 and KROK-2 exams consist of 200 questions, 150 of which are in Ukrainian and 50 in English. The STEP-3 exam is divided into two parts. The first takes place after the first year and is a multiple-choice test. The second part, on the other hand, depends on the decision of the respective university and can be oral, written with open-ended questions or a multiple-choice test (Striukov, Hromtseva, 2022).

After graduation, it is mandatory to undergo the so-called internship, which includes an internship and specialisation. Depending on the specialisation, this stage lasts between one and three years (e.g. gynaecology takes two years, surgery takes three years, and family medicine takes two years). To start the internship, you have to take the state examination II. During the internship, choosing primary specialities (there are eight total) is possible. For example, cardiac surgery is possible after the internship in general surgery. The internship is carried out in the department of the graduate's choice and is not dependent on the results of the second examination (after the sixth year of study). Thus, anyone can start the specialisation of their choice as soon as there is space in the department concerned³. Those studying paediatrics upon graduation automatically become specialised as paediatricians. In addition,

³ According to the researcher, there is a lot of corruption at this stage (Remez, 2022).

an ordination (Remez, 2022) must be held if you hold a higher post in a medical institution. A full licence to practise medicine and a specialist diploma are obtained after an internship (Medical education...).

In light of the comments made above, there are significant differences in the training systems for doctors in Poland and Ukraine. These differences relate in particular to the pathway allowing for a specialised internship, which includes several stages allowing for the receipt of the right to practise and specialisation training by doctors trained in the Polish system.

4. Opening up the healthcare system in Poland

In Poland, granting the right to practice a profession is an example of one of the essential competencies transferred to professional self-governments through the decentralisation of public administration (Pawlowski, 2022). In the case of the medical self-government, the implementation of this task has been assigned to the competence of the district medical councils. In 2023, the register of the Supreme Medical Chamber included 166,351 doctors with the right to practice a profession, of whom 4,985 doctors held a citizenship other than Polish⁴ (Table 2). Doctors from countries such as Ukraine (2855), Belarus (1237), Russia (106), Germany (94), and USA (58) predominated. It should be added that doctors with a conditional licence to practice prevailed among foreigners (Polityka Zdrowotna, 2023).

The first facilitation of the so-called conditional right to practise medicine was introduced within the framework of the Act of 28 October 2020 on amending certain acts in connection with counteracting COVID-19 emergencies (Ustawa z dnia 28 października...) and the Act of 27 November 2020 on amending certain acts to ensure medical staff during the declaration of an epidemic emergency or state of epidemics (Ustawa z dnia 27 listopada...). As a result, it was possible for doctors who obtained their diploma in a country that is not a Member State of the European Union to be eligible to start work. This implementation was due to the declaration of the COVID-19 pandemic state and the existing medical workforce shortages.

Under the current legal order, two pathways to qualification were provided for:

- obtaining a so-called conditional right to practice the profession,
- obtaining a licence to practise for a specific range of professional activities (allowing you to work in your area of specialisation).

⁴ Status as of 6 November 2023.

Table 2.*Number of doctors in Poland with a licence to practice*

Type of licence to practise	Number of the right to practice a profession
Non-practising doctors	10076
Right to practise medicine	142152
Right to practise medicine - duration of internship (trainee)	10004
Foreign doctors' licence to practise	47
Foreign doctors' license to practice medicine - for a limited period of time	747
Right to practise as a doctor for a foreigner from the European Union	380
Right to practise medicine - limited by resolution of the ORL*	34
Licence to practise medicine from outside the European Union - specific scope of practice	546
Right to practice a profession from outside the European Union - conditional	2234
Right to practise medicine - suspended	131

* District Medical Council.

Source: (Polityka Zdrowotna, 2023).

The first of the solutions mentioned above, the so-called conditional right to practice, proved to be the most popular. However, this type of pathway offered the possibility to work in a medical entity designed to provide health services to patients with COVID-19. The situation has changed since the outbreak of the war in Ukraine in February 2022. The provisions on the employment of foreign nationals were narrowed to Ukrainian citizens who crossed the border after 24 February 2022 (Ustawa z 12 maja...). Following the lifting of the epidemic emergency and the abolition, as of 1 April 2022, of the ring-fencing of medical entities for providing health services to COVID-19 patients, persons with a conditional licence to practise could only work as general practitioners. To this end, those interested in obtaining such entitlements were required to apply to the Minister of Health for permission to practise their profession outside a medical entity dedicated to providing health services to COVID-19 patients. The application had to indicate the entity where the profession would be practised. The group in question was allowed to provide health services to medical entities serving refugees from Ukraine. In this case, approval was not required; only the place of work and the period of employment had to be notified by seven days (Ministerstwo Zdrowia, 2022b).

5. Obtaining approval from the Minister of Health

Any person with Ukrainian citizenship and a completed medical degree may obtain a permit to practice medicine in Poland. This aspect is regulated by the relevant law (Ustawa z 12 maja...). For this purpose, the following conditions must be fulfilled:

- a diploma in medicine or a diploma in dentistry, certifying successful completion of studies of at least five years, issued in a country other than a Member State of the European Union,

- full legal capacity,
- a state of health permitting the exercise of the medical profession,
- an impeccable ethical stance.

Required documents to be submitted by interested persons are as follows (Ministerstwo Zdrowia, 2022a):

- a diploma of doctor, doctor-dentist certifying the completion of studies of at least five years' duration, together with information on the duration of the studies (e.g. a diploma supplement). It is not required to legalise diplomas or duplicates and to have an apostille of diplomas or duplicates. If a foreigner does not have the original graduation documents, he/she may present the diploma as an unambiguous copy. Copies may be submitted instead of originals if their conformity with the original has been certified by a Polish notary public or consul or by the party's attorney, a barrister, legal counsel, patent agent or tax advisor appearing in the case. A translation made by a sworn translator must also be included. Within six months after the end of the armed conflict in Ukraine, the original diploma or a notarised copy of the document must be provided;
- a statement to the following effect: „Aware of the criminal responsibility for making a false statement, I declare that I have the full legal capacity”⁵;
- a document issued by a doctor certifying that their state of health allows them to practise the profession of doctor or dentist. This document can be issued by a Polish doctor as well as by a doctor from another country⁶;
- a statement of the following content: „Aware of the criminal liability for making a false statement, I declare that I have not been convicted of an intentional crime or an intentional fiscal crime and that no criminal proceedings are pending against me for a deliberate crime or a fiscal crime, and that there are no circumstances which, according to the Code of Medical Ethics and other provisions of law, could affect the practice of the profession of doctor or dentist in the territory of the Republic of Poland”⁷;
- a document attesting to „clean professional conduct” and compliance with the requirements concerning ethical behaviour, issued by a competent authority in the country in which the doctor or dentist practiced;
- a document with a photograph proving citizenship (passport, identity card) and a document confirming the date of crossing the border with Poland;
- a hand-signed application.

The legislator has also distinguished between three groups of doctors and dentists who can apply for a conditional licence to practise (Table 3).

⁵ The declaration should contain the declaration's name, place, and date and a legible signature.

⁶ The decision is valid for three months from the date of issue.

⁷ The declaration should also contain the surname and first name, the place and date of the declaration and the legible signature.

Table 3.*Groups of doctors and dentists eligible to apply for a conditional licence to practise*

Group	Description
Persons who do not hold a specialist diploma issued outside the European Union	<ul style="list-style-type: none"> • attaching a doctor's/dentist's diploma attesting to the completion of at least five years of study, together with information on the duration of study
Persons who obtained their specialist title outside the European Union	<ul style="list-style-type: none"> • to enclose a medical/dental diploma attesting to the completion of at least five years of study, together with information on the duration of the studies, • to be accompanied by a document attesting to the title of specialist issued by the competent authority in the country concerned
Persons who have obtained their specialist title outside the European Union and have at least three years' professional experience as a specialist	<ul style="list-style-type: none"> • to enclose a medical/dental diploma attesting to the completion of at least five years of study, together with information on the duration of the studies, • to be accompanied by a document issued by a competent authority in the country in which the profession was practised or other documentary evidence of periods of employment (e.g. certificates of employment) attesting to possession of at least three years' professional experience as a specialised doctor or specialised dental practitioner in the field concerned during the five years immediately prior to the date on which the certificate was obtained, • to be accompanied by a document issued by the competent authority (specialisation training programme), certifying that the specialisation training followed corresponds in essential respects to the specialisation training programme in Poland, • attaching a certificate from an entity conducting medical activity in Poland containing a declaration specifying the list of organisational units of the medical institution and the period of planned employment, indicating the scope of health services to be provided in accordance with the foreigner's specialisation

Source: (Medidesk).

The Department of Medical Staff Development of the Ministry of Health reviews the submitted documents. In the case of applying for a conditional right to practice by doctors who have obtained the title of specialist and have at least three years of professional experience as specialists, the Minister of Health may request an additional opinion⁸. If there are deficiencies, the applicant is called upon to complete them. Depending on the number of applications submitted, the applicable procedure takes up to six months (NIL, 2022). Unfortunately, this is due to the many formal deficiencies and identified errors. Based on the documents attached to the application, the Minister of Health gives the consent or refuses to provide the applicant consent to practise the profession of doctor and dentist in a medical entity. The consent is issued in the form of an administrative decision, which is given the so-called order of immediate enforceability.

⁸ The Minister of Health shall then apply to the national consultant competent in the relevant field of medicine or, if there is no such consultant, to the national consultant in a related field or the provincial consultant skilled in the appropriate field of medicine or in a related field, in the area of the province where such person intends to practise his profession.

6. Conditional licence to practise

The next step after receiving a favourable decision from the Minister of Health is to present the complete set of documents together with the administrative decision to the district medical council depending on the place of residence⁹. The district medical board shall grant a conditional right to practice the profession and issue a document on the right to practice the profession of doctor or the right to practice the profession of dentist within seven days of receiving the decision of the Minister of Health. Suppose the district medical board has refused to issue a conditional right to practice the profession or the time limit for its granting has expired ineffectively. In that case, a foreigner may practice the profession based on the decision of the Minister of Health until a resolution of the district medical board in this regard is received. In a situation where the district medical board refuses to grant a conditional right to practice the profession, a foreigner may continue to practice the profession based on the decision of the Minister of Health, provided that an appeal is made to the Supreme Medical Council within 14 days of the delivery of the district medical board's resolution containing the refusal to grant a conditional right to practice the profession (Figure 2).

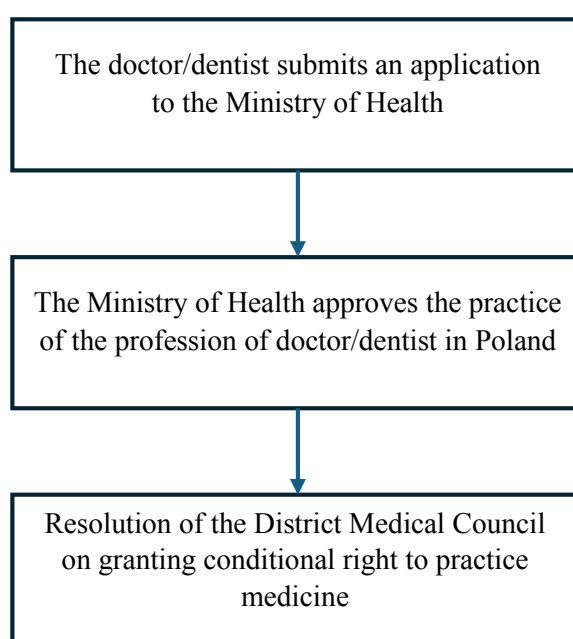


Figure 1. Pathway to obtaining a conditional licence to practise.

Source: own study.

Supreme Medical Council may uphold a resolution on refusal to grant a conditional right to practice the profession. The practice of the profession based on the decision of the Minister of Health may continue if, within 30 days from the date of delivery of the resolution of the Supreme Medical Council, a complaint against the resolution is filed with the locally competent provincial administrative court (Ministerstwo Zdrowia, 2020; 2022b).

⁹ The same documents that were addressed to the Ministry of Health are submitted (2 copies).

7. Employment of a doctor in a healthcare provider

Doctors with a conditional licence to practise may practise in any medical entity in Poland. After signing the employment contract, you must notify the Minister of Health within seven days where and for what period you are employed. The notification is made in person using the Doctor Registration System. Failure to notify may be grounds for Withdrawal of permission to practise as a doctor and dentist, respectively¹⁰. The right to practise a profession granted under the discussed rules remains valid for five years from the date of its issuance and cannot be renewed (Ministerstwo Zdrowia, 2020).

Depending on the authorisations granted by the Minister of Health, work in a treatment facility may take place under the supervision of a doctor:

- for doctors and dentists who do not hold a specialist diploma issued outside the European Union: a supervisor who is a doctor having a second degree specialisation or a specialist title;
- for doctors and dentists who have obtained their specialist title outside the European Union, with the permission of the Minister of Health, to practise the profession of doctor and dentist independently after three months of work („practice”) under the supervision of a doctor holding a second degree specialisation or specialist title;
- for doctors and dentists who have obtained their specialist title outside the European Union and have at least three years' professional experience as a specialist: authorisation by the Minister of Health to work in the medical entity indicated in the decision, where they will work for one year under the supervision of a supervisor who is a doctor holding a second-degree specialisation or a specialist title in the relevant field of medicine, designated by the head of the entity that issued the certificate to the Minister of Health.

It is worth noting that the Ministry of Health does not require foreign doctors to have a document confirming their knowledge of the Polish language (NIL, 2024). Doctors only submit a declaration of their understanding of the Polish language. The first verification of such language proficiency often can only occur at the district medical council. The applicant's knowledge of the language can be verified during the submission of the Minister of Health's decision. The next place is when the required documents are submitted to the treatment facility. During the interview, the applicant's language proficiency can be assessed¹¹. In response to these needs, the district medical chambers organise Polish language courses for doctors from Ukraine (Ojczyk, 2022) and Ukrainian language courses for Polish medical staff. Due to the high interest in this kind of project, the Medical Centre for Postgraduate Education has prepared an intensive Polish language course and a glossary of Polish-Ukrainian medical phrases¹².

¹⁰ Withdrawal of consent shall be by administrative decision issued by the Minister of Health.

¹¹ Often Polish language tests are conducted as part of internal arrangements.

¹² A course on the basics of the health care system in Poland is also available. The training is in the form of e-learning in Polish with Ukrainian subtitles and a script in Ukrainian available.

8. Discussion of the results obtained

Managing the quality of healthcare services is an interdisciplinary issue that concerns the application of current knowledge and applicable standards and meeting patient requirements and expectations (Głód, Głód, 2017). Quality in healthcare is perceived differently by different stakeholder groups. It is perceived differently by patients, health system employees, insurers or government institutions. Representatives of each stakeholder group will define their expectations differently. The following basic categories defining the quality of a healthcare service can be distinguished (Czerw et al., 2012):

- the quality of the structure: the level of education of the medical staff, the equipment of the medical facilities, the organisational structure, the management style and the organizational culture,
- process quality: patient care, course of treatment,
- quality of outcome: includes morbidity, mortality, and patient satisfaction with the treatment process.

Several factors determine the analysis of the quality of medical services provided by Ukrainian doctors:

- the level and quality of education,
- experience and specialisation,
- knowledge of the Polish language,
- compliance with the principles of professional ethics,
- knowledge of the legal basis governing the medical profession,
- ability to communicate with the patient.

The determinants mentioned above influence the perception of the quality of medical care the analysed group of doctors provides. It should be noted that the most important of these is knowledge of the Polish language. The Ministry of Health, in the requirements for the entry of doctors from Ukraine into the market of medical services, did not include a procedure for verifying the knowledge of the Polish language in a form other than the doctor's declaration. This implementation was met with many protests from representatives of the medical community and the Ministry of Health's challenge to the Supreme Court of the resolution of the Supreme Medical Chamber regarding the requirement for doctors from Ukraine to confirm their knowledge of the Polish language (Sąd Najwyższy, 2021).

The provision of health services without a conditional right to practice also threatens the safety of all participants in the health care system. A doctor without a conditional right to practice is invisible to the Supreme Medical Chambers. It implies an inability to complain about the doctors' services and verify their work, which directly threatens the health system's safety.

Based on the results obtained, the first facilitation of the so-called conditional right to practise medicine was introduced during the COVID-19 pandemic in 2020. The solution implemented concerned citizens of third countries of the European Union. Given the existing legislation, interested persons could apply for a conditional right to practice medicine in Poland. However, as discussed, the situation changed when the war in Ukraine escalated in February 2022. The provisions on the employment of foreign nationals were narrowed down to citizens of that country and applied to persons who found themselves in Poland due to hostilities. The procedures adopted for granting a conditional right to practice were dictated by the significant differences in the training systems for future doctors in Poland and Ukraine.

The problems of the article concern the relations created between such groups of stakeholders in the national health care system as the Ministry of Health, the doctors' professional self-government and doctors from Ukraine. The last distinguished group can start operating in the healthcare system based on granting a conditional right to practice the profession. The analysis made it possible to distinguish the implemented solutions in the system under study, which were aimed at confronting conditions of exogenous stimulants (COVID-19 pandemic, full-scale invasion of Ukraine by Russia). However, it should be recalled that there has been a significant shortage of medical staff in the Polish healthcare system for a long time.

Data published by the Supreme Medical Chamber indicate that doctors from Ukraine constitute the most numerous foreigners who have been granted a conditional right to practice medicine in Poland. Consequently, they form a group of stakeholders whose provision of work in medical entities is supervised according to their qualifications:

- doctor with a specialist title – three months,
- doctor with a specialist title and three years' experience as a specialist – one year,
- non-specialist doctor – practising under supervision during the entire period of employment.

However, in the opinion of the representatives of medical circles, the solutions introduced by the Ministry of Health constitute an example of a violation of the principles of medical self-government, as well as may be treated in terms of deregulation of the profession. Misunderstanding of the regulations, including the often observed deliberate action of doctors with a conditional right to practice the profession, leads to undermining their rights. The most common is the unjustified use of the specialist title, including such information on business cards and stamps, consequently misleading patients. A significant problem is also the employment of a doctor outside the place covered by the consent of the Minister of Health, the resolution of the district medical council, and the failure to notify this fact by the legal order in force. In such situations, submitting an appropriate notification to the public prosecutor's office is justified.

In addition, there are cases of setting up a business whose name indicates a registered medical practice. Notably, a person with a conditional right to practice must start something other than this type of business. Cases of violations in this area are dealt with by the district

professional liability ombudsmen of the chambers of medicine (Medexpress, 2023). Notably, the health care system in Poland has also included doctors who have yet to apply for a conditional licence to practice. In most cases, these are dentists employed in the beauty industry. Most often, their representatives promote their activities on social media and use the professional title of doctor to provide invasive procedures using preparations of unknown origin. In their biographies, these individuals refer to the fact that they graduated from medical school in Ukraine, obtained specialisation and took courses (Wyborcza, 2022). It should be noted that in most cases, verifying a person and his or her qualifications in the Central Register of Doctors is impossible. Often, this is due to an incorrect transcription of the first and last name, which is inconsistent with the transliteration of Ukrainian names.

It is worth emphasising that the problems outlined above only exhaust some of the issues that illustrate examples of practices occurring in providing medical services by persons with or without a conditional right to practice medicine in Poland. However, they exemplify essential issues that require implementing systemic solutions that put the good of the patient first and create transparent relations between different stakeholders in the healthcare system in Poland.

9. Conclusions

The implementation of health objectives is the foundation of the healthcare system in Poland. Doctors constitute a particular group of stakeholders in the analyzed system, as their availability determines, among other things, the safety and quality of medical services provided. The outbreak of the COVID-19 pandemic exposed staff shortages in healthcare institutions in Poland. However, the decisions taken by the Ministry of Health to ensure the sanitary and medical safety of citizens were only sometimes accurate. A quick response to attracting medical staff was to prepare a "fast track" entry into the Polish health care system for citizens of so-called third countries. As a result of the introduced solutions, the citizens of Ukraine benefited the most.

In summary, there are significant differences in the training systems for doctors in Poland and Ukraine. These differences are mainly related to the pathway allowing for specialised internship, which includes several stages allowing for the receipt of the right to practice and specialisation training by doctors in the national system. The Ministry of Health's decision caused concern in Poland's medical community. This implementation was due to the need for more cooperation between government administration bodies and medical community representatives in preparing procedures for granting conditional rights to practice the profession. The implemented solutions have the characteristics of a „shortcut”. This approach threatens the health care system in Poland, including the safety of patients and doctors with conditional right to practice the profession.

Management of the health care system in Poland is the responsibility of the Ministry of Health. Still, the role of the medical professional self-government must be considered in this process. In solving systemic problems, dialogue with medical community representatives contributes to implementing transparent solutions in business practice. Based on the considerations, the authors show that the current challenges of the national healthcare system concern doctors from Ukraine. In the professional environment of doctors, ideas are presented about a compulsory adaptation internship with the possibility of learning the Polish language and within the scope allowing to work in an appropriate position along with familiarisation with Polish regulations (in the area of patient rights, doctor's duties and legal responsibility related to the profession). The article's topic is the socio-professional adaptation of medical staff. This topic will contribute to further research on the employment of doctors from Ukraine in Poland.

It is also necessary to look into the functioning of several intermediary entities for obtaining a conditional right to practice in Poland. The highlighted aspects indicate further research areas that should be extensively analysed (OIL in Warsaw, 2022).

The considerations presented here are a contribution to further research. As a limitation, one should point out the lack of scientific sources in which the issues covered by the analysis were discussed. Consequently, this article aimed to fill the research gap and outline selected issues related to integrating doctors from Ukraine into the Polish health care system.

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THE IMPACT OF SHARED SERVICE CENTRES ON THE FINANCIAL POSITION OF COMPANIES IN A TURBULENT ENVIRONMENT

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Purpose: The aim of this article is to identify and evaluate the economic benefits for companies that result from the provision of business services provided by a Shared Service Centre.

Design/methodology/approach: The study used primary and secondary data. Data were obtained using, among others: descriptive analysis, content analysis, diagnostic survey, cause-effect analysis and qualitative analysis. The study, in the form of in-depth interviews, was conducted in 2021-2022. It was attended by experts with many years of professional experience in managerial and managerial positions.

Findings: In the search for new opportunities to improve the efficiency of enterprises, a conceptual framework for an enterprise business model was developed, taking into account Shared Service Centre services. In a turbulent environment, Shared Service Centre services are becoming valuable competitive instruments, especially in terms of their ability to influence a company's financial situation, as confirmed by the experts participating in the study.

Research limitations/implications: The article does not undertake a quantitative assessment of the impact of the services provided by Shared Service Centers on the financial situation of the enterprises covered by the study. Due to the confidentiality of the data, the experts participating in the study did not consent to their disclosure. The results of these analyzes encourage further, extended research in this area, including entities publishing financial data.

Practical implications: The essence of the services provided by the Shared Service Centre means that they have a significant role to play in the management of the company. Indeed, all categories of Shared Service Centre services are fundamentally oriented towards a greater degree of coordination and flexibility of activities and the reduction of associated costs.

Originality/value: The proposed enterprise business model can contribute to the improvement of decision-making tools for cooperation with the Shared Service Centre, in an effort to improve the financial situation of enterprises. This need is triggered by constant cost competition, which prompts companies to create an efficient value chain to build competitive advantage and grow.

Keywords: Shared Service Centre, business efficiency, business model, financial situation of the company.

Category of the paper: research paper.

1. Introduction

The dynamics of the environment, the ongoing processes of consolidation and globalisation require continuous improvement of the methods of building competitive advantages of enterprises operating on the open market. They are expressed in changes in the business models of enterprises, resulting from the implementation of the concept of building these advantages (Sharma et al., 2020). Indeed, business models are viewed in the literature through the prism of ensuring a firm's profitability, which is determined by the combined impact of sectoral and firm-specific factors (Ali et al., 2022). In doing so, the category of profitability is viewed from the revenue side as well as from the cost side (Brzóska, 2015).

According to Afuaha (2004), the business model is supposed to create revenue and is therefore a function of, among other things, the company's market position, the resources it has and the activities it undertakes, conditioning the efficiency of their use. This researcher clearly points to cost as an important element of the business model and consequently profitability. In his view, doing business always generates costs and this regardless of the strategy adopted by the enterprise. Similar to Afuaha's views in their approach to the business model are represented by Thomson and Strickland (2003), believing that it treats the economic effects of the strategy pursued. As a configuration of the strategy in terms of revenue and profit sources, the business model of a company is treated by Grant (2005).

The importance of the value chain in shaping the business model is emphasised by Obłój. This is because he links the concept of this chain with the operational side of the company's activities, on which the effectiveness of the company's operation and the renewal of its resources and skills depend (Obłój, 2002; 2007). The researcher states that the value chain is one of the key elements of the business model on which the creation of customer value is based, as the activities carried out determine the success of the enterprise. Therefore, the optimal interconnection of these activities within a company should lead not only to profit generation but also to competitive advantage (Rojek, 2014; Raj et al., 2022).

In recent years, an increasingly prominent and thus widespread direction for improving value chains and business models of enterprises is the use of Shared Service Centres (SSCs), which are entrusted with the provision of modern business services (Aksin, Masini 2008; Herbert, Seal, 2012). These services are therefore the main instrument for shaping the relationship between the SSCs and the enterprise in the context of achieving its objectives.

Modern business services are mainly concerned with support processes, but also with core processes, thus influencing them significantly. Enterprises, mainly multinational corporations, operating in multiple locations, aiming to improve the efficiency of these processes, mainly by reducing the costs of their constituent activities, strive to eliminate the duplication of activities by employees of dispersed units and provide them from one central location (Richter, Brühl, 2021). Therefore, modern business services are concerned with repetitive activities, performed

with high frequency in different locations of the same enterprise, which, despite their repetitiveness, do not proceed in an identical manner, which determines their varying efficiency (Ciolek, 2018).

Regardless of the specifics and immanent features of each service, the very fact of entrusting them to SSCs makes almost automatically a 'space' for the provision of services of a universal nature. The set of such services includes, above all, the coordination, consolidation and standardisation of processes and procedures, which consequently promotes their consistency within the corporation (Modrzynski, 2018). The provision of services 'from a single location' furthermore creates favourable conditions for the identification and elimination of inefficient activities and processes and the development of new procedures that are already uniform from the corporation's point of view, which promotes more effective and efficient service provision for business processes (Gnusowski, 2018).

The aim of the study, the results of which are presented in this article, is to identify and assess the economic benefits for companies that result from the provision of business services provided by SSCs. According to the thesis, the increasing uncertainty and volatility of the environment have a significant impact on taking action to improve efficiency and strengthen the competitiveness of enterprises, which encourages the creation of new business models.

2. Material and methods

In pursuit of the aim of the study and to confirm the thesis, primary and secondary data were used. Data were obtained using selected research methods and techniques. Descriptive analysis was used to define the subject of the study and to identify within it the basic relationships within new business models. A desk research analysis was useful to systematise the existing scientific output and state of knowledge on the essence of modern business services from the perspective of business efficiency. The literature review was carried out according to the classical approach, i.e.: selection of sources, keyword search, review and selection of articles, in-depth analysis of selected publications in relation to the subject of the study. It made it possible to identify a general knowledge gap on improving business models in a dynamic environment from the perspective of improving the efficiency and competitiveness of enterprises through appropriately targeted SSC services.

Using analysis and logical construction, a conceptual framework for an enterprise business model including SSC services was developed. With the expectation that it can contribute to improving the efficiency of enterprises and strengthening their competitiveness, an empirical study was conducted. The empirical study used methods and techniques including: diagnostic survey, cause-effect analysis and qualitative analysis. They made it possible to identify the main directions for improving the efficiency of enterprises within the framework of SSC activities

and to determine the degree of significance of the impact of these services on the financial situation of the enterprise in the opinion of the surveyed group of experts.

The research procedure consisted of two stages. In the first stage of the study, the authors, on the basis of literature studies and their own research and professional experience, determined the directions of the impact of SSC services on meeting the needs of the enterprise as well as the customer. In the second stage, the experts participating in the study assessed the impact of SSC services on the parameters of the company's financial situation. The survey was conducted between 2021 and 2022, with 123 experts participating. The selection of the research sample was purposive. The invitation was addressed to experts with many years of professional experience in managerial and executive positions.

3. Results

In the face of contemporary market conditions and increasing competition, companies are obliged to continuously strengthen the efficiency of their operations, improve internal processes in the face of threats and opportunities from the environment and eliminate disadvantages (Singh et al., 2019). The primary strategic management instrument for strengthening this efficiency is the enterprise business model, which contains a certain set of elements and relationships between them that provides the overall framework for doing business (Figure 1). It therefore reflects the ways in which appropriate economic performance, as expressed by the relationships of revenue, costs and profit across the enterprise, can be achieved (Gołębiowski et al., 2008).

The business model can be used as a tool to promote, as a result of optimisation, changes in the enterprise and to adapt the optimisation mechanism to the current market situation. Numerous studies in the field of entrepreneurship have shown that a company cannot succeed without having, creating and applying a good business model (Walaszczyk et al., 2018). Many definitions of a business model can be found in the literature. Among others, it seems that Ott and Schiemann, Afuah and Tucci have formulated definitions that most expose the causal dependencies of the model, thus confirming its suitability for analysing the directions for increasing business efficiency through the use of SSC services (Ott, Schiemann, 2000). According to the researchers, a business model is a method of skilfully combining a company's vision and plan, leading to the realisation of its strategic/complex goals and the implementation of the planned concept of action with its feasibility.

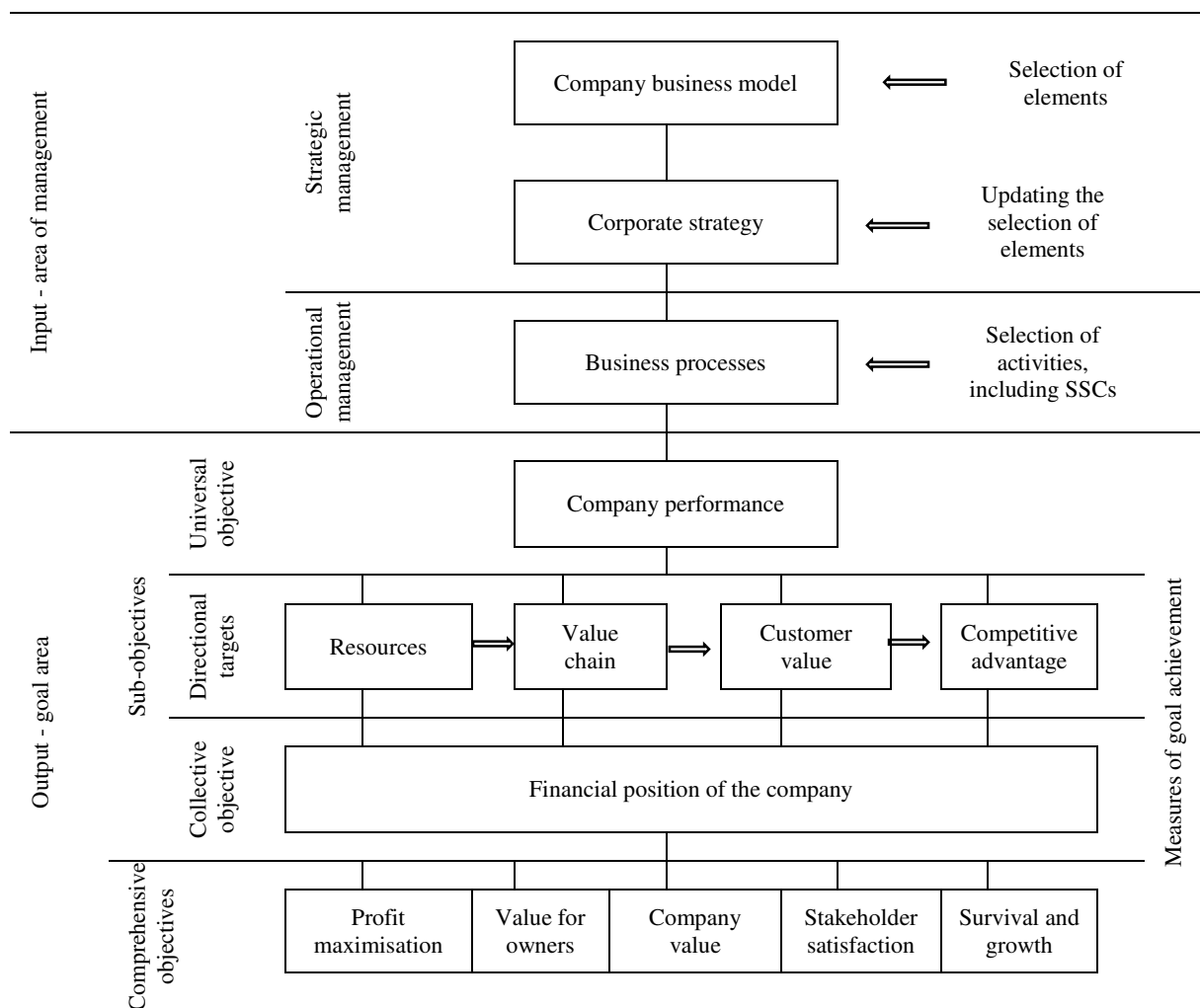


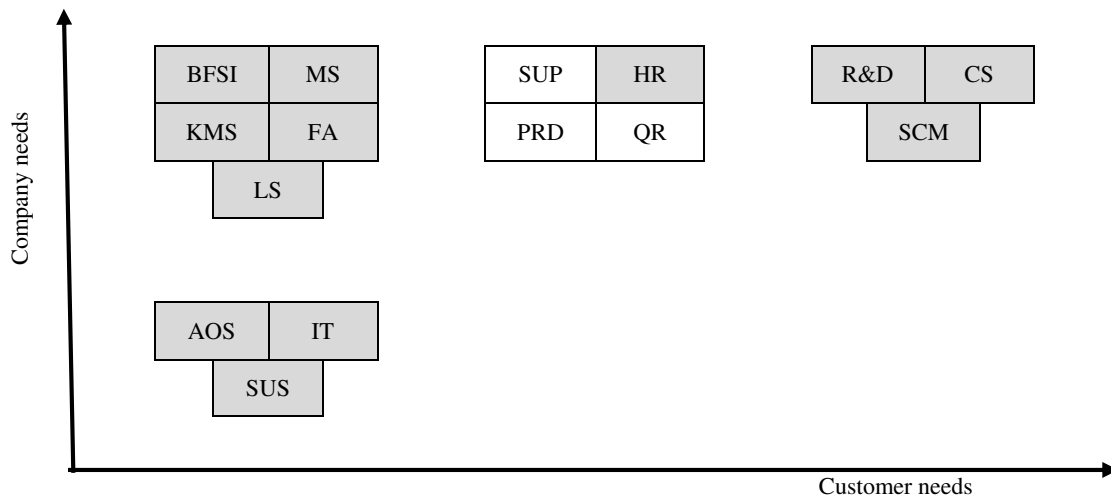
Figure 1. Complex Business model of a company including SSC services.

Source: own compilation based on literature analysis.

Critical to the success of a business model is the selection of elements that, when integrated together, allow value to be created and delivered (Johnson, 2008). In view of the generally static nature of the business model, representing a picture of the enterprise at a chosen moment (Doligalski, 2014), the updating of this selection is done at the stage of strategy formulation, expressing the way it acts and behaves (often very flexible) in the face of changing conditions of the environment and its interior (Nogalski, 2009). In these conditions, the business model, which is in line with the view of, among others, Falencikowski and Banaszyk, constitutes the support and starting point for the enterprise's strategy, which describes the dynamics of the business, i.e. its ongoing conduct and implementation (Wiśniewski, Raczyńska, 2019). Consequently, actions are defined, shaping the ongoing operations and business processes of the enterprise, which marks the transition from strategic management to operational management (Figure 1).

One of the currently important instruments for the operational management of companies is the use of SSCs. Indeed, the fundamental motive for setting up SSCs is linked to the pursuit of savings in overhead costs, mostly through resource arbitrage and economies of scale (Gilal et al., 2022). By providing a more efficient and qualitatively better service to the company and its customers, SSCs also support them directly and indirectly in the pursuit of sales revenue growth. The services are therefore geared towards both satisfying the needs of the enterprise (i.e. the internal customer) and the business customer (i.e. the external customer), which positively influences the efficiency of the enterprise's processes (Richter, 2021).

The predominant cost or revenue direction of the impact of SSC services on the efficiency of the enterprise makes it possible to distinguish four conventional groups of them (Figure 2). It can be thought that from the point of view of satisfying the needs of the enterprise, the most relevant services and processes are MS, FA, BFSI, KMS and LS (the first group of services), SUP, PRD, HR, QR (the second group of services and processes) and R&D, CS and SCM (the third group of services), with the increasing importance of each successive group of services for ensuring customer satisfaction. The distinctly technical and orderly nature of AOS, IT and SUS services (the fourth group of services) makes them somewhat less important for meeting the needs of the company, while being neutral from the point of view of ensuring customer satisfaction. SSC services are mostly concerned with auxiliary processes taking place in the enterprise (services included in groups one, two and four), but also with core processes (group three services).



Symbols: **MS** - marketing services, **SUP** - material and technical procurement, production preparation, **PRD** - production, **CS** - customer service, **SCM** - logistics, forwarding, transport, **FA** - finance, accounting, **BFSI** - liquidity management services, **LS** - legal services, **AOS** - administrative and organisational services, **R&D** - research and development, **KMS** - knowledge management, **IT** - IT services, **HR** - human resources management, **QR** - resource quality control **SUS** - universal services; grey - services offered by the SSC.

Figure 2. The role of SSC services in the operational management of a company.

Source: own elaboration based on (Grajewski, 2016).

The actions taken in the area of management, both strategic and operational, mainly related to the creation of the business model and the day-to-day configuration of its elements, are directed towards the achievement by the enterprise of efficiency at an overall level, embodying its capacity to achieve its objectives. This multidimensional capability "spills over" from this level into the already targeted sub-capabilities that determine the potential and degree of achievement of these objectives. The sub-capabilities must therefore be linked to the individual categories of economic efficiency or organisational effectiveness, demonstrating its multidimensional nature (Borman, Janssen, 2013). Under these conditions, the achievement of an appropriate level of efficiency by a company can be seen as the realisation of a kind of universal sub-goal, which can ensure the realisation of other, already targeted, sub-goals and an aggregate sub-goal, which presupposes the attainment of certain values of the parameters of the financial situation, forming the basis for the realisation of comprehensive goals.

The realisation of the directional sub-objectives implies the correct identification of resources and their effective use as a result of the apt configuration of the value chain, which in turn creates, to a large extent, value for the customer, which is the main determinant of the company's competitive advantage. Obtaining this advantage, as a result of the effective use of competitive potential, enables the enterprise to generate an attractive market offer (Bigelow, Barney, 2020), which is an important tool for shaping the financial situation in the desired direction. The relevance of competitive advantage for the possibility of shaping this situation also stems from the fact that it is, along with competitive potential, competitive instruments and competitive position, an important determinant of a company's competitiveness, signifying the ability to adapt to change (McKinsey, 2020).

In these conditions, SSC services become valuable instruments of competition, especially in the context of their ability to influence the financial situation of a company, in particular its profitability, liquidity, the length of current receivables and inventory turnover cycles, the volume of sales revenue and the quality of current receivables, as confirmed by the experts participating in the study. Based on the results of the study, the relationships between these services and the aforementioned parameters of the company's financial situation can be summarised as presented in Table 1.

The analysis of the data obtained during the interviews with experts and the authors' professional experience shows that the most intensive and at the same time comprehensive SSC services, from the point of view of their favourable impact on the financial situation of the enterprise (horizontal analysis of Table 1), are FA, CS, SCM, BFSI services. In fact, their intensity was assigned 10, 9, 9 and 8 units respectively, which are distributed practically across all key parameters of this situation. Only the relationship between BFSI services and 'quality of current receivables' was identified as 'weak'. In addition, relatively many of the relationships between the aforementioned services and these parameters are of a "very intensive" nature. This is, for example, the nature of the relationship between FA services and liquidity, receivables turnover cycle, inventory turnover cycle and quality of

current receivables, as well as between SCM services and profitability, inventory turnover cycle and sales revenue volume.

Table 1.

Essential directions of the impact of SSC services on the financial position of a company

No.	Services provided by SSC	Profitability	Liquidity	Receivables turnover cycle	Stock turnover cycle	Sales volume	Quality of current receivables	Total
1.	IT	X		X	X	X	X	5/0
2.	R&D	X				X		2/0
3.	KMS	X				X		2/0
4.	LS	X	X	X		X	XX	6/1
5.	MS	XX	X			XX		5/2
6.	FA	X	XX	XX	XX	X	XX	10/4
7.	BFSI	X	XX	XX	XX	X		8/3
8.	CS	XX	X	X	X	XX	X	8/2
9.	AOS	X						1/0
10.	HR	X	X	X	X	X	X	6/0
11.	SCM	XX	X	X	XX	XX	X	9/3
TOTAL		14	9	9	9	13	8	x

Symbols: blank - insignificant/weak dependence, X - intensive dependence, XX - very intensive dependence.

Source: own elaboration based on survey results.

The most sensitive parameter of a company's financial situation in relation to SSC services is profitability (vertical analysis of Table 1). This is because it is the "recipient" of 14 units of their intensity, with a "very intensive" favourable impact on it from MS, CS and SCM services. The recipient of 13 units of intensity of SSC services is sales volume, which experiences a 'very intense' beneficial impact from MS, CS and SCM services. To a lesser extent, the other parameters of the company's financial situation considered in Table 1 are sensitive to SSC services. Their sensitivity is about 30-40% lower, although, for example, the correlations between the inventory turnover cycle and FA, BFSI and SCM services are "very intensive".

4. Discussion and conclusions

The construction of an enterprise business model (Figure 1), treating SSC services as an element of improving enterprise efficiency and achieving enterprise objectives, is supported by the literature. The direct relationship between the business model and the economic efficiency of the enterprise follows directly from the definition of the model by Afuaha and Tucci (2003). In their view, the business model can be regarded as one of the two (besides the environment) direct factors affecting the economic efficiency of a company. These researchers, along with Ehiraj, Guler and Singh (2000), particularly emphasise the idea of an economic efficiency model, whose main objective is to achieve current and long-term profitability. The essence of the economic efficiency of the enterprise, expressed in the form of the ratio of

benefits to costs incurred, as an effect of the application of the business model, is also clearly emphasised by Gołębiowski, Dudzik, Lewandowska and Witek-Hajduk, which is expressed, for example, by models of the traditionalist, contractor and distributor types (Iwasieczko, 2014). The aspect of ensuring efficiency through the business model is also recognised by Grant (Brzóska, 2015).

There is a clear theme in the literature emphasising the universal nature of efficiency, especially economic efficiency, treated as the potential of a company to achieve its different categories of objectives, ranging from directional sub-objectives, through the collective objective, to comprehensive objectives (Figure 1). Druker (2017) explicitly states that efficiency determines the degree of 'mastery of the goal'. His indication that the implementation of ancillary (non-production) processes in a company typically consumes 80-90% of costs, further highlights the importance of SSC services in shaping this efficiency (Drucker, 2016). Samuelson and Marks (2009) note that economic efficiency is the best (possible) use of a company's resources.

The set of directional sub-goals corresponds to the elements of the business model including SSC services (Figure 1). In order for the enterprise to achieve the collective goal and the comprehensive objectives, the selection of these elements at the management stage should ensure that the business model is not only organisationally efficient, but also economically efficient, which can be considered in the category of goal achievement. This is because the identification of resources and the apt configuration of the value chain is intended to lead to the generation of a value proposition for the customer and the attainment of a competitive advantage, which implies the shaping of the elements of the business model which, because of their clear causal relationship, can determine the success of the enterprise.

A business model incorporating SSC services is often seen, by both theoreticians and practitioners, as a source of competitive advantage. This is because its sustainability translates positively into the financial performance of the company (Kolodziejczuk, 2015). The sources of competitive advantage, providing an opportunity to increase the value of the enterprise and its other comprehensive goals, are mainly sought in resources, competences, the configuration of the value chain and the generated value in use for the customer. Particularly important in this regard are those core competencies, which include the ability to exploit the potential inherent in the knowledge at the disposal of both employees and managers, which becomes a strategic resource for generating value for customers (Yang et al., 2021).

Among the key competences, skills in the sphere of business management play a special role. The essence of SSC services means that they have a significant role to play in shaping this sphere (Richter, Brühl, 2017). Appropriately shaped relationships between the different links in a company's organisational structure provide benefits to the company, e.g. in the form of access to resources for greater operational flexibility, reduced operational and transaction costs, better coordination of activities or increased innovation. All categories of SSC services are essentially oriented towards a greater degree of coordination and flexibility of activities and the reduction

of associated costs. In addition, IT, HR and AOS and R&D and KMS services can be identified as particularly useful for access to resources and increased innovation.

The concepts of value chain management encountered in the literature take into account SSC services, although they are treated as a form of outsourcing, implemented using internal resources. This is because these services allow the elimination of processes that are insignificant to the core business operation and the streamlining of relationships between them, contributing to the improvement of its existing value chain (Stoner et al., 2011). The result is a simplified and more agile organisational system, enabling the building of competitive advantage (Mao, Yang, 2023). This is because its implementation means that the enterprise concentrates on its core competencies within the value chain, while delegating the implementation of its other elements to other entities whose activities are coordinated. This is because each enterprise endeavours to generate a product that has the highest utility value for the customer, which makes it possible to win the competitive battle. For an enterprise, the most important financial dimension of the customer value generated is profitability, the level of which is significantly influenced by the resources it possesses and how they are used in the configured value chains. The favourable picture of the financial situation of enterprises created on the basis of the conclusions of the study confirms the relevance of SSC in the quest to improve the efficiency and competitive advantage of enterprises in a turbulent environment.

This paper does not undertake a quantitative assessment of the impact of SSC services on the financial position of the companies surveyed. A prerequisite for the successful completion of such a task is the availability of a comprehensive and accurate dataset. Due to the confidentiality of the data, the experts participating in the study did not consent to their release. The results of the present analyses call for further extended research in this area, taking into account those publishing financial data.

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STANDARDS IN THE IT INDUSTRY – THE DEVELOPERS' PERSPECTIVE

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Purpose: The aim of this article was to present the typology of information technology standards and to explore their importance for programmers.

Design/methodology/approach: The research was exploratory in nature, and based on grounded theory and ethnography. The tool used to collect data were interviews.

Findings: On the basis of the research it is concluded that standards were of utmost importance to the respondents, and were a thing that allowed them to work efficiently.

Research limitations/implications: The conducted research was qualitative and inductive. For this reason, there is limited possibility of making generalizations about the results.

Originality/value: The paper presents important findings that might increase the work efficiency of programmers. Additionally the research was conducted using a relatively uncommon approach in IT and management field (grounded theory, ethnography, qualitative methods, interviews).

Keywords: standards, vendor lock-in, IT, software development.

Category of the paper: Research paper.

1. Introduction

Modern computer science owes its development to a number of elements. The concept of the modern computer was created by Turing and was expressed in a theoretical construct called the Turing machine (van Leeuwen, Wiedermann, 2001), whose task was to process strings of the digits 0 and 1. In turn, the architecture commonly used today dates from the 1940s and is the work of von Neumann (1993), who is known more widely in management as one of the founders of game theory.

In terms of hardware advancement, when viewed from a historical perspective, the significant milestones included the invention of the transistor in 1947, as well as Intel's introduction of the first microprocessor (model 4004) in 1971, which hit the broad market. It is noteworthy that Intel did not perceive the microprocessor as a significant product during its development efforts, and instead focused its resources primarily on the development of the

memory (Aspray, 1997). However, it was thanks to these inventions – in a relatively short period of time – that computers, from calculating machines occupying entire rooms, became devices that could fit on a desk.

In the software dimension, such developments can be cited in abundance. From the creation of the FORTRAN programming language, to the COBOL programming language (which was a language that was less "mathematized" and more geared toward business applications), to the start of work at Bell Labs on the Unix operating system in 1969. On the other hand, it could also be the release of the VisiCalc product in 1979, which was the first spreadsheet for personal computers (Ceruzzi, 2003).

Many factors have influenced what the broader IT market looks like today – from the number of electronic devices in use, to the range of applications, to the number of users. However, there are two among them that share one common characteristic. These were, namely, the openness: on the one hand, of the architecture of the IBM Personal Computer (PC) (IBM, 2006; Vaughan, 2004), and on the other, of the communications standards on which the Internet operates (Davies, Bressan, 2010; Muller, 2005).

This text presents the subject matter of standardization from two distinct perspectives. The first is an attempt to show how standards were born, how they evolved, and what is the current state of standards in information technology. The second, on the other hand, is based on a self-study in which standards are shown from the perspective of the actors whose work depends very much on them – programmers and information system administrators¹.

2. Theoretical background

Consideration of standards is worth starting by looking at them from a historical perspective. The cradle of standardization was the United States of America, and the origins of the work on industry standards can be traced to the activities of engineers working in industrial enterprises since the second half of the 19th century. At that time they formed self-organizing teams, within which certain requirements for specific components, materials or processes, among others, were established by consensus. Previously, standardization was based not so much on any agreements, but simply on the adoption of a given solution. An example is the Morse alphabet, which – although not officially defined as a standard in any way – functioned as a standard *de facto* in telegraphic communications (Russell, 2014).

An important step in formalizing standardization processes was the establishment of private organizations with this profile. These dealt with, among other things, standards for mining (American Institute of Mining Engineers), or electricity (American Institute of Electrical Engineers). Parallel activities in this area were carried out by the federal government – in the 1830s the Office of Weights and Measures was established, and in 1901 National Bureau

of Standards. These organizations, unfortunately, due to the paucity of funding, were for a long time only a façade (Russell, 2014).

3. Standardization in information technology

Attempts to standardize various areas related to computing have been taking place since the very beginning of its existence in the "modern" form, i.e. since the 1940s. An example is IBM's standardization of input/output support in its System/360 series computers, for example. This allowed tape drives or printers to interoperate with multiple models of devices, which greatly simplified the product line and made the offerings more attractive in the eyes of customers (Ceruzzi, 2003).

Research on standards in the IT industry, embedded in the economic sciences, has been carried out since the 1980s, when there was an explosion in their development (David, Greenstein, 1990). In the last 30 years, the approach to standards has been evolving along with the development of this market. Importance is often placed on using – beneficial to end users – open solutions. It is noteworthy that these, among other things, are the foundation of the Internet of Things (Duguid, 2015).

Standards in IT are crucial to the ability to develop any system. The standardization of all their components – hardware as well as software, among others – makes it possible to create universal solutions. This was the case with PCs, which began to dominate the market in the 1980s. The cornerstone here was IBM's decision to also make the PC's technical documentation available with the start of PC production in 1981, so that independent suppliers could create hardware extensions for it, as well as write independent software. In addition, it was decided that key components of the PC would be developed by third-party companies – the processor was provided by Intel, and the developer of the operating system was Microsoft with its Microsoft Disk Operating System (MS-DOS). The open architecture meant that – in addition to them – clones of the IBM computer with better performance began to emerge. Competing vendors began to take advantage of the open specification, resulting in a strong feedback loop: widespread PCs – growing software resources – growing user base. In this way, other vendors emphasized that a given computer admittedly was not made by IBM, but you could run (almost) any program written for the IBM-PC on it (Bradley, 2011).

In 1987, a line of computers called Personal System/2 (PS/2) entered the market, featuring many of the solutions commonly copied by others – including a 3.5-inch disk drive and a new type of keyboard and mouse slots. PC-class clones were based on components of various generations of the IBM PC. The PC has become an open standard *de facto* because of its widespread adoption. The phrase "IBM-PC-compatible" emerged, and the test of whether

a particular PC-clone was IBM PC-compatible was the ability to run the Lotus 1-2-3 spreadsheet and Microsoft Flight Simulator on it (Haigh, 2012).

As noted by Dargan (2005, p. 22-23), it was thanks to such unification, which was put in an institutional framework, that it was possible to develop, among other things, the Linux project (under which the operating system kernel is developed) or the Internet as we know it today.

Linux is an open source software² (OSS) development project founded in 1991, which at one point operated in so many variants that its development came into question. It became necessary to establish an organization called Free Standards Group, which developed a common specification referred to as Linux Standard Base (LSB). In time, the LSB was adopted as the ISO 23360 international standard, and the Free Standards Group itself was merged into the Linux Foundation organization (Updegrove, 2007). In the area of computer networks, on the other hand, the role of a standard-setter was taken on by the organization Internet Engineering Task Force (IETF) (Bradner, 2003).

Standardization in the IT industry is a win-win phenomenon for all actors who operate in this market. Hardware suppliers create components that can be combined with components from other manufacturers. Software developers can write a single "core", and only customize products for specific hardware architectures, or specific components with which that software is to interact. In general, it can be said that standardization for players in this market reduces barriers to entry. Additionally, as a result of it, the potential customer base grows. End users, in turn, have relatively easy access to new technologies as a result, and potentially their degree of digital exclusion is reduced.

4. Characteristics of standards in information technology

Standards in the IT industry can be divided according to numerous criteria. For example, taking into account the subject matter that is subject to the process, one can distinguish those for hardware, software, data or communication protocols, among others. The following section discusses two classifications. The first distinguishes standards by who their creator is; the second divides them by the license under which they are made available.

5. Official and unofficial standards

According to the first division – which runs along the lines of who is the creator – the following basic types of standards can be distinguished:

1. official – created by standardization organizations,
2. unofficial – created by industry consortia.

Standards belonging to the first group are developed and approved by national and international standardization organizations, which operate at several levels. The lowest are national institutions (e.g., the Polish Committee for Standardization, PKN), the higher are regional ones (e.g., *Comité européen de normalisation*), and at the highest level are international bodies (e.g., International Organization for Standardization, ISO).

Approval processes for individual standards are extremely slow in organizations belonging to this group – usually a process that takes several years. In the highly dynamic IT industry, on the other hand, it is important to act quickly in this area. With this in mind, consortia have been formed that create their own standards – belonging to the second group. They are organizations maintained, most often, by membership fees (members are companies, public institutions, academic institutions, but also individuals) operating in a specific market segment. The standards they develop are usually made available to the public and are not subject to intellectual property protection regulations. A primary example of such a consortium can be the World Wide Web Consortium (W3C), which develops Web standards – including such widely used ones as HTML and CSS (Blind, Gauch, 2008).

Another example of this form of operation is the IETF, which has been operating as an independent organization since 1993 (it was previously supported by the United States Government). It is highly formalized. There is no formal membership or fees associated with it, the work is public and anyone can take part in it (IETF, 2021). However, this does not mean that IT companies do not have a say in the solutions that are worked out. As the data shows, in total, the IETF has produced more than 10,000 documents, in which representatives of more than 2600 companies have participated (Arkko, 2021). However, since everyone contributes as an individual who does not have to give an affiliation, it is likely that this number is underestimated.

Many times these consortia have much more influence over the IT standards used than formal organizations. However, this does not mean that one group of entities operates in isolation from the other. For example, the Institute of Electrical and Electronics Engineers (IEEE) – a consortium dedicated to, among other things, setting IT standards – collaborates with the American National Standards Institute (ANSI) (Blind et al., 2010).

6. Proprietary and open standards

The division described below has become particularly evident since the 1990s. It runs along the type of a license under which the standards are made available. In this case, one can distinguish:

1. proprietary standards,
2. open standards.

The distinction between one and the other is not sharp – there are also intermediate states between which a standard can move. Overall, there are four main classes of standards (Cerri & Fuggetta, 2007):

1. proprietary – protected by patents or copyrights, which might be *de facto* standards due to their wide adoption,
 - a) proprietary undisclosed – the documentation is not made public, and use is possible only under a license granted by the owner,
 - b) proprietary disclosed – the documentation is public; use is free or upon payment of a certain fee to the owner,
2. concerted disclosed standards – *de facto* standards whose creators are "closed" associations of organizations; in formulating them, comments submitted during open consultations were used,
3. open standards (concerted) – created by "open" groups of organizations, whose members are companies, academic centers, etc.,
4. open standards (*de jure*) – approved by standardization organizations.

In the IT industry, so-called *de facto* standards are relatively common. They are characterized by the fact that they are solutions that are used because of their widespread adoption – regardless of who the developer is. One of the earliest examples in this group was, created in 1969 in Bell's laboratories, the Unix operating system. Under its control in the 1970s the vast majority of computers in academic and research and development centers operated. Its popularity was due to the fact that it could be run on virtually all hardware configurations in use at the time (West, 2003).

7. Standards in practice – the developers' perspective

8. Research methodology

The research described was a part of a project aimed to study on the reasons for using open source software, which was analyzed through the lens of the diffusion of innovations theory (Rogers, 1962). The study itself was conducted using qualitative methods. Two complementary approaches were used here: grounded theory (Glaser, Strauss, 2009; Konecki, 2000) and ethnography (Kostera, 1996). Derived from grounded theory, coding allowed structuring the collected data and identifying relevant conceptual categories.

The ethnographic approach, in turn, was used in two dimensions. First, as a "tool", thanks to which very rich data on the phenomenon under study was collected. This is because semistructured interviews (so-called anthropological interviews) were used here (Kostera, 2003). On the one hand, this made it possible to collect very rich data. On the other hand, it provided an opportunity to follow new threads that were relevant to the respondents and thus benefit from the so-called serendipity (Konecki, 2004). All but one of the interviews were recorded and transcribed. For the interview that was not recorded, notes were taken. For the purpose of presenting the results of the study, each interviewee was assigned a code, with which the individual quoted statements were marked. These quotes are marked in the text with different formatting.

Secondly, ethnography has been used in an object-oriented sense. The record of the survey is ethnographic, that is, it describes in detail – using what is known as thick description (Geertz, 1973) – the area under study. This description presents the issues under study from the point of view of the subjects themselves.

The study was exploratory in nature. Its purpose was to try to answer the question of what factors influenced the use of free and open source software³ in IT enterprises. One of the important conceptual categories that emerged during the analysis of the collected data was standards, and specifically open standards.

The research was conducted in small IT companies. This made it relatively easy to reach people at all levels of the organizational hierarchy. A total of 13 interviews were conducted with 12 people. The interviews were conducted, according to the grounded theory methodology, until the thematic categories were saturated – that is, until the value of the subsequent interviews from the point of view of informational value began to diminish.

9. Results and discussion

Standards were one of the main categories raised by respondents during their interviews. As the interviewees claimed, standardization allowed to be independent from the vendor (a phenomenon referred to as vendor lock-in). This was true both for companies, which may have had to incur large costs associated with being "attached" to specific solutions, but also for users, who may find themselves in an identical situation. With standards comes the security of maintaining business continuity.

The specific topic that interviewees most often referred to was file formats. A format is a standard-compliant way of storing data. Referring to the classifications described in the section 3, it can be described by indicating the type of its creator. It can also be characterized in terms of openness. It is this property that was mainly raised in the interviews.

[Interviewee 2] When a programmer creates code, he does it internally in the company. These are text files simply. The more text files in circulation the better. (...) Because a text file simply contains human-readable content. Well, and possibly formatting. (...) A text file is a text file. Simply put. The ASCII code is inside, publicly known. Alternatively, if you're delivering some files externally somewhere, well, a PDF is a gold standard. That way, some years from now, there will be access to it. Only the more text files the better.

Statements of this type appeared relatively frequently in the course of the survey. The interviewee here referred to several important issues related to standardization and the working environment. IT companies are usually engaged, at least in part of their business, in software development. Even if hardware is produced, the software layer is also usually an important component of it. Software from the programmer's point of view is source code, i.e. instructions written in one of the programming languages that are human-readable⁴. Source code, in turn, is stored in the form of text files, that is, files whose contents are successive lines composed of characters. They are universal due to the fact that they can be read on virtually any hardware. A text file is also considered to be "the lowest common denominator of data storage formats" (Murrell, 2009).

From the programmers' point of view, text files are considered a kind of gold standard. They are seamless to use – they can be opened and edited on virtually any hardware and using a very wide range of editors. In addition, working with them means a relatively high degree of freedom in the choice of hardware and software. Also mentioned in the interview cited above was the so-called ASCII code (American Standard Code for Information Interchange). This is a system for encoding characters in electronic communications, which has been standardized by ISO⁵.

The PDF format mentioned in the statement cited above has similar advantages. It has been an open ISO standard since 2008 and, among other things, is a common format for saving text documents (including formatting, but also graphic elements, for example).

In addition to the standards for file formats, and the related comfort of work, interviewees also raised the issue of the tools (software) used. With regard to it, two perspectives were present in the interviews. First, it was important to use software that not only enables specific tasks to be carried out, but that at the same time to be as popular as possible on the market.

[Interviewee 5] Usually, to solve one problem on the Internet, or in the world in general, there are 3, 5, 10 tools. We usually choose one. We try to use solutions like the most standard ones. The most standard, because they are the most tested.

The advantage of this approach was highlighted in the statement quoted above. In the case of closed-source software, testing and quality assurance is largely on the side of the developer of a given solution, and its widespread use is important, though arguably not crucial. In contrast,

the situation is different in the case of open source, community-developed software. Here, widespread use translates into the number of people directly involved in development, which in turn can have a positive impact on quality. This is a reference to Raymond's (1999) formulation of the so-called Linus's Law⁶. It proclaims that *given a large enough beta-tester and co-developer base, virtually every problem will be characterized quickly and the fix obvious to someone*, or in short: *given enough eyeballs, all bugs are shallow*.

Based on the data collected, there are four cases relating to the relationship between software and data storage standards, or file formats. Closed software, i.e., software whose source code is not publicly available, supports closed file formats (case 1), as well as – usually – open ones (case 2). Open source software, on the other hand, usually relies on support for open file formats (case 3). Closed formats in OSS (case 4) are often supported less well. This situation is due to several factors, the most important of which are licensing issues and lack of adequate documentation.

The issue of problems related to the handling of open and closed standards is well summarized in a statement by one interviewee regarding standards in office suite files.

[Interviewee 7] Because you can use closed software and open formats. For example, in Microsoft Office you can save files in ODT format. But it always depends on how (...) the vendor supports this format, that is, whether it saves everything according to the documentation of the format or not. Because I know many programs that, despite the fact that this format is popular, don't save data in compliance with this format.

In fact, there is an internationally defined ISO/IEC 26300 standard, which was established in 2006 (ISO, 2006). It defines OpenDocument, which is an open file standard for office suites that includes text documents, spreadsheets and presentations, among others. Interestingly, a competing ISO/IEC 29500 standard was adopted in 2008 covering exactly the same area (ISO, 2008). The author of the former is the independent consortium Organization for the Advancement of Structured Information Standards (OASIS), while the author of the latter is Microsoft. Thus, there are two standards of the same level – both published by ISO.

From the point of view of the market as such, and the people using them in particular, this is not an ideal situation, although it cannot be said to be unequivocally unfavorable either. The important thing is what the interviewee pointed out in the statement cited above. The problem is not the mere existence of two twin standards. Instead, it is the way they are handled by the software available on the market. This is because they can be implemented in so-called extended versions, so that a file correctly opened and displayed with one tool may not be supported in the other tool. From the programmers' point of view, this is a major inconvenience. However, it concerns an area that is usually outside the scope of the tasks they perform.

10. Conclusions

Standards for IT in the broadest sense are constantly emerging and evolving. From the study emerges a picture of programmers, however, who value in this field above all not novelty, but stability and simplicity. Operating on text files gives them the freedom to accomplish tasks with the tools of their own choosing. This freedom was emphasized as a very important part of the work. As noted by Raymond (2003) for programmers, standards are one thing, but informal rules that are elements of professional culture are equally important.

In the approach presented by the interviewees, one can see a convergence with the concept called "Unix philosophy" (McIlroy et al., 1978), and the guidelines contained therein for the way the Unix operating system works. Among the principles set forth therein, relevant in the context of the standards and the described study, it is worth mentioning, among others, the creation of such software whose "output" will be able to be the "input" of another – perhaps not yet existing – program. One possible implementation of this idea is specifically using text files described by the respondents, which are a universal way of storing and exchanging information.

It is also worth noting that the fact of defining and publishing a standard is important, but this is not a value in itself. This is because the adoption of the standard in the market and – in the case of software – its correct operation are also important.

In conclusion, standards in the IT industry are crucial for the development of both software and hardware. They are also important in the work of programmers. Of the standards defined in this way, those that are as universal as possible and do not restrict them in their choice of methods and means of accomplishing tasks were particularly highly valued. This confirms the observations of other researchers on this professional group (Jemielniak, 2008; Lin, 2007). In this case, a standard should be understood not only as a formal description of a certain issue – whether by a standardization organization or an industry consortium – but also as a custom and established practice of operation.

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Footnotes

¹ In the following text, differentiation between representatives of the two groups is abandoned; all are referred to as programmers.

² Open source software – software whose source code is made publicly available under a license that permits free use, modification and redistribution for any purpose; usually developed in an open collaboration model, that is, by self-organizing teams.

³ For the purposes of the article, it was considered that free and open source software are the same phenomenon. The differences lie outside of the scope of the paper.

⁴ In order for source code to be executed by a computer, it must undergo a process of compilation, i.e. transformation into a form that the machine can "understand".

⁵ Nowadays, existing ISO standards for encoding are widely used, covering characters outside the English alphabet.

⁶ Name comes from Linus Torvalds – the creator of Linux, which is the kernel of the Unix-like operating system.

THE ROLE OF ARTIFICIAL INTELLIGENCE IN DIGITAL EDUCATION

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Purpose: The article presents a bibliometric analysis of studies in the artificial intelligence field, with the principal source of scientific articles selected being the academic platform Scopus.

Design/methodology/approach: The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to “artificial intelligence” “in” “education” issue in title, abstract and keywords. The analysis was performed using the VosWiewer program.

Findings: The study showed that AI assesses students' skills and requirements using machine learning, and then utilizes the findings of that analysis to develop and disseminate personalized or tailored information that improves learning via increased retention and uptake. AI improves learning for students by providing them with possibilities for experiential or hands-on learning, particularly when paired with other technologies like virtual reality, 3-D, gaming, and simulation.

Research limitations/implications: The first limitation of the study is a result of the papers and reviews that were selected that deal with artificial intelligence. Since a broad variety of scientific fields are included in the field of artificial intelligence, findings may vary if publications from other domains are completely taken into account. Consequently, one should use extreme caution when extrapolating the study's conclusions to the vast domain of artificial intelligence. Another limitation is the research timeline (2019-2024); future results may vary since we anticipate that new topics, concepts, and techniques will emerge in the expanding field of artificial intelligence, which will significantly change the outcomes of our study. Finally, since the study's data came from Scopus, it's possible that this research is impacted by some of Scopus's restrictions.

Practical implications: The manuscript can be a guide for universities on what students need for AI as well as how to improve the didactic process.

Originality/value: Manuscript fills the gap in the analysis of what is the main role of AI in the education area from the student life-cycle and university effectiveness.

Keywords: digitalization, education, artificial intelligence, Wosviewer analysis.

The real power that AI brings to education is connecting our learning intelligently to make us smarter in the way we understand ourselves, the world and how we teach and learn. For the first time we will be able to extend, develop and measure the complexity of human intelligence – an intellect that is more sophisticated than any AI. This will revolutionise the way we think about human intelligence.

Luckin, Holmes, 2016

1. Introduction

The educational process may be enhanced by digital technologies like artificial intelligence (AI), the Internet of Things (IoT), and other developments in information and computer technology (ICT) (OECD Education Working Papers, 2024; Rosak-Szyrocka et al., 2022b; Santos et al., 2022). "Artificial Intelligence" (AI) is being pushed as a means of enhancing education via more individualized, adaptable, inclusive, and captivating learning when it comes to the abundance of real-time data (Big Data) (Bhutoria, 2022; Halagatti et al.). Governments, the education sector, and technology organizations have been investigating the introduction of AI tools and platforms to deliver educational system monitoring that is more effective (with timely, accurate, and informative indicators) and efficient (with less administrative burden) than in the current educational system in order to realize these benefits (Rosak-Szyrocka, 2024). "The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings" is the definition of artificial intelligence (Vries, Bliznyuk, Pinedo, 2023). Artificial Intelligence in Education is one of the newest areas of educational technology, according to several worldwide studies (Zawacki-Richter et al., 2019; Rosak-Szyrocka et al., 2024; Rosak-Szyrocka et al., 2022a). "Computers which perform cognitive tasks, usually associated with human minds, particularly learning and problem-solving" is the broad definition of artificial intelligence (Baker et al., 2010). They clarify that the term AI does not refer to a particular technology. It's a catch-all word for a variety of tools and techniques, including algorithms, machine learning, data mining, neural networks, and natural language processing. Intelligent virtual reality, intelligent assistance for collaborative learning, and personal tutors are the three types of AI software solutions in education that are now accessible (Holmes et al., 2022; Luckin, Holmes, 2016).

In order to select the most relevant studies in the artificial intelligence field, bibliometric analysis was used, with the principal source of scientific articles selected being the academic platform Scopus. The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to "artificial intelligence" "in" "education" issue in title, abstract and keywords. In order to highlight the structure of the scientific field a content analysis was used, inspecting the most common words and the relationships between words. Additionally, a network of co-occurrences was taken into

account. The analysis was performed using the VosWiewer program. Manuscript main aim is to respond to the following main research question by exploring the valuable information the world's clouds provided:

1. Which are the most common all keywords found in the full scientific articles on artificial intelligence in education?
2. What are main key words used by authors?
3. What does network visualization look like between co-authorships network and countries? There are many studies on artificial intelligence (Abduljabbar et al., 2019) but they usually concern the challenges or opportunities that existed before this term (Bholat, Susskind, 2021; Hwang et al., 2020; Luckin, 2017; Navarro-Espinosa et al., 2022; Alam, 2021; Abulibdeh, Zaidan, Abulibdeh, 2024; Mao, Chen, Liu 2024), applications (Venkateswaran et al.; Suresh Babu, Dhakshina Moorthy, 2024; Techniques and applications..., 2024) or ethics aspect (Mhlanga, 2023; Abulibdeh, Zaidan, Abulibdeh, 2024). Some recent relevant studies concerning issues related to AI are summarized in Table 1. The manuscript fills the research gap because it analyzes the issue AI from the perspective of education nowadays and its future. Therefore, the study is novel.

Table 1.

Chosen studies concerning issues related to AI

Author(s) and year	Methods	Analysis aspects
(Hinojo-Lucena et al., 2019)	A bibliometric study of 132 scholarly works on artificial intelligence in higher education that were indexed between 2007 and 2017 in the Web of Science and Scopus databases.	The aim of this study is to examine the current state of production, examine the correlation between the quantity of authors and publications, and identify the primary sources, authors, organizations, and nations that have produced the most scientific research on artificial intelligence in higher education.
(Garg, 2020)	Position paper: guidelines for medical educators to ensure appropriate AI preparation.	To assist medical educators prepare for the new opportunities and demands, this section will outline the general ideas of artificial intelligence (AI), discuss how AI is affecting medicine, and highlight how AI directly affects the style and content of medical education.
(Zhai et al., 2021)	A total of 100 publications were chosen from the Social Sciences Citation Index database's education and educational research category between 2010 and 2020. Of these, 63 empirical papers (74 studies) and 37 analytical papers were included.	The study offered a content analysis of research papers with the goal of revealing the ways in which artificial intelligence (AI) has been used in the field of education and investigating future directions and obstacles in AI research in this field.
(Sanusi et al., 2022)	A total of 605 students contributed insightful answers to the WarpLS software study. In order to comprehend the link between the chosen variables used in the research, structural equation modeling was done.	Using data from Nigerian secondary school pupils, the study looks at the competences needed to be literate in artificial intelligence while taking gender variance and school ownership type into account.

Cont. table 1.

(Roopal Shrivastava, 2023)	Five-fold Cross-Validation with 206 students from Delhi NCR and outside is beneficial for the classification algorithms SVM, Naive Bayes, and Random Forest.	A study looks at how, over the last 150 years, globalization has drastically changed human civilization. The study evaluates existing literature and makes predictions about the near future of artificial intelligence and education (AIED) research based on three applications of educational process models.
(Ivanashko et al., 2024)	The research combined quantitative (survey and statistical analysis) and qualitative (interviews, focus groups, and classroom observations) methodologies. Every study process was set up in accordance with the moral guidelines for gathering and analyzing data. In order to provide a thorough overview of the research subject and assess it from many angles, more than fifty contemporary scientific papers were chosen. 56 individuals, who represented teachers from various Ukrainian higher education institutions, participated in the research.	The study's objective is to characterize artificial intelligence's place in education by examining its advantages and disadvantages.

Source: own study.

2. Literature review

Over the last ten years, one of the key forces behind innovation in classroom instruction has been digitalization (Vincent-Lancrin et al., 2019). The majority of innovation has been on using computers and the internet more in the classroom, but the next wave will be centered on artificial intelligence (AI) or on combining AI with other technologies. Numerous economic areas, including finance (Bholat, Susskind, 2021), healthcare (Eggmann et al., 2023; Yu, Beam, Kohane, 2018), and transportation (Abduljabbar et al., 2019; Wu et al., 2022). The International Journal of Artificial Intelligence in Education was first published in 1989, and the International AI in Education Society (IAIED) was founded in 1993, indicating that "AI in education" has been a cohesive area of academic study at least since the 1980s. The AI Group of Experts at the OECD described an artificial intelligence (AI) system in 2019 as a machine-based system that can make predictions, suggestions, or judgments impacting actual or virtual environments for a specified set of human-defined goals. Different degrees of autonomy are built into AI systems. Phases of an AI system's lifespan include: 1) planning and design, gathering and analyzing data, and creating and interpreting models; 2) validation and verification; 3) deployment; and 4) operation and monitoring (Artificial intelligence in society, 2019). Machine learning (ML), which is defined as a collection of methods that enable computers to learn automatically via patterns and inferences rather than through explicit

instructions from a human, is one of the most promising AI approaches. The "neural network" technology, which powers machine learning, is made possible by advances in computing power and the availability of large datasets, or "big data" (OECD skills..., 2019). Applications for language learning in education, for instance, depend on ML. The idea that AI offers strategic relevance for education has gained traction (Seldon, Abidoye, 2018; Loeckx, 2016; Gruševá, Blašková, 2022).

According to Loeckx, artificial intelligence (AI) has the potential to be a useful teaching tool that relieves instructors of some of their workload while providing students with engaging learning opportunities. There are many of chances for the development of AI applications in education, especially when combined with contemporary educational reforms like gamification, digitization of instructional materials, and tailored learning experiences. For instance, by using intelligent tutoring systems (ITS) to create personalized learning environments in place of a teacher shortage, the modeling capability of AI approaches has been methodically used to create reactive and adaptable tutorials (Du Boulay, 2016). ITSs provide individualized learning experiences via four primary methods: keeping an eye on students' input, assigning activities that are suitable, giving constructive criticism, and using interfaces for human-computer interaction (Seldon, Abidoye, 2018). The goal of modern artificial intelligence (AI) is not to create computational "superintelligences" or "strong AI," but rather to build machines that can learn from their own mistakes, adapt to their environments and purposes, enhance their own performance, create new algorithms, make predictions, and perform automated tasks without the need for human supervision or control (Alpaydin, 2021; Mackenzie, 2017). It is possible to replicate one-on-one private tuition using intelligent tutoring technologies. They may decide which material to choose for a student's learning route, give cognitive scaffolding, and facilitate interaction with the student based on learner models, algorithms, and neural networks. Since human one-on-one tutoring is impractical at large-scale distance learning institutions that conduct modules with thousands of students, intelligent tutoring technologies hold great promise. But supervised and encouraged online communication is required (Salmon, 2008; Williamson, Eynon, 2020). By enabling online group interactions, supporting adaptive group formation based on learner models, or summarizing discussions that a human tutor can use to direct students toward the course's goals, artificial intelligence in education can support collaborative learning. Lastly, intelligent virtual reality is used to engage and mentor students in real-world virtual worlds and game-based learning environments, relying on intelligent tutoring systems as well. For instance, in remote or virtual laboratories, virtual agents may take on the roles of peers, instructors, or facilitators (Perez et al., 2017). Just-in-time evaluation and feedback may be given via Artificial Intelligence. Artificial Intelligence in education may be included into learning activities for a continuous assessment of student success, as an alternative to stop-and-test methods. High accuracy predictions of a student's likelihood of failing an assignment or dropping out of a course have been made using algorithms (Bahadir, 2016). Three approaches are used by Baker and Smith (Educ-AI-tion rebooted?..., 2019) in their most

recent study when discussing educational AI tools: a) learner-facing, b) teacher-facing, and c) system-facing artificial intelligence in education. Learner-facing AI tools are programs, such as personalized or adaptive learning management systems, that students utilize to acquire knowledge. Teacher-facing technologies automate administrative, assessment, feedback, and plagiarism detection procedures to help teachers and lessen their burden. Artificial intelligence is being used in educational technologies to provide teachers proactive help and advice when required by giving insight into students' learning progress. Artificial intelligence solutions in education that are system-facing provide managers and administrators institutional-level information, such as tracking trends in faculty or college turnover. The idea of the student life-cycle is used in the context of higher education as a framework to explain the many AI-based services on an institutional and administrative level that are more general, as well as to assist the academic teaching and learning process in a more focused sense (Navajas et al., 2024) (Fig. 1).

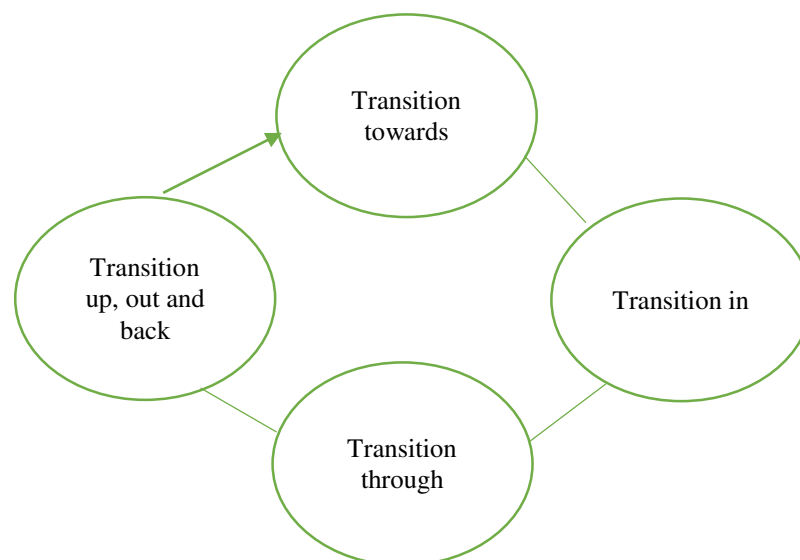


Figure 1. The student lifecycle.

Source: Own study basis on: (Bates, Hayes, 2017).

The first phase, called transition towards, pertains to students prior to commencing their studies and encompasses their goals and research before determining the course of study (Student lifecycle..., 2012). Transition in is the second stage. Beginning students dedicate themselves to their academics at this point. Transition through, the third step, is all on keeping pupils in school. Students work for academic accomplishment throughout this phase. The last phase, known as transitions up, out, and back, is when graduates and alumni concentrate on their next successes and how they might stay connected to the institution (Student lifecycle..., 2012).

Artificial intelligence (AI) has been widely applied in educational practices with the advancement of computing and information processing techniques. Examples of AI applications in education include intelligent tutoring systems, teaching robots, learning analytics dashboards, adaptive learning systems, and human-computer interactions (Chen et al.,

2020). Artificial intelligence is woven throughout numerous technology advancements in education that provide learning analytics, suggestions, and diagnostic tools in a variety of formats and for a range of uses. AI applications are often still in their infancy and are implemented locally or in experimental settings rather than on a large scale at the system level. However, there are several instances of potential applications that target various stakeholders, including students, teachers, administrators, parents, and policy makers, and hint at how AI can change education in the next decades. These examples occur both in the classroom and at the systemic levels. SDG 4, "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", is one of the global education objectives that AI may be especially helpful in achieving (OECD Education Working Papers, 2024).

More so in less wealthy nations, giving all children more comprehensive access to education has proven to be a recurring difficulty for most nations. One of the global goals outlined in SDG Goal 4 is inclusive education, specifically aiming to provide equitable access to all educational levels for all people, including those with impairments. Artificial intelligence systems have shown their efficacy in facilitating the educational process for individuals with disabilities, such as those involving vision, hearing, or social skills deficits (communication and language). Wearables with AI capabilities, for instance, may assist visually challenged students in learning and socializing in their communities by enabling them to recognize people and read books. Systems specifically intended to help kids with various types of impairments have been developed. Robotics, augmented and virtual reality (AR/VR), and other AI-powered technologies help kids with mental health problems and physical disabilities study and participate in class. Certain technologies, such as text-to-speech or speech-to-text apps, assist in getting around some of the challenges, while other solutions are grounded in research and have encouraging outcomes. For instance, while engaging and working together with virtual characters and digital things in a classroom, kids with autism may explore and enhance social skills (OECD Education Working Papers, 2024). Additional AI applications that make use of pattern recognition to provide personalized recommendations to parents, instructors, or students have been created for:

- Online and blended learning: instructors and students may access learning metrics via chatbots that are driven by artificial intelligence agents.
- Classroom dynamics: Various sensors and cameras monitor student participation and classroom dynamics to provide instructors immediate or retrospective feedback and ideas.
- AI functionalities like voice recognition and analysis, pronunciation correction, and foreign language acquisition aid instructors in teaching foreign languages.

The greatest area of potential for revolutionary change in education provided by artificial intelligence is probably assessment. But this isn't evaluation in the sense that it's usually understood. Compared to typical assessments, AI-enabled assessments involve radically different objects and methods, some of which we will now outline. In fact, AI may mean the

end of conventional exams and their replacement, which would mean a change in educational procedures. Select and supply response tests are unique and atypical artifacts used in traditional assessments for summative, retrospective sampling. In contrast, recursive feedback systems—which are essential to learning itself—can be supported by artificial intelligence. All recordable activities that take place throughout the learning process, such as using computer-mediated content resources, interacting with peers and instructors, and producing student work as knowledge representations, may be included in the dataset instead of sampling (Cope, Kalantzis, Sears, 2021).

Vosviewer analysis

In order to select the most relevant studies in the artificial intelligence field, bibliometric analysis was used, with the principal source of scientific articles selected being the academic platform Scopus. The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to “artificial intelligence” “in” “education” issue in title, abstract and keywords. In order to highlight the structure of the scientific field a content analysis was used, inspecting the most common words and the relationships between words. Additionally, a network of co-occurrences was taken into account. The analysis was performed using the VosViewer program. To respond to the following main research question by exploring the valuable information the world's clouds provided:

1. Which are the most common all keywords found in the full scientific articles on artificial intelligence in education?
2. What are main key words used by authors?
3. What does network visualization look like between co-authorships network and countries?

Specifically, Vosviewer can create maps with numerous publications, journals based on networks (co-citation), multiple item maps, country maps, and publication maps. It can also create keyword maps based on networks that are shared. Users may change how many keywords are used and remove phrases that aren't as important. To summarise, the Vosviewer programme enables the processing, clustering, and tagging of articles coming from scientific databases (Zhang, Quoquab, Mohammad, 2024). To study the contents, the author examined the distribution of all key words (Fig. 2). The keywords used by writers in their article titles, abstracts, and keywords sections are examined in this analysis. The word "co-occurrence" refers to the frequency with which two terms occur together. Researchers may locate understudied topics by using keywords to identify patterns in past works and predict future themes that may become popular. Keyword co-occurrence analysis of a study location may effectively reflect

research hotspots, adding to the body of data supporting scientific research. VOSviewer divided the keywords of artificial intelligence publications into six clusters (minimum number of occurrences of a keyword: 20). Cluster 1 is blue colour (artificial intelligence, higher education, chatbots, chatGPT, computer science, AI education, computational thinking, academic integrity, language model, generative artificial intelligence, ethics, ethical technologies). Cluster 2 is green colour (personalized learning, learning systems, online systems, e-learning, learning process, computer aided instruction, intelligent tutoring systems, intelligent highway system, active learning, learning analytics, student learning, educational data mining, software engineering). Cluster 3 is red colour (virtual reality, engineering education, big data, internet of things, blockchain, internet security, 5G mobile communication system, edge computing, network architecture). Cluster 4 is yellow colour (algorithm, deep learning, image enhancement, decisions trees, forecasting, convolution, learning technology, machine learning, machine learning algorithms, diagnosis). Cluster 5 is violet colour (human, technology, education medical, social media, human experiment, internet).

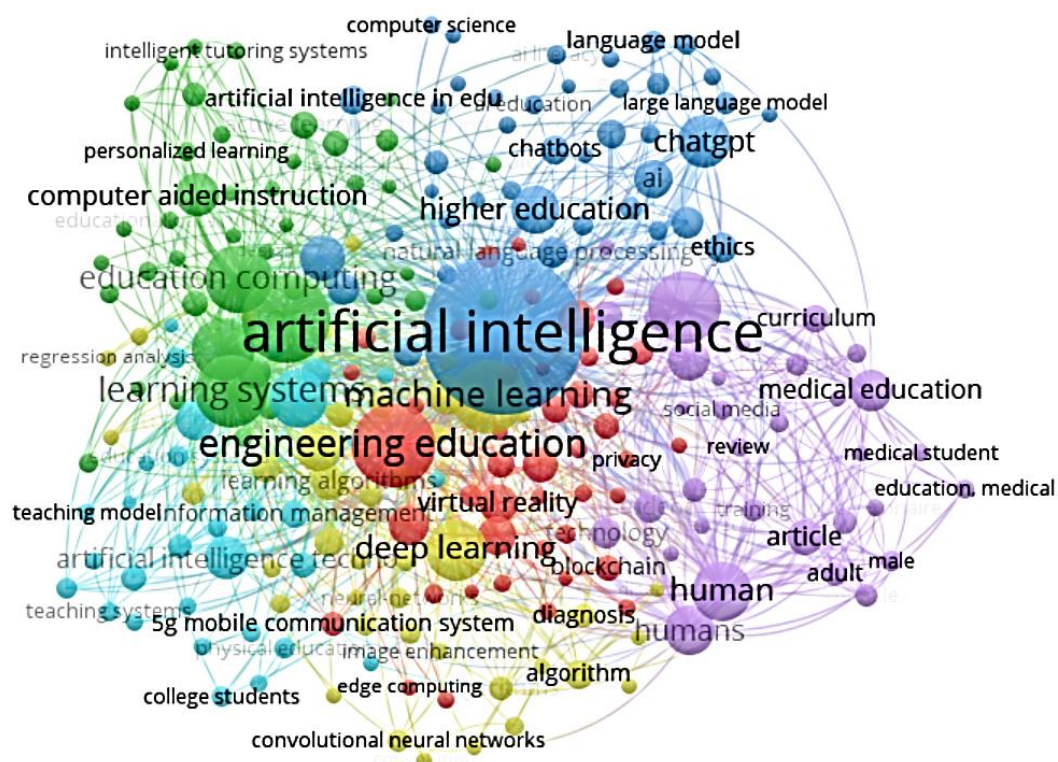


Figure 2. Co-occurrence all key words.

Source: own study.

Figure 3 shows the selected keywords with the highest total link strength.

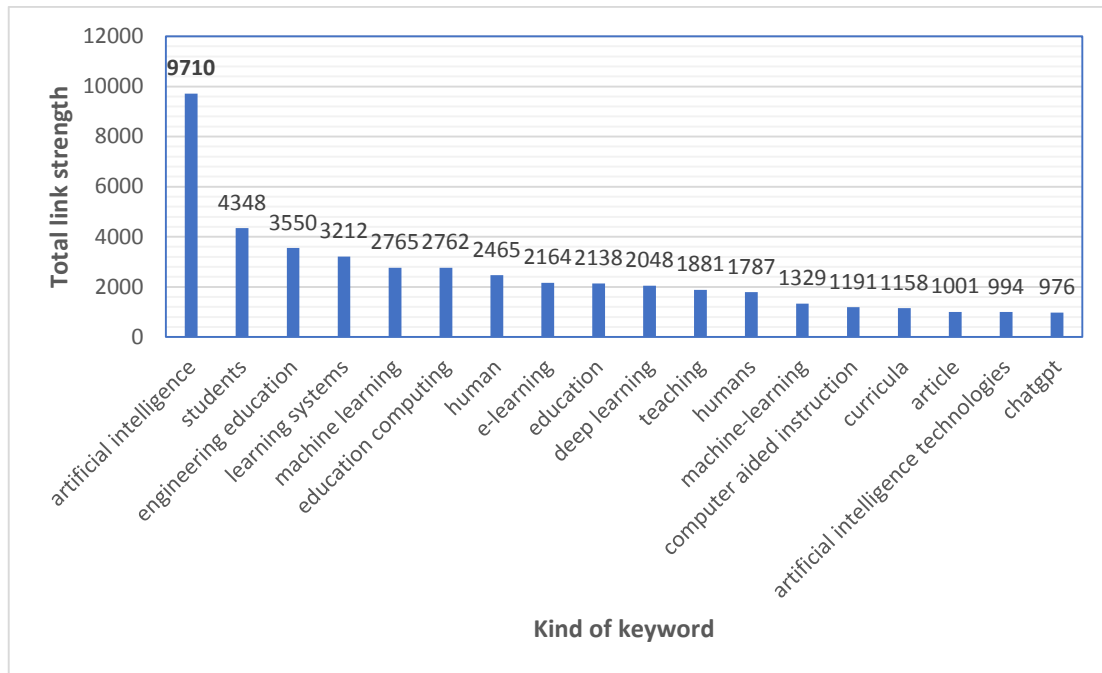


Figure 3. Kind of keywords, and total link strength.

Source: own study.

Figure 3 shows that artificial intelligence has the highest total link strength, followed by students, engineering education, learning systems and machine learning. By examining the useful data that the globe clouds offered, we attempted to address the following primary study question: In the whole scholarly publications on artificial intelligence in education, which terms are most frequently used? According to the empirical investigation, the following terms appear often across the whole of a few chosen articles: “learning system”, “decision support systems”, “internet of things”, “machine learning”, “big data”, “teaching”, “deep learning”, “teaching model”, “student”, “higher education”, and “teachers” (Figure 4).

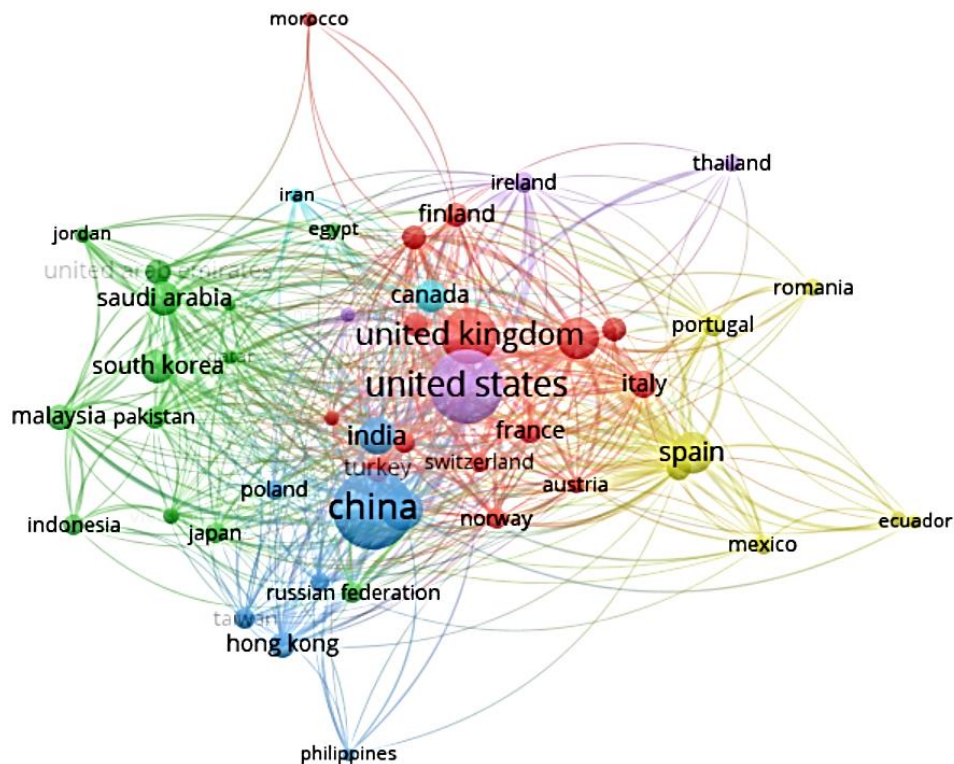


Figure 5. The country co-authorship network of artificial intelligence.

Source: own study.

Discussion

Artificial intelligence is a rapidly developing technology that has the potential to significantly improve education (The Role of Artificial Intelligence..., 2024; Wolniak, 2023; 2024). Artificial Intelligence (AI) has been seen as a potent instrument that may help create new paradigms in educational research, technology development, and instructional design that would not be able to create in more conventional educational settings (Holmes et al., 2022; Hwang et al., 2020). AI has opened up new possibilities, problems, and opportunities for educational breakthroughs. Some of these include the shift to individualized learning, the difficulty of the instructor's position, and the creation of intricate educational systems (Education rebooted?..., 2019; Holmes, Bialik, Fadel, 2019; Holmes et al., 2018; Ouyang, Jiao, 2021). AI has the potential to completely transform a number of societal spheres, including education (Adiguzel, Kaya, Cansu, 2023). By offering individualized, real-time feedback and adjusting to different learning styles, artificial intelligence (AI) may improve student learning (Luckin, 2017). Universities may assist educate students to be active participants in the development and use of AI technology, ensuring that it benefits society as a whole, by teaching

them about AI (Chan, 2023). Creating an AI curriculum for higher education is crucial to preparing students for the future. Because AI technology is developing so quickly, it will probably become more and more significant in society in the years to come. Universities can help guarantee that graduates are prepared to contribute to the development of AI and to manage the ethical, social, and economic concerns that are anticipated to emerge as AI becomes more widely used by offering instructors and students training in the field. Additionally, with this kind of instruction, students ought to be able to utilize AI responsibly and competently in their everyday lives (Aoun, 2017). Accordance with authors (Alam, 2021-2021) Artificial Intelligence (AI) and related technological developments will replace some professions (didactics will not be necessary), drastically change other professions (didactic materials will need to be updated), and create a large number of new professions (new-fangled didactics must be constituted). AI will both reform and facilitate the work of education, changing the nature of education and the division of labor. Personalized learning and automated assessment are two possible uses of AI-driven technology in education (Lin, Huang, Lu, 2023). AI is employed to improve teacher-student communication and provide a customizable learning environment, claim Kamalov et al. (Kamalov, Santandreu Calonge, Gurrib, 2023). Additionally, it offers adaptive learning, which encourages a more personalized learning experience (Gligorea et al., 2023), and real-time support is provided by AI-powered tutoring systems (Lin, Huang, Lu, 2023). According to (Ruiz-Rojas et al., 2023), artificial intelligence (AI) makes virtual classrooms easier to use by enabling active learning, adaptive content distribution, and attendance monitoring. AI enhances teaching methodologies, maximizes teaching resources, and supports data-driven decision-making via the use of data analytics (Rahmani et al., 2021). Additionally, learning management systems (LMS) powered by AI are made to simplify administrative work, tailor learning pathways, or provide immediate feedback (FIRAT 2023). Authors (Da Tan & Cheah 2021) and (Yordanova 2020) discovered that artificial intelligence (AI) significantly influences gamification by enhancing the personalization and engagement of educational games. It is vital to note that artificial intelligence (AI)-driven technologies have been useful in emergency education, particularly when conventional education institutions are interrupted by war, pandemics, natural catastrophes, or other emergencies. Artificial Intelligence (AI) enables the deployment of remote learning systems that provide educational information to students impacted by catastrophes (Bakhov et al., 2021). The positive effects of AI tools on delivering personalized learning experiences are described by (Kamruzzaman et al., 2023). This is especially significant in emergency education, as students may have varying stress levels and different learning requirements. AI made education accessible during the COVID-19 epidemic via content distribution methods, educational applications, and virtual classrooms (Pantelimon et al., 2021). According to (Danylchenko-Cherniak, 2023), AI-based tools help create a "normal" educational process in the midst of the Ukrainian conflict. Chmyr & Bhinder (2023) claim that artificial intelligence (AI) may greatly improve military training effectiveness.

2. **What are main key words used by authors?** According to the empirical investigation, the following terms appear often across the whole of a few chosen articles: “learning system”, “decision support systems”, “internet of things”, “machine learning”, “big data”, “teaching”, “deep learning”, “teaching model”, “student”, “higher education”, and “teachers”
3. **What does network visualization look like between co-authorships network and countries?** Data analysis based on the number of documents in 49 countries showed that the largest share is held by China (15.3%), the USA (13.2%), and the UK (7.5%). Figure 7 shows a radar chart for the selected nine countries with the largest number of documents.

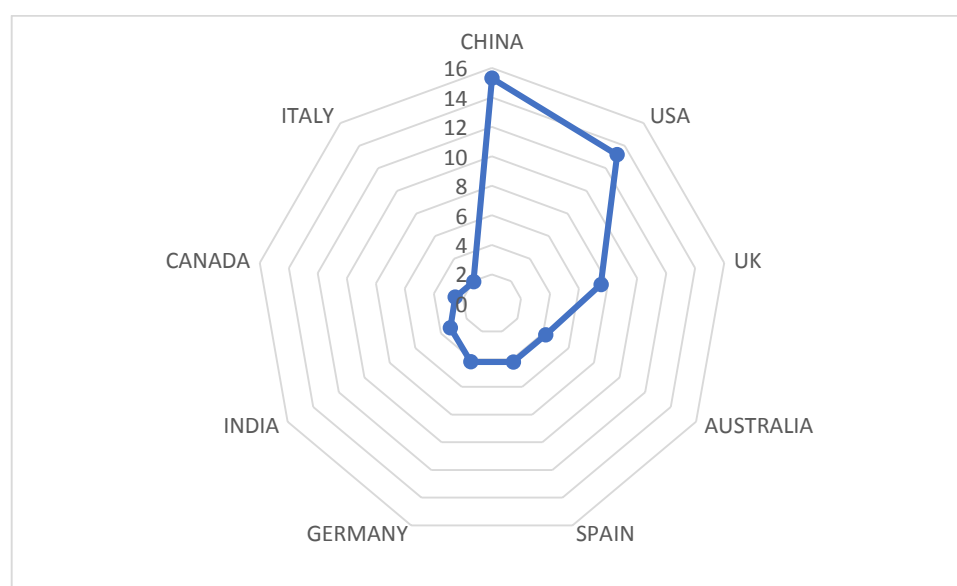


Figure 7. A radar chart for the selected nine countries with the largest number of documents.

Source: own study.

AI also changes the way intelligent material is used in education. It describes digital books, lecture notes, videos, and other virtual information. Because smart information may be accessed remotely, individually, or several times at once—unlike in a traditional classroom—it also facilitates access to education. It improves learning for students and helps professors impart information (Ahmad et al., 2022). Instructors and teachers may do more with more speed and effectiveness when using AI, even when it comes to administrative responsibilities like evaluating, grading, and giving feedback to students on work that they have turned in. Additionally, instructors may increase the quality of their training by using AI, or the many kinds of AI, such as chatbots, cobots, and web-based and online intelligent systems. Contrarily, students benefit from a better and more comprehensive learning experience thanks to AI's use of machine learning, as demonstrated by various studies. AI uses machine learning to evaluate students' abilities and needs, and then uses the results of that analysis to create and distribute individualized or customized content that increases learning through higher uptake and retention. Additionally, AI enhances students' learning experiences by giving them hands-on or

experiential learning opportunities, especially when combined with other technologies like virtual reality, 3-D, gaming, and simulation (Chen et al., 2020; Chen, Chen, Lin, 2020).

Limitations

Like other review efforts, this one is not without limitations. The first limitation of the study is a result of the papers and reviews that were selected that deal with artificial intelligence. Since a broad variety of scientific fields are included in the field of artificial intelligence, findings may vary if publications from other domains are completely taken into account. Consequently, one should use extreme caution when extrapolating the study's conclusions to the vast domain of artificial intelligence. Another limitation is the research timeline (2019-2024); future results may vary since we anticipate that new topics, concepts, and techniques will emerge in the expanding field of artificial intelligence, which will significantly change the outcomes of our study. Finally, since the study's data came from Scopus, it's possible that this research is impacted by some of Scopus's restrictions. Thus, information from other sources—such as the Web of Science—should be included into subsequent studies. Additionally, this kind of researcher may use Altmetrics, a sophisticated and methodical bibliometric technique, to evaluate the academic and social value of study results. This combined with scientometric analysis may be used in novel research domains to enhance the clarity of field dynamics. Nonetheless, by providing a comprehensive and in-depth analysis of significant publications in the field of artificial intelligence research, the bibliometric data analysis conducted in this study contributes to the body of literature.

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EXPLORING THE RELEVANCE OF ORGANIZATIONAL RESILIENCE IN MANAGEMENT RESEARCH – LITERATURE REVIEW

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Purpose: The paper aims to investigate the significance of organizational resilience and to explore its relation with existing organizational theory concepts related to change and uncertainty for a comprehensive understanding of organizational adaptation.

Design/methodology/approach: The objectives were achieved through a focused rapid literature review emphasizing the latest publications. The main method employed involved searching for key concepts, followed by a discussion that explored their interconnections with organizational resilience. The approach to the topic was characterized by a thorough examination of recent literature, aiming to identify and analyze relevant concepts.

Findings: The conducted study enabled the identification and presentation of the key concepts related to management research associated with organizational resilience. These encompass Dynamic Capabilities, Resource-Based View, Ambidexterity, and Organizational Learning Capability. Significant relationships were identified among these concepts, expanding the understanding of the broad research context in this field.

Research limitations/implications: Considering the limitation of the rapid review done, the study is based on the latest works serving as literature reviews. Further research is needed, particularly in expanding the scope to encompass a comprehensive literature review.

Originality/value: The study explores the relationship between organizational resilience and other related concepts. The results can be useful for both researchers and practitioners in this field.

Keywords: organizational resilience, dynamic capabilities, resource-based view, ambidexterity, organizational learning capability.

Category of the paper: Literature review.

1. Introduction

The subject of uncertainty stands out as a recurring focal point in management literature, serving as one of driving forces for scholarly investigations and practical engagements. This article corresponds with this trend, given the contemporary challenges faced by businesses,

such as climate policy, pandemics and wars, which necessitate responses. In the search for new survival methods in business, organizational resilience has gained momentum in both popularity and scientific publications (Su, Junge, 2023). Despite the growing number of works on this subject, a precise definition of what characterizes organizational resilience is still lacking (Hillmann, Guenther, 2021). It is suggested that the concept seems to be intuitively understood (Ingram, 2023), and each stream of research has generated its own definition of organizational resilience (Linnenluecke, 2017, p. 22). Given the confusion, lack of coherence, and multitude of approaches in addressing the uncertainty-related topic, the question arises as to whether organizational resilience is of significance, relevance, within the domain of management research. Existing literature reviews indicate the importance of research in a broad context (Hepfer, Lawrence, 2022), within the context of organizational theory (Zinn, 2022) and in various specific contexts such as higher education (Shaya et al., 2022) or family businesses (Beech et al., 2020; Ingram, Bratnicka-Mysliwiec, 2019). Against this background, it becomes essential to ask how the concept of organizational resilience can be integrated with existing research on organizational theory and what common or unique aspects it may possess. This is also a research direction indicated by Hillmann and Guenther in their work (2021, p. 32) and the author's goal is to attempt to synthesize current concepts related to change and uncertainty and organizational resilience to better understand how organizations adapt to changes in the environment or turbulent conditions.

2. Methods

For the purposes of conducting the study, a decision was made to utilize a rapid literature review, which will be focused on identifying other concepts related to organizational resilience within this review. The first step involves a rapid review focused on analyzing reviews published since 2020 and the most cited articles. This stage aims to identify potential concepts associated with change, uncertainty, and organizational resilience. In the second stage, an attempt was made to organize the existing concepts related to organizational resilience and to assess their consistency with organizational resilience, as well as whether they complement each other. As basis for article selection, Scopus and Web of Science were chosen.

In the first step, a search for "*organi?ation* resilience*" keyword was done to find the number of existing literature. This choice enables the search for articles considering the spelling differences of the term in British English and United States English, as well as any variations of the concept. Given the exploratory nature of the study, no effort was made to bifurcate the term to exclusively focus on the aspect associated with "organizational resilience" as an emerging concept. This approach also allows for complementing work already done in other reviews (Ingram, 2023) on this topic by systematizing it only in this specific direction.

The subsequent steps of rapid systematic review and the number of results is presented in the table 1. The restrictive approach allowed for the selection of the most crucial literature reviews in recent years. In the final step (7), a decision was made to exclude publications focused on the theme of psychological resilience of entrepreneurs and discussion papers.

Table 1.

The subsequent steps of a rapid systematic literature review and the number of results

Review steps	Number of results	
	Scopus	WOS
1. Results for "organi?ation* resilience" (years: 2000-2024)	1699	1423
2. Results for "organi?ation* resilience" (years: 2020-2024)	1118	900
3. Narrowing to English language and review	64	55
4. Narrowing to: Business, Management and Accounting" (Scopus), „Management" and „Business" (WOS)	14	17
5. Narrowing to literature reviews cited 2 or more times	7	11
6. Number of literature reviews with no duplicates	15	
7. Number of literature reviews after abstract verification.	12	

Source: Own work on a basis of Scopus and Web of Science search engines (December 2023).

3. Results of literature review

The first group of literature selected within the review refers to the mentioned before lack of precise definition. The first examined review is engaged in exploring the intricacies of defining and conceptualizing the resilience of firms in the business and management (Conz, Magnani, 2020). Authors refer to the unveiling four distinct categories. These categories encompass resilience as a proactive attribute possessed before an event, an adaptive or absorptive attribute owned during an event, a reactive attribute owned after an event, and a dynamic attribute spanning across all temporal phases. In summary, Conz & Magnani's work expounds on how the resilience of enterprises unfolds along two dynamic trajectories – absorptive and adaptive – both of which are equally effective in achieving favorable adaptations following a disruptive event. This underscores the intricate and multifaceted nature of organizational resilience.

Next examined review also looks for definition of organizational resilience while underscore the varied influences of different disciplines on the understanding and application of the organizational resilience concept. Each of recognized disciplines, including the Ecological perspective, Safety and reliability perspective, Resilience Engineering perspective, Positive Psychology and Organizational Development perspective, and the Strategic perspective, brings its own ontologies and methodologies. Consequently, the diverse applications of the concept result in discrepancies in comprehending the nature and challenges of organizational resilience (Hillmann, 2021).

Many researchers navigate through various resilience definitions before selecting one for their specific study. Saad et al. (2021) underscores this challenge, emphasizing the diverse approach to resilience across some various disciplines. The notion of resilience in entrepreneurship, frequently utilized to characterize firms' economic performance and responsiveness amid specific shocks like financial crises and recessions, has contributed to the complexity of defining and understanding resilience in organizational studies. It is “an ability of firms to bounce back from such a specific “disruption”” (Saad et al., 2021). However, a notable gap exists, particularly in literature adopting a strategic perspective, where an abundance of definitions and conceptualizations coexists, making it challenging to position individual papers within the broader resilience discourse (Hillmann, 2021). This is in some point addressed by the paper of Hepfer and Lawrence (2022) who explore the conceptualization of organizational resilience by identifying three distinct forms: functional resilience, operational resilience, and strategic resilience. Functional resilience pertains to the capacity of a specific organizational function or system to positively respond to adversity independently of others. Operational resilience involves an organization's ability to respond positively to adversity affecting its overall functioning, potentially jeopardizing its continued operations. Lastly, strategic resilience refers to an organization's capability to anticipate and respond to threats against its long-term goals and strategy, emphasizing adaptability in the face of unexpected challenges that may undermine competitive advantage (Hepfer, Lawrence, 2022).

The second set of works may be formed using ones that addresses some specific contexts. The one with positive title *How to emerge stronger* addresses Organizational Learning Capability (OLC). It investigates the less-explored connection between resilience and outcomes of organizational performance. The research reveals that OLC plays a mediating role in this relationship. The research shows that OLC plays an intermediary role in this relationship. The findings suggest that resilience improves learning capacity by encouraging experimentation, risk-taking, environmental interaction, dialogue, open communication and participatory decision-making (Rodriguez-Sanchez et al., 2021). Another concept arises from work of Gichuhi (2021) who take into consideration the growing interest in leadership approaches in the existing literature regarding the correlation between shared leadership and organizational resilience. The model presented underscores the diverse contexts in which shared leadership operates, emphasizing not only decision-making processes but also the crucial aspects of transformation and the exploitation of new ideas to bolster a firm's absorptive capacity in anticipation of an uncertain future. In some way, building on this thread, the discussion extends beyond the realm of leadership to encompass the broader theme of collaboration. In reference to this, the paper delves not only into the nuances of leadership but also the expansive landscape of collaboration. The significance of collaborative networks becomes evident at each level, emphasizing their crucial role (Candeias Fernandes, Franco, 2022).

Some works introduce interest in focusing on the impact of managerial overconfidence on organizational capabilities, decision-making, and action-taking. The study of Kunz & Sonnenholzner (2023) aims to contribute to a comprehensive understanding of the relationship between managerial overconfidence and organizational resilience. Other highlights the growing interest in innovation ambidexterity in management research, emphasizing its importance for adaptability and competitiveness. The review identifies seven main determinants for managing ambidexterity, including process mechanisms, organizational learning, leadership styles, technology investments, organizational contexts, environmental uncertainties, and institutional pressures. (Saleh et al., 2023)

In the group of selected papers there are also works limited in scope, the study by Shela et al. (2023) delves into human capital and organizational resilience within the specific domain of manufacturing. Khlystova et al. (2022) scrutinize the creative industries through the lens of resilience theory. However, their work is constrained by the absence of research on the economic impacts of the pandemic on entrepreneurs and small businesses within these industries. It underscores the necessity for further investigation. In the realm of SME resilience at tourist destinations, Badoc-Gonzales et al. (2022) identify strategies encompassing the emphasis on human capital, network strengthening, enhancement of social resilience, efficient resource utilization, provision of funds for environmental resilience, establishment of a robust legal framework, promotion of collaboration, and securing government support for governance resilience. However, the limitations of these findings must be recognized and their applicability within the given context.

To summarize results of this rapid review - synthesis of current literature reveals several key concepts. First to mention are dynamic capabilities. This concept is presented in works by Saad et al. (2021) and Shela et al. (2023) who underscores the categorization of resilience into operational and dynamic capabilities. Organizational learning capability (OLC), as expounded by Rodriguez-Sanchez et al. (2021), emerges as a critical factor influencing firm performance, with performance feedback acting as a catalyst for enhanced organizational learning and resilience, as articulated by Gichuhi (2021). Furthermore, the significance of shared leadership, elucidated both by Gichuhi (2021) and Saleh et al. (2023), surfaces as a contributing element to organizational adaptability in the face of uncertainties. The concept of ambidexterity discussed by Saleh et al. (2023), adds another dimension to the synthesis, emphasizing the need for organizations to balance exploration and exploitation activities.

To confirm the comprehensiveness of the chosen concepts, a graphical analysis of the most popular scientific articles, without restricting the search to literature reviews, was conducted (Figure 1). This additional step aims to verify the recurrence of certain concepts and identify if any crucial elements might be missing from the synthesized understanding. As key concepts capable of integration in research on organizational resilience, the keywords "dynamic capabilities" and "resource-based view" seem evident in Figure 1. Considering the number of papers and the number of connections, the concept of organizational resilience is an important element of management research.

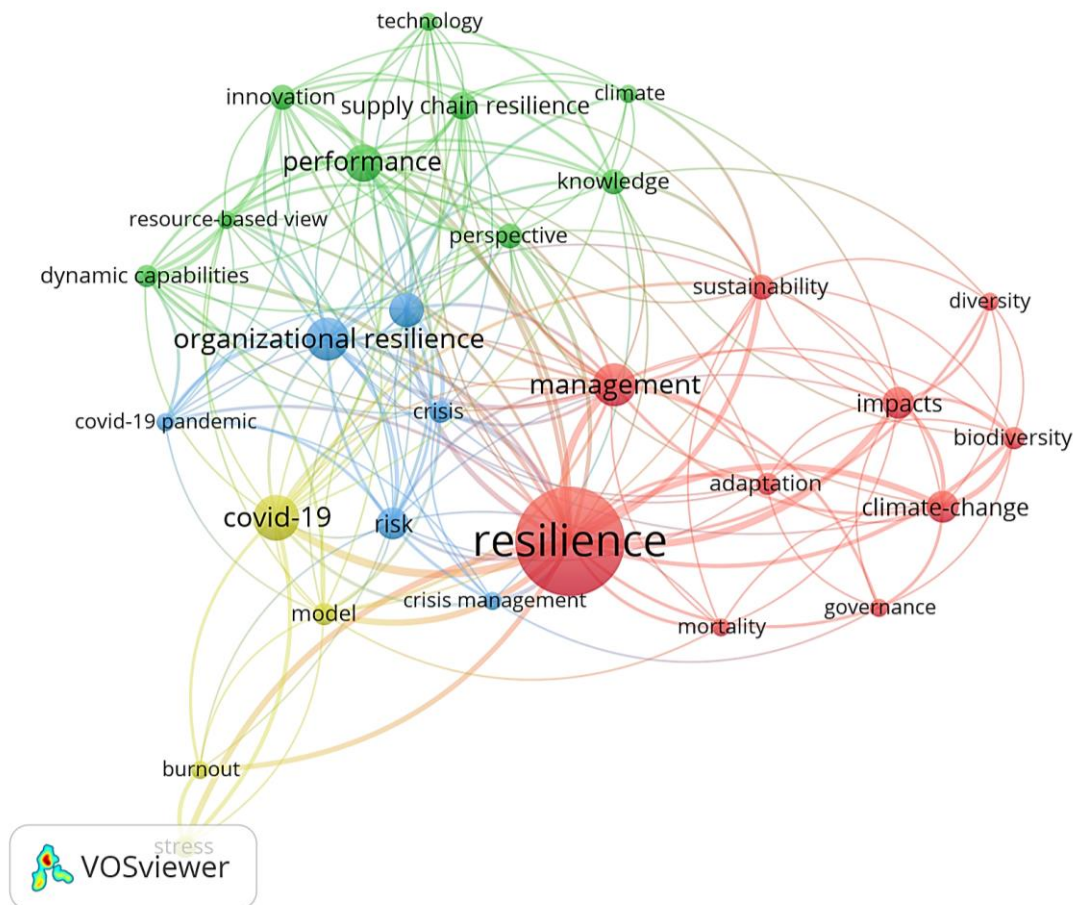


Figure 1. A keyword network map for the 99 most cited publications addressing the topic of organizational resilience according to Web of Science (English language, keywords: organizational resilience, organisational resilience, years: 2020-2024; VOSviewer software was employed; data collected in December 2023).

4. Integrating Resilience in Management Research

The concept of organizational resilience is directly linked to the natural sciences, where the term refers to the "physical system's ability to return to its original form after experiencing disruption" (Barasa et al., 2018). The multifaceted nature of resilience, which also encompasses individual, social, and territorial resilience, makes organizational resilience one of many types of resilience, albeit characteristic of organizations (Ingram, 2023). Resilience addresses the theme of variability and uncertainty, which can be associated with concepts aiming to explain how organizations cope with changes in a turbulent environment. Over the course of time and research numerous concepts have emerged so utilizing the rapid literature review mentioned above along other related concepts found in literature, an effort was made to determine if the current ideas of variability and uncertain environments are compatible with the concept of organizational resilience.

4.1. Dynamic capabilities (DCs)

The organizational resilience perspective provides a framework for perceiving it not only as a return to "homeostasis" but also as development despite adversity. Resilience in this context allows for leveraging crisis experience as a kind of entrepreneurial mindset to embrace growth challenges. This positive context enables the connection of resilience with DCs, actively reconfiguring resources in face of change (Barasa et al., 2018; Manfield, 2016). DCs can have a significant relationship with organizational resilience but this necessitates distinction. According to some studies, resilience is regarded as a dynamic capability, whereas others exemplify that dynamic capabilities have an influence on resilience (Ingram, 2023). It is a challenging task to definitively declare which concept encompasses the other, however, at this stage, a strong interdependence between both concepts is visible.

The investigation of the link between DCs and OR in literature indicates that studies on the volatile market environment shows different forms of DCs. These include replicating, integrating, reconfiguring, generating, and renewing, which play a role in constructing and maintaining organizational resilience in challenging situations, such as the COVID-19 pandemic (Prayag i in., 2023). Similar results has been shown in work of García-Valenzuela et al (2023). In the study, they particularly emphasize the innovation capability which is presented as the most influential factor for small and medium-sized enterprises (SMEs) in enhancing their OR. In other works DCs contribute to the construction of resilience through sensemaking (Wulandhari et al., 2023) and can be promoted by organizational model that enhances resilience by placing human capital at the center (Baravelli et al., 2022). The examination of the relationship between DCs and OR, expanding on the earlier rapid review, suggests a crucial linkage to resource-based view on management.

4.2. Resource-based view (RBV)

RBV can provide a theoretical framework for how different types of resources, also capabilities, can contribute to organizational resilience. RBV highlights the importance of unique combinations of resources and capabilities in creating competitive advantages for organizations (Vargas-Hernández, Ali, 2022). On the other hand, organizational resilience focuses on the organization's ability to adapt and respond to challenges and disruptions, emphasizing the adaptive aspect (Wang et al., 2023). In that theme resources are described in the literature as the "source" and "carrier" of organizational resilience (Ingram, 2023, p. 32). In other works, physical and non-physical resources, such as human and organizational resources, can contribute to a firm's competitive advantage and its ability to withstand and recover from crises (Patnaik et al., 2022). The RBV acknowledges the role of DCs in mitigating the impact of institutional changes, which can also contribute to organizational resilience (Ahmed et al., 2022) Also the perspective of DCs complements the resource-based approach in building organizational resilience (Do et al., 2022).

Resources appear to be a crucial component in the three identified forms of organizational resilience, specifically operational resilience and strategic resilience (Hepfer, Lawrence, 2022). Organization's assets play an important role in strengthening operational resilience, such as financial flexibility and organizational framework. From the strategic point of view the works of Hepfer and Lawrence highlight the organizations' governance structures and processes, as well as organization's business model.

4.3. Ambidexterity

The concept of ambidexterity, as discussed above on work on Saleh et al. (2023) emphasize the need for organizations to balance exploration and exploitation strategies for resilience. The same concept also appears to naturally emerge within the context of the previously mentioned RBV and DCs. Ultimately, it is the idea to create various combinations of resources that dynamically respond to changing conditions. Combining organizational resilience and ambidexterity into a unified framework aids organizations and management in addressing uncertainty by enhancing resilience at strategic and operational level (Colberg, 2022). It is also mentioned that ambidexterity can provide a framework for generating resilient behaviors in the face of disruption and uncertainty. It is found to be a powerful determinant of business resilience, particularly for small and medium enterprises (SMEs) (Gayed, El Ebrashi, 2022; Sijinjak et al., 2022).

Moreover, ambidexterity is connected to the promotion of IT capabilities, which in turn enhances organizational resilience and SME performance. The management of ambidextrous organizations necessitates consideration of multiple factors, such as process mechanisms, organizational learning, leadership styles, technology investments, organizational contexts, environmental uncertainties, and institutional pressures (Trieu et al., 2023). In summary, it seems that ambidexterity leans towards fostering resilience development as it generates behaviors necessitated by the environment but despite mentioned relations it is crucial to highlight that there is a scarcity of research definitively indicating the mechanisms through which organizational ambidexterity may promote organizational resilience (Zhaxylyk, 2020).

4.4. Organizational learning capability (OLC)

OLC as stated by Rodriguez-Sanchez et al. (2021), plays a critical role in firms performance. Learning is connected to resilience through the capabilities that organizations must possess and develop. It plays an essential role in enabling the necessary changes and DCs. The alignment and management of an organization's knowledge base are crucial for adaptation and renewal, which in turn support organizational resilience (Douglas, Haley, 2024). Learning is connected to all three stages of resilience: anticipation, coping, and adaptation (Evenseth et al., 2022). To build the renewal or adaptation domain of organizational resilience, organizations must embody learning into a capability (Douglas, Haley, 2024). It suggests that learning is ongoing across all stages of a disruption and that organizations need to continuously learn and improve

their learning abilities to navigate through disruptions and build resilience. It emphasizes the importance of appropriate management of experiential learning, a systemic approach to learning, the ability to unlearn, and the existence of a context that facilitates organizational learning for effective learning and resilience (Evenseth et al., 2022).

As it was examined as a OLC being the results of organizational resilience (Rodriguez-Sanchez et al., 2021) but with emphasis also to the opinion that OR can indeed be learned and making effective learning a crucial driver in building resilience (Evenseth et al., 2022). Worth mentioning in this context is also the importance of performance feedback as a catalyst for organizational learning and resilience, as Gichuhi (2021) argued.

4.5. Other

It should be noted that the above contexts do not cover all the contexts found in literature review. Although they are less commonly addressed in the literature. The significance of shared leadership, elucidated by both Gichuhi (2021) and Saleh et al. (2023), surfaces as a contributing element to organizational adaptability in the face of uncertainties. Following the post-COVID-19 analysis, the importance of agility, collaboration, and situational awareness and decentralization is also one of set mentioned as ones increasing resilience. Notably, it is underscored in work of Adana et al. (2024) that capabilities play a more substantial role in influencing resilience during the pandemic compared to the pre-pandemic period. The importance of collaborative networks is clear at every level, highlighting their critical role (Candeias Fernandes, Franco, 2022).

Among other works, which were not covered in detail, the work of Li & Lin (2023) is worth to mention because from the perspective of resilience, RBV and DCs it identifies the process mechanism of flexibility-oriented human resource management systems that are positively correlated with intellectual capital and OR. Moreover, their work introduces the concept of digital capability as a contextual element to comprehend how intellectual capital influences organizational resilience. It offers perspectives for future research. In the theme of digital capabilities there is also research available on IT competencies. Together with ambidexterity it strengthens resilience, contributing to increased responsiveness and reduced missed opportunities (Trieu et al., 2023).

5. Discussion

Main point of discussion is related to the entire concept of OR. It has faced criticism due to its lack of clear conceptual definition and operationalization (Hillmann, Guenther, 2021). It remains uncertain whether OR can be understood as an umbrella term encompassing all other concepts. There is no consensus if it is merely one of DCs or it creates DCs. The same lack of

a unified position is also visible among other concepts such as innovation or entrepreneurship (Barasa et al., 2018; Ingram, 2023). These contradictory perspectives on this relation may be the result of differences in approach of researchers dealing with this topic. However, it does reveal that as research on volatile and uncertain environment became more popular, a consensus in management research is needed to intensify work on OR.

Second main critique involves the need for greater clarity in terms of measurement of OR. This also seems to be a consequence of the lack of a consistent definition (Hillmann, Guenther, 2021) and because papers are built with focus on specific industries and contexts (Garcia-Perez et al., 2023; Ingram et al., 2023; Shela et al., 2023). This settings may reduce the clarity and broad applicability of the work results. Overall more research is required to address these critiques.

This research was also based on a rapid literature review, which, due to the desire to achieve the goal, was limited to the newest literature reviews. It was done this way not to replicate or refresh the previous works but in order to summarize the most critical concepts related to OR. The key elements have been organized within a unified context. The findings presented in section four align with those of earlier studies, as exemplified in the work done by Ingram (2023). Nevertheless it would be possible to prepare a separate systematic literature review for each of the highlighted concepts relating to OR.

6. Summary

The conducted study was driven by the necessity to academically position the concept of OR within other management contexts and conceptual frameworks. This work contributes to achieving this goal and serves as a valuable foundation for initiating further research, prompting specific inquiries into the connections between organizational resilience in the identified contexts. In conclusion, the OR is found as a complex and multifaced concept. While it is evident that ambidexterity, OLC, and other contexts such as shared leadership, agility, and collaboration play a crucial role in promoting resilience, there is also a necessity for clarity and consensus in defining organizational resilience for management contexts. The growing interest in research on organizational resilience is justified by the clear need of survival while managers face the reality of VUCA world. The concept of organizational resilience can be integrated with existing research on organizational theory by considering it as a multidimensional and heterogeneous phenomenon (Hepfer, Lawrence, 2022). By relation to resilience of physical objects, OR has potential to be widely used and understood not only by academics. In face of the conflicting viewpoints regarding the connection between OR and other concepts such as DCs, OLC, innovation and entrepreneurship necessitate additional research to establish a more unified comprehension. To sum up results, the study allows to reach its goal

by providing a synthesized perspective on the intricacies associated with organizational resilience.

In face of the review, further study is recommended to explore functional resilience, operational resilience, and strategic resilience. This classification implies avenues for further examination into the alignment of these dimensions with the overarching notion of OR (Hepfer, Lawrence, 2022). Considering the limited scope of this work further research is needed to place each management constructs within the OR theory dimensions to decide on their interdependencies.

Synthesizing the fragmented literature surrounding OR empowers researchers with a more nuanced understanding of the concept, facilitating the identification of future research possibilities. Other direction may be centered around the role of firm size and industry type in building its OR (Safari et al., 2023) or focused on the role of individuals, particularly managers, including the importance of emotional intelligence and ethical leadership (Zhao, Li, 2023). Overall, future research should aim to provide theoretical insights as well as practical solutions for building and maintaining organizations resilient.

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ANALYSIS OF SELECTED MODELS OF MANAGEMENT SYSTEM INTEGRATION – PREVIOUS EXPERIENCE AND DEVELOPMENT PROSPECTS

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Purpose: Comparison of management system integration models.

Design/methodology/approach: The analysis of management system integration models was
based on a review of available literature.

Findings: Systematizing current knowledge about models for integrating standard management
systems. Indication of the differences in these models.

Originality/value: The article schedules the further direction of research of integration of
management systems.

Keywords: integration of management systems, models of integration, quality management
system, environmental management system, occupational health and safety management
system.

Category of the paper: review article, review of the literature.

1. Introduction

In a dynamic and changing environment, the organization is looking for effective solutions
in terms of quality, environment and occupational safety. Ensuring product quality, limiting the
negative impact on the organizational environment and ensuring occupational safety are
becoming one of the most important tasks of today's global management staff. The International
Organization for Standardization (ISO) develops management standards in the above-
mentioned aspects, which facilitates the planning of management activities in the organizations.

This is possible thanks to the ISO 9001, ISO 14001, ISO 45001 standards, which contain guidelines for managers regarding quality, environmental and safety management. The individuality of standards and the systems often implemented on their basis make the integration of these systems in order to rationalize managerial practices in the mentioned areas extremely important (Roszak, 2016; Molenda, 2015; Algheriani et al., 2019; Daneshjo et al., 2021; Domingues et al., 2016; Popescu et al., 2006; Luchian, I., Luchian, C.E., 2017; Velmakina et al., 2018; Maier et al., 2014; Barbosa et al., 2022; Niculare et al., 2019).

Taking into account the importance and topicality of management system integration issues, the article analyzes the current development of management system integration models.

Due to the important context of the time of creation of the models, they are presented chronologically from 1990 to the present.

2. General concept and benefits of integration management system

The organizations may have one certified management system, or the organization may decide to implement another system. Combining independent, accredited management systems in the organization results in integration. This activity aims to improve and optimize processes inside the organization. The integration process allows collaboration between individual systems, which considers external activities by suppliers and subcontractors (Matuszak-Flejszman, 2010).

In source literature, many authors, e.g., Fresner and Engelhardt (Fresner, Engelhardt, 2004), Karapetrovic (Karapetrovic, 2002) or Labodová (Labodová, 2004), define the integration management system as a combination of a quality management system, an environmental management system, and an occupational health and safety management system (Asif et al., 2009). The integrated system combines all management systems into one coherent system to achieve the company's intended purpose (Olaru et al., 2014).

The concept of an integrated management system was created from the need to provide the customer with a high-quality product or service, considering many issues, e.g., processes operating in the company, work environment, and impact on the surrounding environment. Implementing and using one standard management system in the organization brings many benefits (Asif et al., 2009). We can include (Olaru et al., 2014):

- Increasing prestige in the organization and competitiveness in the market.
- Reducing the costs of audits and the certification process due to having only one integrated system.
- Reducing the quantity of documentation.
- A holistic approach to management.

Indeed, managing an organization within one standard system is more straightforward. When implementing a single management system, the organizations use the appropriate ISO standard for the management system, which contains the minimum requirements for functioning the implemented system, planning, supervision, and improvement that the organization should take. The International Organization for Standardization (ISO) does not provide strategies and methods for integrating management systems (Asif et al., 2009). Regarding integration, the BSI British Standards Institution issued only the PAS 99:2012 specification (Publicly Available Specification of standard management system requirements as a framework for integration). The PAS specification defines the basic requirements for integrating a management system (PAS 99:2012, 2012).

Every year, the International Organization for Standardization researches certificates regarding management system standards. The ISO report for 2022 shows, among others, the total number of valid certificates for the 16 - ISO management system standards. The following standards occupy the first three positions: ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018, which confirms that they are the most frequently certified standards in organizations – table 1 (ISO: Global standards..., 2023).

Table 1.

Number of valid certificates for implemented management systems in 2022 (own elaboration based on [<https://www.iso.org/home.html>])

ISO Standards	Number of valid certificates
ISO 9001:2015	1 265 216
ISO 14001:2015	529 853
ISO 45001:2018	397 339

An integrated management system can be built from the moment the decision is made to implement management systems in the organization, or the implementation of management systems and their integration takes place in stages, which rely on implementing systems into one already implemented and functioning management system. The last possible scheme is the function of systems independently - autonomous systems. System integration variants are shown in Figure 1 (Ejdys et al., 2012).

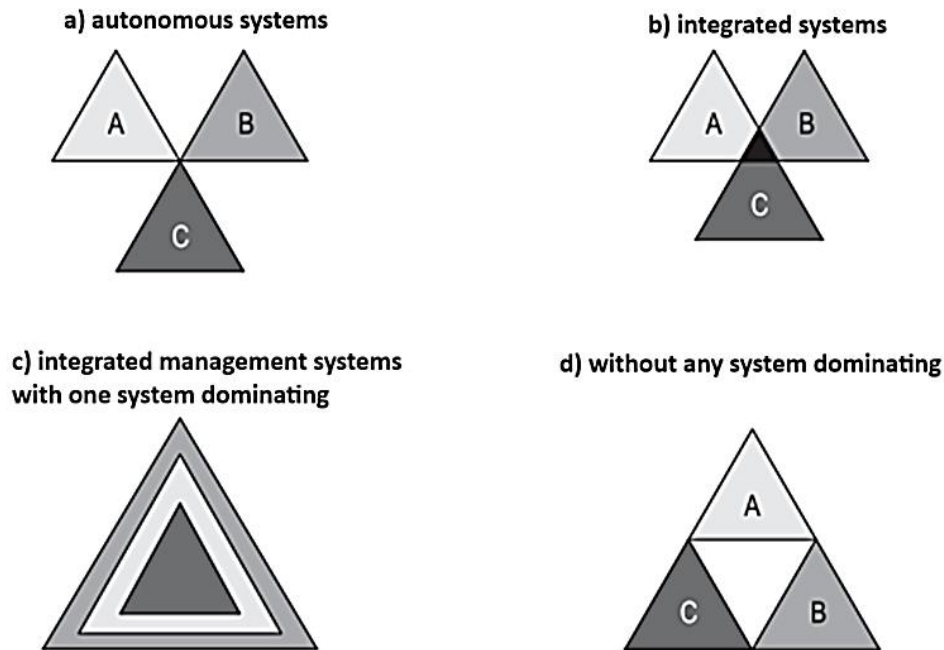


Figure 1. Variant of system integration.

Source: Nowosielski, 1999.

By analyzing the integration process of management systems, it is also possible to determine its level. The essence of integration is between the level of no integration, i.e., individual systems operate independently of each other in the organization, and the level of full integration, where all systems function within one standard system (Figure 2) (Kafek, 2017).

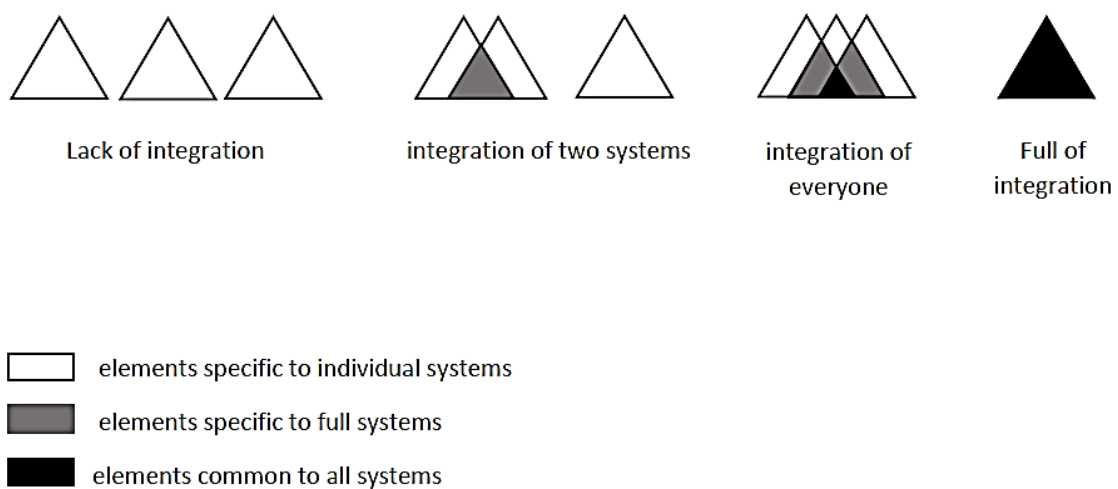


Figure 2. The essence of integration of management systems.

Source: Kafel, 2017, pp. 84-91.

An integrated management system provides advanced agreement with requirements, including specific needs or expectations. The quality requirements the customer sets are essential for the quality management system. However, the requirements raised in the extent of the environmental management system and occupational health and safety mainly concern domestic and international legal requirements. Each of these systems requires compliance with

regulations. Obtaining only a certificate requires identifying the relevant legal regulations for an organization (Ejdys, 2012).

Integration of management systems should be implemented simultaneously on two levels: strategic and operational. Integration at the strategic level should lead to the development of an integrated management system policy because it will be possible to define common aims, plans, and operational programs for the integrated systems. At the operational level, the integration of management systems should be based on the documentation, which is required by standards and standardization of documentation (Figure 3) (Ejdys, 2012).

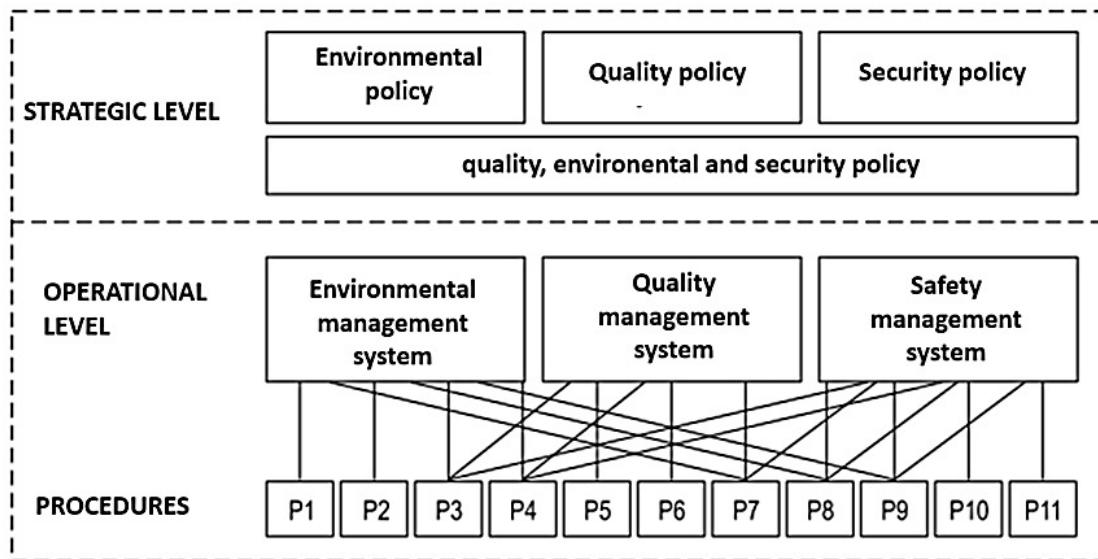


Figure 3. Areas of integration of management systems.

Source: Ejdys, Kobylińska, Lulewicz-Sas, 2012, pp. 5-25.

Benefits of integrating management systems (Węgrzyn, 2007):

- Facilitation of management process in the organization within one standard system.
- Simplifying system documentation.
- Minimization of system procedures and instructions in connection with the development of documents containing simultaneously quality, environmental, and occupational health and safety requirements.
- Saving technical resources and effortfulness by doing joint audits and corrective actions.
- Reducing the costs of the certification process and system control.
- The use of the Deming cycle for one system means that related systems are also improved.
- Improve the image of the company, Increasing employee involvement.

3. Review of integration of management system models

The amendment of ISO standards for the quality management system, environmental management system, and occupational health and safety management system over the years has significantly impacted the interpretation of the management system integration model. The rest of the article will present an analysis of management systems integration models available in the literature, taking into account the chronology of their creation and changes in published standards in the field of management systems. The history of changes in standards in the field of management systems is the reason why the authors divided them into three periods. The first period was until 2000 due to the revolutionary amendment of the ISO 9000 series standard family. The fundamental changes include adopting a process approach to managing organizations and modifying and making the requirements for documentation of management systems more flexible. The second period, between 2000 and 2015, was due to the amendment of standards in management systems dictated by the regulations constituting Annex SL, which currently defines the structure of standards in management systems. The last period is after the ISO 9000 and 14000 standards amendment in 2015 (Cierpiół, Wąsikiewicz-Rusnak, 2021). This article presents management system integration models that can be used on models based on PAS and scientifically on implementing systems into the organization. These include:

- model acc. to Analizy Renfrew and Muir,
- model of integration of documentation system based on TQM,
- model acc. to Zeng S.X., Shi J.J., Lou A.X.,
- model of PEDIMS,
- model integrated management system acc. to PAS 99:2012,
- model of management system consistent with HLS guidelines

Based on the analysis of Renfrew and Muir, a model of the evolution of management systems was created in 1998 (Figure 4). The diagram presents changes taking place in management systems and, as a result, creates a new model. The starting point is implementing a management system based on the ISO 9001 standard in the organization. The next stage is the development of the IMS matrix, which refers to identifying similar requirements in various management systems. Then, according to the scheme, the integration of procedures and processes begins, ultimately creating QUENSH (Qu-quality; EN-environment; SH- occupational health and safety) and a consistent management standard (Domingues et al., 2011).

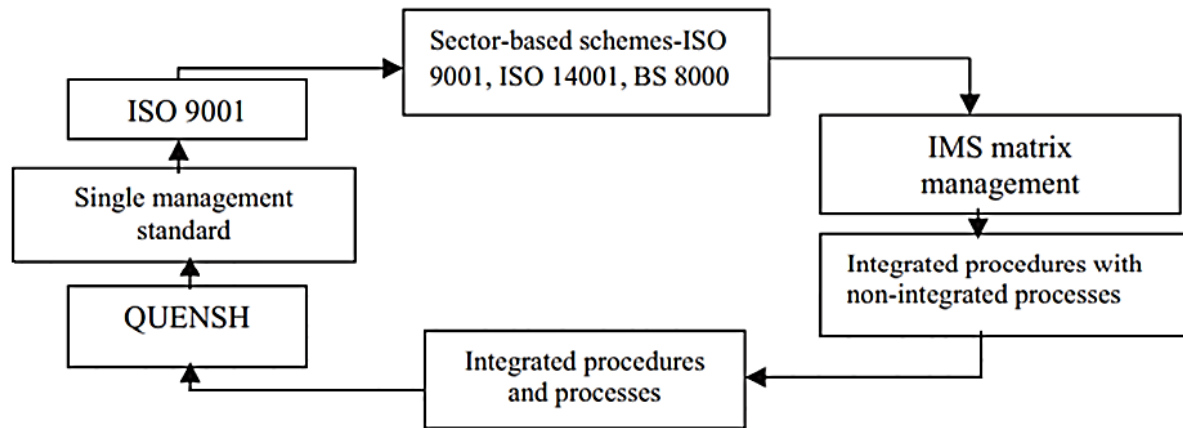


Figure 4. Model of evolution of management systems acc. to Renfrew and Muir 1998.

Source: Domingues, Sampaio, Arezes, 2011, pp. 31-44.

The integration of management systems within TQM – Total Quality Management, is becoming more and more popular. The TQM approach does not have a dominant system. It only requires defining the vision of the organization's development, mission, and values. An essential element integrating the system is the development of policies for the integrated systems and the System Book, which, in addition to the standard system's features, also includes TQM elements. System documentation, i.e., procedures and instructions, are also integrated (Figure 5) (Rajkiewicz, Mikulski, 2016).

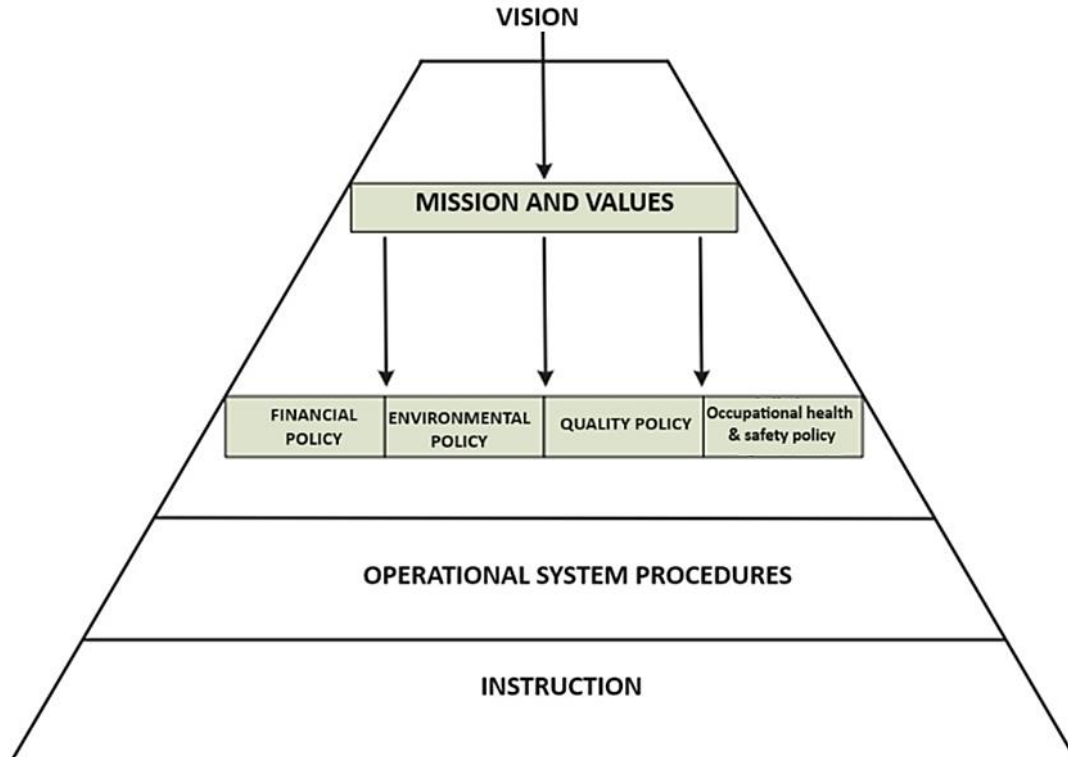


Figure 5. Model of integration of documentation system based on TQM (1998).

Source: Rajkiewicz, Mikulski, 2016, pp. 25-33.

Figure 6 shows the synergistic model of implementing the integrated management system proposed by Zeng S.X., Shi J.J., and Lou A.X. in 2007. The model describes a vertical and horizontal path to integrating management systems, considering different levels of organization. The model indicates a multi-level approach to ensure continuous improvement of organizational and management systems. The awareness and commitment of management guide the integration process. The mission and vision permeate the organizational structure and processes (Asif et al., 2009). Analyzing the model, the authors divided it into three stages. The first stage is strategic synergy. The strategy for managing quality, environmental, and occupational health and safety systems refers to strategic goals, plans, and actions. The strategy stimulates the development of values—all business relationships, mission, and vision of the organization. An organization needs more strategic synergy to focus on short-term goals rather than continuously maintaining requirements. The second level consists of structural, resource, and cultural synergy. Structural synergy speaks of top management awareness, commitment, motivation, and supervision of employees. The actions of top management have a significant impact on the integration process and its subsequent maintenance. Cultural synergy is based on the combination of existing principles in the organization, i.e., procedures, programs, and systems. Such a step is necessary to integrate management systems. Resource synergy includes human and financial resources. As said in the third level of the discussed model, the three mentioned synergies should be supported by documentation synergy. Documentation should be developed by the hierarchy of documents, starting with policies, established values, and principles related to the safety, environment, and quality process (Zeng et al., 2006).

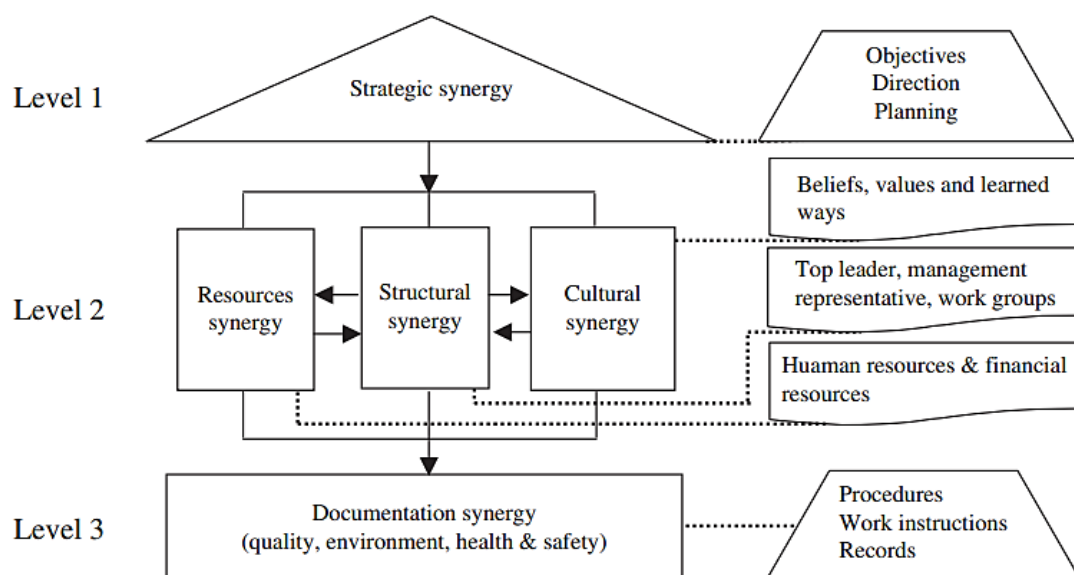


Figure 6. Synergistic model of implementation an integrated management system acc. to Zeng S.X., Shi J.J., Lou A.X.

Source: Zeng, Shi, Lou, 2007.

Another model appearing in the literature is the PEDIMS model (Process Embedded Design of Integrated Management System), which presents four operational activities that are represented by a supplier chain, in which each person is a customer of the previous one and a supplier of the next one in the operational chain (Figure 7). The first stage involves designing the actions to be taken. The next is functional improvement, which consists of improving process management using Pareto Analysis, Six Sigma, Lean Operations, or Lean Sigma. The first two stages are crucial in PEDIMS because they organize the management system integration design process. The third step is integrating strategy and action, i.e., including the requirements of other standards and their integration. In the final stage, business excellence is achieved (Asif et al., 2009).



Figure 7. Model of PEDIMS.

Source: Cierpiol, Wąsikiewicz-Rusnak, 2021, pp. 29-40.

The PAS 99:2012 - Publicly Available Specification of standard management system requirements as a framework for integration supports enterprises in integrating standardized management systems, which results in taking management actions as a result of defining legal requirements (Figure 8) (Kafel, 2017).

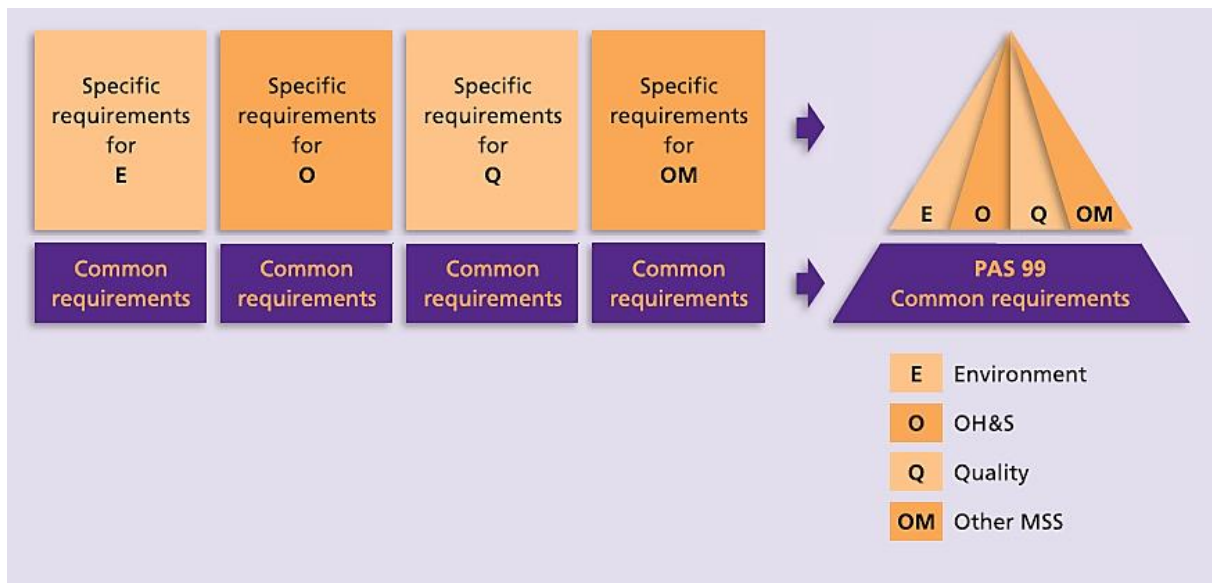


Figure 8. Defining common requirements for management systems in acc. to PAS 99:2012.

Source: BSI, PAS 99:2012 Integrated Management System, ISO, (2012).

The guidelines included in the PAS 99:2012 specification constitute the basis for developing a management system integration model (Kafel, 2017). The document features requirements standard to various systems based on the Deming cycle, which is the basis for integration. The common elements include planning, operational control system, performance assessment, improvement, management review, and management system policy (Figure 9) (Kafel et al., 2013).

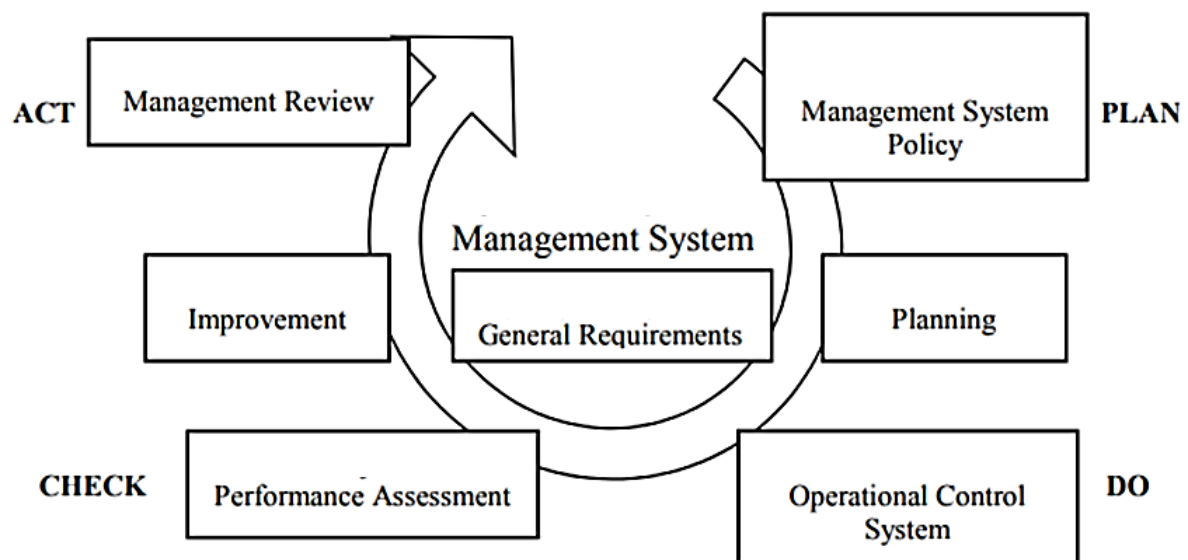


Figure 9. Model integrated management system acc. to PAS 99:2012.

Source: Kafel, 2017, pp. 84-91.

As a result of the amendment to the standards, the integration of management systems should be simpler and more convenient. 2015 was a breakthrough year when a change in the structure of standards in management systems led to their unification based on the high-level

structure (HLS). It significantly facilitates the integration of management systems. The management system model considering the requirements of customers and other interested parties according to the HLS assumptions is presented in Figure 10. However, it is indicated that the unification of the structure of standards in management systems by the HLS guidelines, other than facilitating the integration of management systems, may also bring adverse effects, such as the loss of individual character systems (Kafel, 2017).

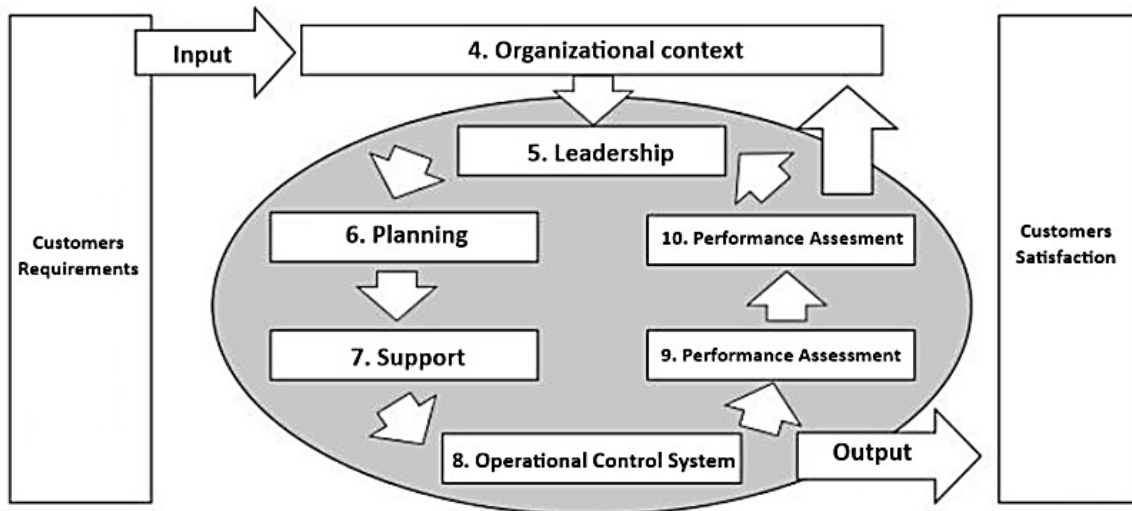


Figure 10. Model of management system consistent with HLS guidelines.

Source: Kafel, 2017, pp. 84-91.

4. Conclusion

The literature review conducted in the field of ideas and methods of integrating management systems allowed the identification of basic integration models such as:

- model acc. to Analizy Renfrew and Muir, the unique feature of this model is the simplicity of presenting the approach to systems integration; when starting the process of integration of management systems, the need for a quality management system implemented in the organization based on the ISO 9001 standard is indicated, in particular the sequence of activities is shown in the model in the integration process based on the integration of management system documentation and, in turn, processes that determine the functionality of the systems;
- a model of integration of documentation system based on TQM, which indicates that an essential aspect in integration is the development of policies, System books, procedures, and instructions; taking into account the TQM philosophy, there is no dominant system in the discussed model;

- model acc. to Zeng S.X., Shi J.J., Lou A.X, which is a synergistic model of implementing an integrated management system, describes the path of integration at various levels in the organization, the model distinguishes strategic synergy, structural synergy, resource synergy, cultural synergy, documentation synergy that ensure continuous improvement in the organization and management systems;
- a model of PARAMS, presenting four operational activities that lead to the system integration design process in the first stages and to business perfection in the subsequent stages;
- model integrated management system acc. to PAS 99:2012, which distinguishes standard requirements (planning, operational control, ocean of execution, improvement, management review, system policy) in integrated systems based on the Deming cycle;
- a management system model consistent with HLS guidelines, which is the youngest of those described, was created due to the amendment of standards and the introduction of HLS guidelines.

The analysis of selected models proves that integrating systems is a process based on the integration of management system documentation - as indicated by models for integrating system documentation based on TQM, model acc. to Zeng S.X., Shi J.J., Lou A.X. level 3, model of integrated management system acc. to PAS 99:2012, and on process integration – what the models indicate acc. to. Model acc. to Renfrew and Muir, model acc. to Zeng S.X., Shi J.J., Lou A.X. level 1 and level 2, model of PEDIMS, model of management system consistent with HLS guidelines.

Requiring managers to precisely determine the method, form, and scope of integration is presented in the model acc. to Zeng S.X., Shi J.J., and Lou A.X., where the integration process is supervised through the awareness and commitment of the management.

The models presented in the literature prove that systems integration occurs not only at the operational level but at a much broader - strategic level. The strategic models mentioned include the model acc. to Renfrew and Muir, model acc. to Zeng S.X., Shi J.J., Lou A.X., and the model of an integrated management system according to PAS 99:2012. Many models go beyond the technical domain - documentation integration or organizational - goal integration.

An advanced integration process approach requires a culture of continuous learning, involvement of interested parties, and continuous improvement of all areas of activity towards sustainable development. The management system model is consistent with HLS guidelines and PAS 99:2012 and emphasizes all the abovementioned aspects.

The analysis of the models shows that a multi-aspect approach to system integration can bring many benefits to the organization, for example:

- homogeneity in management methodologies,
- avoid duplications between procedures of the systems,
- reduction in external certification costs over single certification audits,

- improvement of internal efficiency and effectiveness,
- unification of goals, processes, and resources in various areas,
- synergy effects,
- a holistic approach to managing business risks,
- improve internal and external communication,
- focus organization on business goals,
- time-saving.

The review of selected literature describing management system integration models indicates the need for more presentation of research results regarding assessing the effectiveness of their implementation in organizations. The above allows us to diagnose a gap regarding the lack of description of the practical aspects of implementing these models in organizations, which indicates the need to conduct research in this area, in particular, to assess the effectiveness of individual models depending on the specificity of the organization, business profile or organizational culture.

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ASSESSMENT OF THE RELATIONSHIP BETWEEN THE OCCURRENCE OF CSR INSTRUMENTS AND INDUSTRY 4.0 PILLARS IN MANUFACTURING COMPANIES IN POLAND

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Purpose: The purpose of this article is to assess the relationship between the CSR (Corporate Social Responsibility) instruments used and the implemented pillars of Industry 4.0 in manufacturing companies in Poland.

Design/methodology/approach: Literature review, survey questionnaire research, correlation analysis.

Findings: The article describes the correlations between the CSR instruments used and the implemented Pillars of Industry 4.0 in manufacturing companies in Poland, based on the research conducted using a survey questionnaire. Subjecting the results of the questionnaires, to correlation analysis, made it possible to isolate the most strongly correlated pairs of variables, juxtaposing CSR Instruments and Industry 4.0 Pillars. The overall level of correlation is not at a very high level, which may indicate a moderate or differentiated relationship between CSR and Industry 4.0 Pillars. Despite such results, it was possible to observe distinctive pairs of variables that significantly stand out from the others. These include pairs such as Socially Engaged - Incremental Manufacturing, Investment in Ecology - Cybersecurity and Eco-labeling - Big Data. Despite the existing limitations, the area of research presented in the paper can inspire further research to identify the relationship between CSR and Industry 4.0.

Originality/value: An assessment of the relationship between the CSR (Corporate Social Responsibility) instruments used and the implemented pillars of Industry 4.0 in manufacturing companies in Poland, which may inspire further research in this area.

Keywords: Industry 4.0, Pillars of Industry 4.0, CSR, Sustainability, Correlation.

Category of the paper: Research paper.

Introduction

In an era of increasing globalization and rapid development of technology, manufacturing companies face the challenge of not only operational efficiency, but also sustainability and social responsibility (Orbaninigsih, 2021; Chen, Jin, 2023). In Poland, as a country that is intensively developing its industrial sector, there is a unique opportunity to examine how the implementation of Corporate Social Responsibility (CSR) strategies correlates with the adaptation and use of the Pillars of Industry 4.0.

The purpose of this article is to accurately assess and analyze the relationship between the CSR (Corporate Social Responsibility) instruments used and the implemented Pillars of Industry 4.0 in manufacturing companies in Poland. The analysis includes the identification of positive (synergistic) and negative (conflicting) relationships between pairs of variables - CSR Instruments and Pillars of Industry 4.0. Consideration of such relationships is crucial for understanding how modern technologies and innovations affect the socio-economic aspects of enterprises' activities.

The research methodology is based on a case study of manufacturing companies in Poland that have implemented elements of Industry 4.0 while actively pursuing CSR strategies.

The article contributes to the literature on the subject by providing valuable information for managers and entrepreneurs interested in the harmonious implementation of technological innovations while maintaining high standards of corporate social responsibility.

Pillars of Industry 4.0

The changing business environment, combined with greater technological capabilities and rising customer expectations, has led to the concept of Industry 4.0, a reference to the fourth industrial revolution (Davies, 2015; Bendkowski, 2017).

Industry 4.0 is characterized by the key features of a digital manufacturing plant, which relies on the full automation of production processes, effective collaboration between people and autonomous machines that are essential for optimal operation, and their harmonious integration with supply chain systems (Gabor, 2021).

Research on Industry 4.0 shows a variety of approaches to classifying its main elements. These classifications often include common pillar categories, such as: Autonomous Robots, Augmented Reality, Simulations, Incremental Manufacturing, Integration of Information Systems, Cybersecurity, Internet of Things, Cloud Computing, Big Data, Artificial Intelligence (Erboz, 2017; Tay et al., 2018; Trzop, 2020; Dubey et al., 2022). Table 1 shows the definitions, advantages and disadvantages of each of the listed pillars of Industry 4.0.

Table 1.

Definitions, advantages, disadvantages and examples of applications of each pillar of Industry 4.0

Pillar	Definition	Advantages	Disadvantages
Automated Robotics	Devices programmed to perform tasks without human intervention.	Efficiency, precision, 24/7 availability	High maintenance costs, job displacement, limited functionality
Augmented Reality	Technology superimposing virtual objects onto the real world in real time.	Mobility, enhances training, improves interaction	High maintenance costs, requires specialized hardware, technical limitations
Simulations	Process of modeling real systems for analysis or testing.	Safe testing, resource savings, rapid analysis	Requires specialized knowledge, time-consuming, costly
Incremental Manufacturing	Creating 3D objects by layering material based on a digital model.	Rapid prototyping, local manufacturing	High initial costs, limited materials
Integration of Information Systems	Linking disparate systems into a functional whole.	Data management, increased efficiency	High complexity, error risk
Cybersecurity	Protecting computer systems, networks, and data from digital threats.	Data security, increased trust	High costs, continuous updating
Internet of Things (IoT)	Network of physical objects with sensors exchanging data over the Internet.	Task automation, data collection, remote monitoring	Privacy risks, complexity
Cloud Computing	Delivering computer resources over the Internet.	Resource availability, scalability	Lack of data control, dependence on providers
Big Data	Large and complex data sets analyzed for insights.	Deep analysis, decision support	Requires advanced tools, high costs
Artificial Intelligence	Creating algorithms for human-like tasks.	Automation, precise data analysis	Ethical concerns, high costs, limited contextual understanding

Source: Own elaboration based on: Sojak et al., 2009; Jeffrey, Neidecker, 2010; Zaskórski, 2012; Sasimowski, 2015; Głuchy et al., 2015; Jabez et al., 2015; Negandhi et al., 2015; Wielki, 2016; Romero et al., 2016; Rusek et al., 2016; Erboz, 2017; Krok, 2017; Kaczmarek et al., 2017; Pniewski et al., 2017; Tay et al., 2018; Malucha, 2018; Szajna et al., 2018; Chong et al., 2018; Mantravadi et al., 2018; Zaskórski, Ogórek, 2019; Surma et al., 2019; Orłowski, 2019; Gaku et al., 2019; Trzop, 2020; Vinitha et al., 2020; Kolny et al., 2020; Grabińska et al., 2020; Dubey et al., 2022; Skórno, 2023; Wolniak, 2023.

Despite the use of many innovative solutions in Industry 4.0, it faces significant environmental challenges, which are very often the result of rapid technological change (Aquilani et al., 2020). A study by Banyai et al. (2019) describing the optimization of municipal waste collection in cities highlighted Industry 4.0, which increases cost efficiency, as one of the challenges. Despite the many benefits of Industry 4.0, environmental and sustainability challenges must be faced at the same time. Rapid technological change requires equally rapid adaptation to new environmental realities, which is key to a long-term sustainable future (Banyai et al., 2019; Aquilani et al., 2020).

Corporate sustainability

In an era of dynamic technological change, the goal is to achieve a balance between development and environmental protection, the concept of sustainable development was developed. This concept, is to shape human activity in such a way as to meet the needs of current generations without compromising the ability to meet the needs of future generations (Atisa et al., 2021; Densmaa et al., 2022). At the UN Conference on Environment and Development, which took place in 1992, two documents were adopted (the Rio Declaration and Agenda 21), the general thrust of which was to achieve three basic goals of sustainable development (Sielicka, Choma, 2019):

- Ecological goal - by reducing environmental degradation and removing potential threats to the environment;
- Economic goal - to meet the basic material needs of man, while avoiding environmental degradation;
- Humanitarian and social purpose - to meet basic human needs.

When describing sustainability, it is also worth noting a related term, CSR. CSR is defined as the responsibility of companies for their impact on society, taking into account economic, environmental and social issues (Kaźmierczyk, Kamińska, 2017). Today, there are a number of corporate social responsibility instruments that, when properly implemented, can provide a source of competitive advantage in the market. Table 2 shows the instruments of corporate social responsibility, which include: Social Campaigns, Ethics Program for Employees, Employee Volunteerism, Eco-labeling, Investment in Ecology, Socially Engaged Marketing, Corporate Governance, Social Reports, Socially Responsible Investment (Leoński, 2016).

Table 2.
CSR Instruments

Instrument Name	Description
Social Campaigns	Social campaigns in CSR aim to change public attitudes and behavior, often by raising awareness of important social issues.
Ethics Program for Employees	Workplace ethics programs aim to promote ethical behavior among employees, often through training and codes of conduct.
Employee Volunteerism	Employee volunteering is an initiative in which employees engage in social activities, often supported by employers.
Eco-labeling	Eco-labeling is the process of certifying products and services that meet certain environmental standards.
Investment in Ecology	Green investments include financing projects and initiatives aimed at environmental protection and sustainable development.
Socially Engaged Marketing	Socially engaged marketing is marketing strategies that take into account the social and environmental aspects of a company's operations.
Corporate Governance	Corporate governance refers to a company's governance structures and processes to ensure accountability and transparency.

Cont. table 2.

Social Reports	Social reports are documents published by companies that report on their activities and impact on society and the environment.
Socially Responsible Investment	Socially responsible investments are investments that incorporate environmental, social and governance (ESG) criteria into the investment process.

Source: Own elaboration based on: Schleifer, Vishny, 1997; Haniffa, Cooke, 2005; Dobson, 2020; Kirschstein et al., 2022; Dempsey-Breach, Schantz, 2022; Okun, Ayalon, 2022; Kim, 2023; Kolwas, Domański, 2023; Shahid et al., 2023).

The instruments used in corporate social responsibility, shown in Table 1, indicate a variety of methods that aim not only to improve the image of companies, but also to engage employees and the public for a better future. This includes supervision and activities that are key to transparency and business responsibility.

Methods

The purpose of this article is to assess the relationship between the CSR Instruments used and the implemented pillars of Industry 4.0 in manufacturing companies in Poland. In order to thoroughly analyze and verify the research objective set, the research question "How are the various CSR instruments related to the selected pillars of Industry 4.0?" was formulated. In order to find an answer to the research question, an auxiliary question was formulated, "What are the differences in the application of CSR instruments in enterprises of different sizes, measured by the number of employees?".

To find an answer to the research question, a survey was conducted using a questionnaire based on a five-point Likert scale on a sample of 137 enterprises in the manufacturing sector. The questionnaire was aimed at administrative employees, managers and directors of enterprises.

The survey included 7 manufacturing companies with up to 10 employees [5%], 11-50 employees, 40 companies [29%], 51-250 employees, 57 companies [57%], and 33 companies [24%] with more than 250 employees.

Respondents were subjected to 19 variables, nine of which relate to the degree of use of CSR instruments, such as: Social Campaigns, Ethics Program for Employees, Employee Volunteerism, Eco-labeling, Investment in Ecology, Socially Engaged Marketing, Corporate Governance, Social Reports, Socially Responsible Investment (Leoński, 2016). While 10 more refer to the pillars of Industry 4.0 used in the company, such as: Autonomous Robots, Augmented Reality, Simulations, Incremental Manufacturing, Integration of Information Systems, Cybersecurity, Internet of Things, Cloud Computing, Big Data, Artificial Intelligence (Erboz, 2017; Tay et al., 2018; Trzop, 2020; Dubey et al., 2022).

In order to achieve the research objective, the results of the surveys were subjected to correlation analysis, in order to assess the dependencies and relationships between the various variables.

Results

Survey results for two groups of variables (CSR Instruments and Industry 4.0 Pillars) were subjected to Pearson correlation analysis, as shown in Table 3.

Table 3.
Correlation analysis of CSR Instruments and Pillars of Industry 4.0

	Automated Robotics	Augmented Reality	Simulations	Incremental Manufacturing	Integration of Information Systems	Cybersecurity	Internet of Things (IoT)	Cloud Computing	Big Data	Artificial Intelligence
Social Campaigns	-0.0354	0.0507	0.0689	-0.0752	0.1053	-0.0302	-0.0231	-0.0315	-0.0383	0.0506
Ethics Program for Employees	-0.0183	0.0814	-0.0935	-0.0766	-0.0215	0.0463	-0.0811	-0.0235	-0.0440	0.0605
Employee Volunteerism	0.0028	-0.0832	-0.1021	-0.1513	-0.0849	-0.0542	0.1265	-0.1876	0.0646	-0.0493
Eco-labeling	0.0218	-0.1789	-0.1038	0.0188	0.0834	-0.0025	-0.0317	-0.1202	0.1656	-0.0317
Investment in Ecology	-0.0127	-0.0605	-0.1130	0.0187	0.0577	0.2150	0.0285	-0.0859	0.0651	0.1376
Socially Engaged Marketing	-0.1026	-0.0593	-0.0004	0.2408	0.0343	-0.0202	-0.0484	0.0117	0.0933	0.0036
Corporate Governance	-0.1317	-0.0127	0.0753	0.0811	-0.0433	-0.0834	-0.0311	-0.0780	0.1003	-0.0466
Social Reports	-0.0168	-0.1055	-0.0650	0.0830	0.0739	-0.0881	0.0172	0.0000	0.0363	-0.0953
Socially Responsible Investment	-0.0564	-0.0868	0.0627	-0.0860	0.0942	-0.0113	0.0567	0.1254	-0.0436	-0.1213

Source: Own elaboration based on survey results.

Correlation analysis shows values from -1 to 1, where -1 indicates a strong negative correlation, 0 no correlation, and 1 a strong positive correlation. Correlations close to zero indicate no relationship, negative values indicate an opposite relationship (one factor increases while the other decreases), and positive values indicate a commensurate relationship (both factors increase or decrease together).

Social Campaigns have the highest positive correlation with Integration of Information Systems and the highest negative correlation with Incremental Manufacturing. This may suggest that CSR initiatives are better perceived in the context of Integration of Information Systems, but less associated with Incremental Manufacturing.

Ethics Program for Employees shows stronger positive relationships with Augmented Reality and Cybersecurity, which may indicate that ethics programs are more valued in companies that invest in modern technology and care about data security.

Employee Volunteerism shows a strong positive correlation with Internet of Things (IoT), which could mean that employees of high-tech companies are more likely to engage in social activities.

Eco-labeling has a strong positive correlation with Big Data, suggesting that companies using big data may be more likely to promote green activities.

Investment in Ecology has a positive correlation with Cybersecurity and Artificial Intelligence, indicating that investment in ecology may be more common in companies involved in these technology areas.

Socially Engaged Marketing shows the highest positive correlation with Incremental Manufacturing, suggesting that socially engaged marketing may be more effective in companies using incremental manufacturing.

Corporate Governance has a positive correlation with Incremental Manufacturing, which may suggest that good governance practices can support modern production methods.

Social Reports have a positive correlation with Incremental Manufacturing and Integration of Information Systems, which may indicate that CSR transparency and communication are important to companies investing in these technologies.

Socially Responsible Investment shows the highest positive correlation with Cloud Computing and the highest negative correlation with Artificial Intelligence, which may mean that investors prefer companies using cloud computing technologies, but may have some ethical reservations about companies investing heavily in AI.

In general, the correlation values are not very high, suggesting that the relationship between CSR and the pillars of Industry 4.0 is moderate or varied. This could be due to a number of factors, including differences in industries, company strategies, and the varying impact of technology on aspects of CSR.

Discussion

The article describes the correlations between the CSR instruments used and the implemented pillars of Industry 4.0 in manufacturing companies in Poland. In the correlation analysis presented, the highest positive correlation between Social Campaigns and Integration

of Information Systems suggests the importance of CSR initiatives in a technological context. Bag and Pretorius (2022) emphasized the importance of intelligent systems in sustainable manufacturing, which may complement the observed pattern, indicating that integrating CSR with technology is beneficial to companies (Bag, Pretorius, 2022).

The strong positive correlation of the Ethics Program for Employees with Augmented Reality and Cybersecurity is reflected in the work of Alkaraan et al. (2022), where it was noted that investments in technology and attention to data security are associated with advanced CSR practices (Alkaraan et al., 2022).

The positive correlation of Employee Volunteerism with the Internet of Things is consistent with the findings of Jayashree et al. (2021), who found that technology companies often promote social engagement among employees by using advanced technologies to support social causes (Jayashree et al., 2021).

Similarly, the strong correlation of Eco-labeling with Big Data can be supported by a study by Vrchota et al. (2020), which suggests that companies using big data can effectively monitor and communicate their environmental activities (Vrchota et al., 2020).

In summary, while the correlations in my study are not very high, they suggest a moderate relationship between CSR and the pillars of Industry 4.0, which is consistent with the literature indicating the complexity of the relationship between high-tech and responsible business. The discrepancies may be due to the diversity of industries and the specific activities of companies, which is a valuable area for further research.

Conclusion

This study focused on assessing the relationship between the CSR Instruments used and the implemented pillars of Industry 4.0 in manufacturing companies in Poland. The literature review enabled the identification of Industry 4.0 pillars such as: Autonomous Robots, Augmented Reality, Simulations, Incremental Manufacturing, Integration of Information Systems, Cybersecurity, Internet of Things, Cloud Computing, Big Data, Artificial Intelligence, and CSR instruments: Social Campaigns, Ethics Program for Employees, Employee Volunteerism, Eco-labeling, Investment in Ecology, Socially Engaged Marketing, Corporate Governance, Social Reports, Socially Responsible Investment. Based on the information gathered during the literature review, a questionnaire was developed and sent to companies in the manufacturing sector.

Realization of the research objective of assessing the relationship between the CSR Instruments used and the implemented pillars of Industry 4.0 was made possible by conducting a correlation analysis.

The results showed the strongest positive correlations between pairs of variables such as Socially Engaged - Incremental Manufacturing, Investment in Ecology - Cybersecurity, and Eco-labeling - Big Data. The correlation between Socially Engaged and Incremental Manufacturing suggests that companies that place importance on social responsibility can simultaneously invest in modern, efficient and flexible production methods. The link between investment in eco-labeling and cybersecurity suggests that companies that care about the environment often use advanced technologies that require robust digital protection. The link between eco-labeling and Big Data underscores how important it is in today's business world to manage and analyze large data sets, especially in the context of monitoring and reporting on the environmental impact of products. These correlations reflect the trend of combining sustainability with technological innovation, which is increasingly important in modern business. The correlations are not high, indicating a moderate to varied relationship between CSR and the pillars of Industry 4.0. These differences may be due to a number of factors, such as industry specifics, company strategies and the diverse impact of technology on aspects of CSR.

The study conducted has its limitations, which may affect the generality of the conclusions. One limitation is that the study is based on correlation analysis, which can indicate relationships between variables, but cannot determine whether one variable causes changes in another. Another limitation is the ongoing development of industry technology and CSR practices, so the results can quickly become outdated. Despite the careful selection of variables based on academic articles, there is a risk that some key studies or results were missed, which could affect the completeness of the research. There is therefore a need for further research, which should be conducted on larger samples of the population.

Despite the existing limitations, the work is an important step to understand the relationship between CSR and Industry 4.0, which may prompt researchers to conduct further research in this area.

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COMPARISON OF SOCIO-ECONOMIC DEVELOPMENT CONDITIONS IN MUNICIPAL AND LAND COUNTIES OF EASTERN AND WESTERN REGIONS OF POLAND

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Purpose: The aim of the article is to identify and assess the conditions of socio-economic development in municipal and land counties of the eastern and western regions of Poland.

Design/methodology/approach: The article identifies and assesses the conditions of socio-economic development in municipal and land counties in the eastern and western regions of Poland. The empirical material of the article applies to all municipal and land counties in the country, as well as to all municipal and land counties in the eastern and western regions of Poland. The numerical data come from the Local Data Bank of the Central Statistical Office in Warsaw and concern 2022. The collected and organised empirical material was developed in descriptive, tabular, and graphic form, using the method of comparative analysis. Furthermore, the article provides a point assessment of the diagnostic features illustrating the conditions of socio-economic development in the municipal and land counties of the eastern and western regions of Poland against the background of all municipal and land counties in the country for 2022.

Findings: The analysis of statistical data carried out in the article confirmed the research hypothesis, assuming that the conditions of socio-economic development are differentiated between municipal and land counties in the eastern and western regions of Poland, with better conditions in municipal counties, especially in the western regions, and the worst in land counties of the eastern regions.

Originality/value: The originality of the work lies in the approach to the analysis of the research issues undertaken. For the purposes of the research, the article included a point assessment of the analyzed diagnostic features illustrating the conditions of socio-economic development in the municipal and land counties of the eastern and western regions of Poland against the background of all municipal and land counties in the country. The work is addressed primarily to local government officials responsible for the conditions, opportunities, and directions of local socio-economic development of counties local government units in Poland, as well as to all other decision-makers involved in the implementation of local development policy.

Keywords: socio-economic development, development conditions, municipal and land counties in Poland.

Category of the paper: research paper.

1. Introduction

The issue of socio-economic development on a regional and local scale arouses wide interest among economists. The main reasons for this are, above all, the danger of disappearing the specific features of the regions, their cultural identity and historical heritage, as well as the growing threats to the values of the natural environment. In turn, from an economic point of view, the key issue is the optimization of the use of human capital and natural resources in the management process. Another significant problem is the growing interregional and intraregional disproportions in the level of development and quality of life of residents, which generally leads to migration of people from less developed regions and, consequently, weakens their development opportunities (Green-Leigh, Blakely, 2016; Błachut, Cierpiał-Wolan, Czudec, Kata, 2018; Grzebyk, Miś, Stec, Zając, 2019).

Socio-economic development is a process encompassing all beneficial changes of a quantitative and qualitative nature, the attribute of which is durability and impact on the level and quality of life of the population. It should be considered in the social, economic, political, and cultural aspects, and its indispensable components are the natural environment and spatial order. Socio-economic development is a complex, multi-threaded process that varies in time and space. Therefore, it is difficult to talk about a universal set of its factors, but they are generally divided into two groups, i.e., endogenous and exogenous (Szlachta, 1996; Sekuła, 2001; Korenik, 2003; Łabędzki, 2008; Józefowicz, Smolińska, 2019).

Socio-economic development, understood as the scale, pace, and direction of changes in regional and local communities leading to better conditions and quality of life, as well as the resulting spatial structure and forms of space development, are spatially diverse and are the result of many conditions. They can be divided into the following groups regarding conditions: historical, related to the location in geographical space and economic structures, the natural environment and the quality of the human environment, the level of infrastructure development (social, technical, economic, institutional), the activity and effectiveness of local government activities, and also the entrepreneurship and innovation of residents. From a different perspective, we can also mention site conditions, environmental conditions, conditions resulting from space development, and conditions related to the quality of the regional or local community. The literature on the subject emphasises the key importance of sustainable development of local government units (including counties and communes), because it leads directly to improvement of the functioning of the economy and society, as well as the condition and quality of the natural environment (Heffner, 2007; 2011a; 2011b; Akgün, Baycan, Nijkamp, 2015; Holden, Linnerud, Banister, 2017; Dziekański, 2018; Miłek, 2018; Józefowicz, Smolińska, 2019; Utzig, Raczkowska, Mięka, 2023).

A very important factor determining socio-economic development is the improvement of the quality of human and social capital, and therefore also intellectual capital. Factors accelerating development may also include special values of the natural environment, convenient location along communication routes, or cultural heritage (Kłodziński, 2001; Nerdrum, Erikson, 2001; Bontis, 2004; Spsychalski, 2005; Kamińska, 2011; Wosiek, 2012; Sikorska, 2013).

In the process of socio-economic development, a special role is played by institutions at various levels, including local government (regional and local), which create and implement development policy. It should be emphasised that lasting cooperation of institutions responsible for the directions and dynamics of changes in the region, county, or commune is necessary. Moreover, due to the uneven distribution of resources or different development paths of regions in the past, the activities of regional and local level institutions require support from the state. The problem of economically weaker regions does not concern only their inhabitants and, like positive changes, have a supra-regional dimension and serve the general society (greater dynamics of development of the entire economy, improvement of the condition of the natural environment, limiting the negative effects of excessive migration, etc.). One of the important instruments to support socio-economic development are investments by local government units (regional and local) that improve technical and social infrastructure. Taking over the costs of investment and maintenance of road, water and sewage infrastructure, or waste disposal infrastructure by the local government increases the attractiveness of the region or local environment (county, commune) and thus promotes their development. In turn, a well-developed social infrastructure improves the quality of life of residents and motivates them to stay in their current place of residence, which is particularly important in the case of young and well-educated people. The dynamics of the socio-economic development of the region or the local environment (county, commune) largely depends on the number and economic strength of economic entities. Therefore, among the instruments of regional and local development policy, activities that support the development of entrepreneurship should have an important place. In this way, not only does the market offer of goods and services addressed to a wide range of consumers expand, but new jobs are also created. This, in turn, is an important factor in increasing the level and quality of life of residents and reducing migration pressure (Paul, 2014; Błachut, Cierpień-Wolan, Czudec, Kata, 2018).

A particularly important task of local government is to initiate, organise, coordinate and support activities for the socio-economic development of a given territorial unit (county, commune) and to meet the collective needs of the community, as well as dealing with public matters of local importance (improving the quality of life and the level of service for residents, improving the conditions for running a business, improving the quality of the natural environment, spatial order, securing the effective use of local development factors, improving competitiveness, etc.). In turn, creating a socio-economic development policy should be based on well-thought-out, calculated and consciously selected instruments, tailored to the conditions

and needs as well as the economic situation of a given territorial unit (county, commune). These instruments are grouped into several categories, i.e. income and expenditure, financial and non-financial, influencing economic entities and their environment, as well as obligatory and optional (Paul, 2014; Skica, Bem, 2014; Parysek, 2015; Kogut-Jaworska, 2017).

Effective implementation of local socio-economic development policy depends on many factors, including primarily: understanding the essence and meaning of local development, willingness to act in this area, knowledge and ingenuity of the entities of this policy and the local economy, resources enabling development, unmet social needs that stimulate and direct this development, as well as on collecting appropriate financial resources, gathering people around the idea of local development and creating an appropriate social climate, as well as on the effectiveness of the existing organisational structures of this development. However, the basic structure initiating and organising the process of socio-economic development will always be the local government, in relation to which the following conditions for the effectiveness of development policy are distinguished: pro-development activity, entrepreneurship, openness to innovation and cooperation, inducing the process of collective learning, readiness to build partnerships and create social capital (Paul, 2014; Guzal-Dec, 2015; Parysek, 2015; Zwolińska-Ligaj, 2019).

The originality of the article lies in the approach to the analysis of the research issues undertaken. For the purposes of the research, it included a point assessment of all the diagnostic characteristics analysed diagnostic features illustrating the conditions of socio-economic development in municipal and rural poviats of the eastern and western regions of Poland against the background of such poviats in the country.

The article poses a research question that attempts to answer it. What is interesting is what the conditions of socio-economic development in urban and rural districts in the eastern and western regions of Poland and are they different?

This is the reason for creating the article, its structure and the method of processing the research results.

2. Research aim, empirical material, and research methods

The aim of the article is to identify and assess the conditions of socio-economic development in municipal and land counties of the eastern and western regions of Poland.

The article puts forward a research hypothesis assuming that the conditions of socio-economic development vary between municipal and land counties of the eastern and western regions of Poland, with better conditions in municipal counties, especially in the western regions, and the worst in land counties of the eastern regions.

The empirical material of the article concerns all municipal and land counties in the country, as well as all municipal and land counties in the eastern and western regions of Poland, i.e., in six provinces, i.e. Lubelskie, Podkarpackie, and Podlaskie, as well as Dolnośląskie, Lubuskie and Zachodniopomorskie¹. The numerical data come from the Local Data Bank of the Central Statistical Office in Warsaw and concern 2022. The collected and organised empirical material was developed in descriptive, tabular, and graphic form, using the method of comparative analysis.

To identify and assess the conditions of socio-economic development in municipal and land counties of the eastern and western regions of Poland, the following diagnostic features illustrating them in 2022 were analysed: population density (population per 1 km²), percentage of the working-age population, nonworking-age population per 100 people of working age, natural increase per 1000 population, net migration for permanent residence per 1000 population, working people per 1000 population of working age, registered unemployment rate (%), percentage of population using the water supply, sewage and gas networks, total income county budgets per capita (PLN), own income of county budgets per capita (PLN), share of own income in total income of county budgets (%), total expenditure of county budgets per capita (PLN), investment expenditure of county budgets per capita (PLN) and share of investment expenditure in total expenditure of county budgets (%).

Additionally, the article provides a point assessment of the analyzed diagnostic features illustrating the conditions of socio-economic development in the municipal and land counties of the eastern and western regions of Poland against the background of all municipal and land counties in the country for 2022. Individual diagnostic characteristics were compared with the average of counties in the country, which was taken as 100 points, and their advantage or underweight was assessed accordingly in all counties covered by the study. Then, all points were summarised and the average was calculated (Figures 1-4). It should be emphasised that this is a new approach to the research problem discussed in the article.

3. Results

Each local government unit has its own specificity, which is determined primarily by such features as: spatial location and accessibility, population and demographic situation (number and structure of population, quality of human and social capital, socio-cultural features, changes in the number of inhabitants, i.e. growth, stagnation, decline), level of development and structure of the economy, labour market and unemployment, material and intangible resources, infrastructure (social, technical, institutional), natural environment (quality, values), local

¹ One of the administrative borders of these provinces is the state border.

initiatives (establishing and developing cooperation, entrepreneurship, innovation, openness to new solutions). In turn, the conditions in which the local government operates, i.e., the features of a given local environment (county, commune), largely determine its financial situation (level and structure of income and budget expenditure, debt) and determines the possibilities and directions of its activities in the field of further socio-economic development. Particularly important conditions for the development and functioning of local government lie in the endogenous (often specific and unique) features of the local environment (county, commune). These features have a significant impact on the scale, directions and dynamics of socio-economic development, and also constitute the primary (somewhat natural) conditions in which the local government operates and conducts its own development policy (Grzebyk, Sołtysiak, Stec, Zając, 2020; Sołtysiak, Zając, 2023).

Table 1.

Selected characteristics characterising demographic conditions and the situation on the labour market in municipal and land counties covered by the research in 2022

Specification	Counties		
	total	municipal	land
Poland			
Number of counties	380,0	66,0	314,0
Population density - population per 1 km ²	355,4	1572,0	99,7
Percentage of the population of working age	58,5	57,6	58,7
Population of non-working age per 100 people of working age	70,9	73,7	70,4
Natural increase per 1000 population	-4,5	-5,1	-4,4
Balance of migration for permanent residence per 1,000 population	-0,9	-3,0	-0,4
Working persons per 1,000 working-age population	361,7	568,2	318,3
Registered unemployment rate	7,3	4,5	7,9
Eastern regions of Poland			
Number of counties	66	11	55
Population density - population per 1 km ²	318,5	1541,7	73,8
Percentage of the population of working age	58,8	57,7	59,0
Population of non-working age per 100 people of working age	70,2	73,3	69,6
Natural increase per 1000 population	-4,4	-4,6	-3,3
Balance of migration for permanent residence per 1,000 population	-2,5	-3,4	-2,3
Working persons per 1,000 working-age population	318,2	543,0	273,2
Registered unemployment rate	9,4	6,6	10,0
Western regions of Poland			
Number of counties	65	9	56
Population density - population per 1 km ²	224,6	1140,8	77,3
Percentage of the population of working age	58,4	57,4	58,6
Population of non-working age per 100 people of working age	71,2	74,4	70,7
Natural increase per 1000 population	-5,5	-5,9	-5,5
Balance of migration for permanent residence per 1,000 population	-0,3	-1,9	-0,1
Working persons per 1,000 working-age population	364,0	546,9	334,6
Registered unemployment rate	7,3	3,5	7,9

Source: Central Statistical Office in Warsaw.

According to the territorial division of the country, there are 380 local government units in Poland, including 66 municipal counties and 314 land counties. It should be added that in the eastern and western regions of Poland, both the number of counties and the percentage of municipal and land counties are similar. In the eastern regions, the percentage of municipal

counties is 16.7% and land counties 83.3%, while in the western regions it is 13.8% and 86.2%, respectively (Table 1).

Demographic conditions and the situation on the labour market are an important factor determining the possibilities and needs of socio-economic development in a given area (Grzebyk, Miś, Stec, Zająć, 2019; Grzebyk, Sołtysiak, Stec, Zająć, 2020).

The data in Table 1 shows that among the analysed features illustrating the demographic conditions and the situation on the labor market in county local government units in Poland, the following are more favourable for counties in the eastern regions: population density, percentage of the working-age population, number of the working-age population, unproductive people per 100 people of working age and natural increase per 1000 population. However, in the case of other characteristics, i.e. the net migration for permanent residence per 1000 population, the number of employed persons per 1000 working-age population and the registered unemployment rate, the situation is better in the counties of the western regions of Poland.

Moreover, there are differences in this respect between municipal and land counties, both throughout Poland and in its eastern and western regions. In the case of features illustrating demographic conditions and the situation on the labour market, such as population density, the number of employees per 1000 working-age population and the registered unemployment rate, the situation is better in municipal counties. However, other features, such as the percentage of the working-age population, the number of the non-working-age population per 100 working-age people, the natural increase per 1000 population and the net migration for permanent residence per 1000 population, are more favorable in land counties (Table 1).

Infrastructure constitutes the backbone of the economy and the basis of all economic activity, determining its scope, structure, and spatial distribution. The level of its development largely determines the investment and economic attractiveness of a given area and determines its development possibilities. Among the elements of infrastructure that play an important role in the economic activation of a given area, as well as in shaping the conditions and quality of life of its inhabitants, the following include: roads, communications, energy and gas networks, water supply, and sewage systems, which has been confirmed in many studies and analyses. It should be added that infrastructure in Poland is still relatively underdeveloped, and there are very large regional and local differences in this respect (Pięćek, 1999; Czudec, 2003; Kołodziejczyk, 2009, 2013; Jarosiński, 2011; Grzebyk, Miś, Stec, Zająć, 2019).

In county local government units in Poland, the best developed element of infrastructure is the water supply network, followed by the sewage network, and the least developed is the gas network. However, counties in the western regions of Poland have better access to these infrastructure elements compared to counties in the eastern regions. Additionally, it should be noted that there are differences in this respect between municipal and land counties, both throughout Poland and in its eastern and western regions. Because in the case of municipal counties, the access of their inhabitants to the elements of the analysed infrastructure elements is better compared to land counties (Table 2).

Table 2.

Selected characteristics characterising infrastructure conditions in municipal and land counties covered by the research in 2022

Specification	Counties		
	total	municipal	land
Poland			
Percentage of the population using the water supply network	91,7	97,5	90,5
Percentage of the population using the sewage network	65,9	92,4	60,4
Percentage of the population using the gas network	46,3	76,5	40,0
Eastern regions of Poland			
Percentage of the population using the water supply network	85,1	95,8	82,9
Percentage of the population using the sewage network	59,2	92,6	52,5
Percentage of the population using the gas network	45,3	70,3	40,2
Western regions of Poland			
Percentage of the population using the water supply network	94,9	97,9	94,4
Percentage of the population using the sewage network	74,3	91,1	71,6
Percentage of the population using the gas network	54,6	83,0	50,0

Source: Central Statistical Office in Warsaw.

The basic condition for the effective and efficient implementation of tasks by local government units is to provide them with stable budget revenues, which not only allow them to finance current expenses, but also enable them to undertake investments that support further socio-economic development (Dziekański, 2018; Czudec, 2021).

The average value of total income and the own income of the county budgets per capita, as well as the share of the own income in the total income of the county budgets, are lower in counties of the eastern regions of Poland, compared to the average for counties throughout the country. However, in counties in the western regions of Poland they are similar to the average for counties throughout the country. It should be added that there is a clear difference in this respect between municipal and land counties, and this applies both to the entire country and its eastern and western regions. The average value of the total income and the own income of the county budgets per capita, as well as the share of the own income in the total income of the county budgets, is much higher in municipal counties compared to land counties, and this applies especially to the western regions of Poland (Table 3).

The average value of total expenditure of county budgets per capita in counties of eastern regions of Poland is similar to the average for all counties in the country, while it is lower in counties of western regions. In turn, the average value of investment expenditure of county budgets per capita, as well as the share of investment expenditure in the total expenditure of county budgets, is similar in counties of the western regions of Poland to the average for all counties in the country, and it is higher in counties of eastern regions. Moreover, there is a clear difference in this respect between municipal and land counties, both throughout the country and in its eastern and western regions. The average value of the total expenditure and investment expenditure of county budgets per capita is much higher in municipal counties compared to land counties, and this applies especially to the western regions of Poland. However, in the case of a feature as the share of investment expenditure in the total expenditure of county budgets,

it should be noted that it is the highest in land counties from the eastern regions of Poland and in municipal counties from the western regions (Table 3).

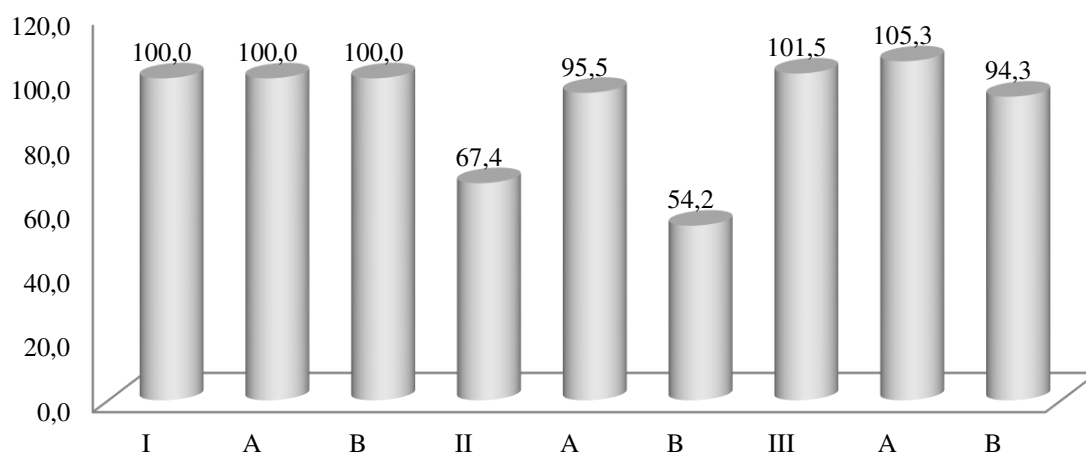
Table 3.

Selected characteristics characterising the economic and financial conditions in municipal and land counties covered by the research in 2022

Specification	Counties		
	total	municipal	land
Poland			
Total income county budgets per capita in PLN	2.809,9	8.380,6	1.639,0
Own income of county budgets per capita in PLN	1.287,1	4.443,8	623,6
Share of own income in total income of county budgets in %	45,8	53,0	38,0
Total expenditure of county budgets per capita in PLN	2.909,3	8.836,8	1.663,4
Investment expenditure of county budgets per capita in PLN	506,7	1.404,6	317,9
Share of investment expenditure in total expenditure of county budgets in %	17,4	15,9	19,1
Eastern regions of Poland			
Total income county budgets per capita in PLN	2.663,2	8.363,4	1.684,8
Own income of county budgets per capita in PLN	1.101,5	3.664,8	588,9
Share of own income in total income of county budgets in %	39,4	43,8	35,0
Total expenditure of county budgets per capita in PLN	2.910,7	8.840,1	1.724,8
Investment expenditure of county budgets per capita in PLN	601,4	1.341,4	453,4
Share of investment expenditure in total expenditure of county budgets in %	20,7	15,2	26,3
Western regions of Poland			
Total income county budgets per capita in PLN	2.797,9	8.622,9	1.705,4
Own income of county budgets per capita in PLN	1.216,6	4.598,1	673,2
Share of own income in total income of county budgets in %	45,7	53,3	39,5
Total expenditure of county budgets per capita in PLN	2.754,0	9.257,1	1.708,8
Investment expenditure of county budgets per capita in PLN	499,6	1.951,9	266,2
Share of investment expenditure in total expenditure of county budgets in %	18,1	21,1	15,6

Source: Central Statistical Office in Warsaw.

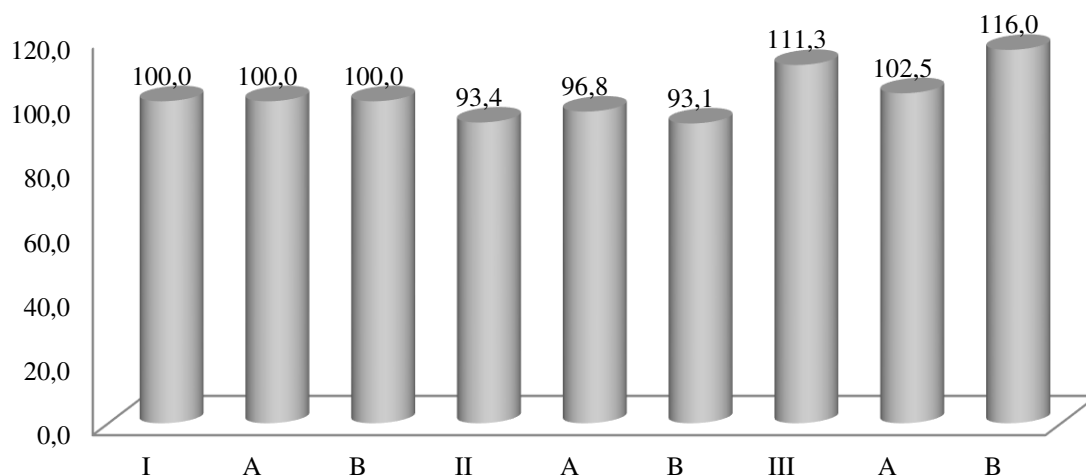
Figure 1 presents the results of the point assessment on demographic conditions and the situation on the labor market in the municipal and land counties covered by the research against the background of all municipal and land counties in the country for 2022. It should be noted that counties in the western regions of Poland are characterised, on average, similar demographic conditions and the situation on the labour market to the average for counties throughout the country. However, in the counties of the eastern regions of Poland they are clearly worse. In addition, there are also differences in this respect between municipal and land counties in the eastern and western regions of Poland, and this applies especially to the eastern regions. In the case of counties in the eastern regions of Poland, land counties are clearly characterised by the worst demographic conditions and the situation on the labor market, and in municipal counties they are slightly worse than the average for city counties throughout the country. In turn, in the case of counties in the western regions, the best demographic conditions and the situation on the labour market are found in municipal counties, and in land counties they are slightly worse than the average for land counties throughout the country.



Explanations: I – total counties in Poland; II – total counties in the eastern regions of Poland; III – total counties in the western regions of Poland; A – municipal counties; B – land counties.

Figure 1. Score assessment of demographic conditions and the situation on the labour market in the municipal and land counties covered by the research against the background of all municipal and land counties in the country for 2022 (counties in Poland = 100.0 points).

Source: Own study.



Explanations: I – total counties in Poland; II – total counties in the eastern regions of Poland; III – total counties in the western regions of Poland; A – municipal counties; B – land counties.

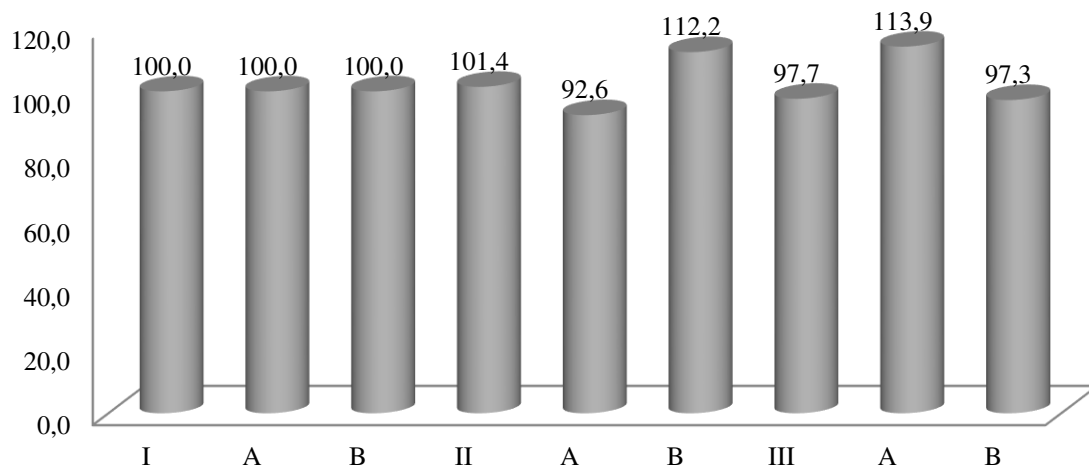
Figure 2. Point evaluation of infrastructure conditions in municipal and land counties covered by the research compared to all municipal and land counties in the country for 2022 (counties in Poland = 100.0 points).

Source: Own study.

Figure 2 presents the results of the point assessment of infrastructure conditions in the municipal and land counties covered by the research compared to all municipal and land counties in the country for 2022. On the basis of this, it should be noted that the counties in the western regions of Poland are characterised by, on average, better infrastructural conditions, compared to the average for counties across the country. In the counties of the eastern regions of Poland, the analysed conditions are slightly worse. Additionally, there are differences in this

respect between municipal and land counties in the eastern and western regions of Poland. In the case of counties in the western regions, the best infrastructure conditions are found in land counties, while this group of counties in the eastern regions is characterized by the poorest infrastructural conditions. However, in the case of municipal counties in the eastern and western regions of Poland, infrastructural conditions are similar to the average for municipal counties throughout the country, although they are slightly better in the western regions.

Figure 3 presents the results of the point assessment of the economic and financial conditions in the municipal and land counties covered by the research compared to all the municipal and land counties in the country for 2022. It should be noted that counties in the eastern and western regions of Poland are characterised by, on average, similar economic and financial conditions, compared to the average for counties throughout the country, with slightly better conditions in the counties of the eastern regions. However, there are differences in this respect between municipal and land counties in the eastern and western regions of Poland. In the case of counties in the eastern regions, the best economic and financial conditions are found in land counties, and in the case of counties in the western regions, this applies to municipal counties. In turn, the worst economic and financial conditions occur in municipal counties in the eastern regions of Poland.



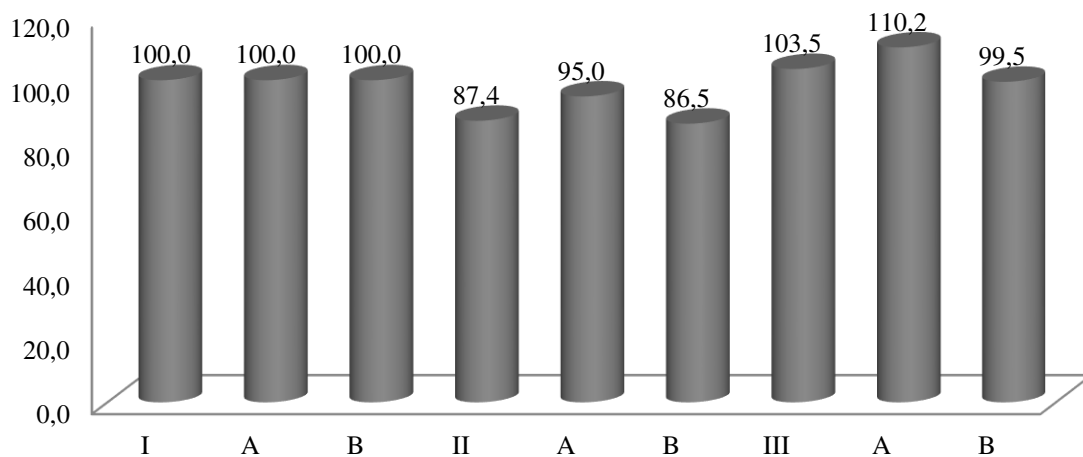
Explanations: I – total counties in Poland; II – total counties in the eastern regions of Poland; III – total counties in the western regions of Poland; A – municipal counties; B – land counties.

Figure 3. Point evaluation of economic and financial conditions in municipal and land counties covered by the investigation compared to all municipal and land counties in the country for 2022 (counties in Poland = 100.0 points).

Source: Own study.

Figure 4 shows the results of the point assessment regarding the conditions of socio-economic development (i.e. demographic conditions and the situation on the labor market, as well as infrastructural and economic-financial conditions together) in the municipal and land counties covered by the research against the background of all municipal and land counties in the country for 2022. On its basis, it should be concluded that counties in the western regions

of Poland are, on average, characterised by slightly better conditions of socio-economic development compared to the average for counties throughout the country. However, in the counties of eastern Poland, these conditions are clearly worse. Moreover, there is also variation in this respect between municipal and land counties in the eastern and western regions of Poland, and this applies especially to the eastern regions. Because in the case of counties in the eastern regions of Poland, land counties are clearly characterised by the worst conditions of socio-economic development, and in municipal counties they are slightly worse than the average for municipal counties throughout the country. In turn, in the case of counties in the western regions, better conditions for socio-economic development are found in municipal counties, while in land counties these conditions are similar to the average for land counties throughout the country.



Explanations: I – total counties in Poland; II – total counties in the eastern regions of Poland; III – total counties in the western regions of Poland; A – municipal counties; B – land counties.

Figure 4. Point evaluation of socio-economic development conditions (that is, demographic conditions and the situation on the labor market, as well as infrastructural and economic-financial conditions together) in the municipal and land counties covered by the research against the background of all municipal and land counties in the country for 2022 (counties in Poland = 100.0 points).

Source: Own study.

This confirms the research hypothesis put forward in the article, which assumes that the conditions of socio-economic development are differentiated between municipal and land counties in the eastern and western regions of Poland, with better conditions in municipal counties, especially in the western regions, and the worst in land counties of the eastern regions.

4. Summary and conclusions

The local socio-economic development of county local government units in Poland and its conditions are very important theoretical and practical issues, especially in the context of the functioning of the economy and society and improving the quality of life.

The analysis of the collected statistical data carried out in the article shows that:

- ✓ the conditions of socio-economic development of county local government units in Poland vary between the counties of its eastern and western regions, as well as between municipal and land counties in the studied regions;
- ✓ demographic conditions and the situation on the labour market are clearly better in the counties of the western regions of Poland, and this especially applies to municipal counties. However, counties in the eastern regions of Poland are characterised by much worse demographic conditions and the situation on the labour market, and this applies especially to land counties;
- ✓ infrastructure conditions are better in counties of the western regions of Poland, and this especially applies to land counties. In turn, the counties in the eastern regions of the country are characterised by worse infrastructural conditions, and this applies especially to land counties;
- ✓ economic and financial conditions are similar in counties of the eastern and western regions of Poland and close to the average for counties from throughout the country. Additionally, the best economic and financial conditions in eastern regions are found in land counties and in western regions in municipal counties, while the worst are in municipal counties of eastern regions of Poland.

Furthermore, statistical data confirmed the research hypothesis, assuming that the conditions of socio-economic development are differentiated between municipal and land counties in the eastern and western regions of Poland, with better conditions in municipal counties, especially in the western regions, and the worst in land counties of the eastern regions.

It should be added that the results and conclusions from the analysis of the collected statistical data presented in the article have important practical implications. They provide important and up-to-date knowledge that may be useful primarily for local government officials responsible for the conditions, opportunities and directions of local socio-economic development of poviats local government units in Poland, as well as for all other decision-makers involved in the implementation of local development policy. This justifies the need to continue similar research and analyses.

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SIMULATION ANALYSIS OF ARTIFICIAL NEURAL NETWORK AND XGBOOST ALGORITHMS IN TIME SERIES FORECASTING

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Purpose: The aim of the article was to prepare a simulation analysis of artificial neural network and XGBoost algorithm with determining which of the method was characterized by a lower level of forecast errors for time series predictions.

Design/methodology/approach: The objective of the article was reached by applying, a simulation study on a sample of 1000 artificially generated time series. The analyzed XGBoost algorithm and the artificial neural network ANN model were intended to prepare forecasts for five periods ahead. These forecasts were compared with the actual implementations of the time series and proposed forecast error measures.

Findings: It is possible to use simulated time series to check which of the presented algorithms were characterized by a lower forecast error. The study showed that applying of the artificial neural networks ANN to forecast future observations generated a lower level of MAPE, MAE and RMSE errors than in the case of the XGBoost algorithm. It was found that both methods generate a lower level of forecast error for time series characterized by a high level of mean value, standard deviation and variance, and levels of kurtosis and skewness close to 0.

Practical implications: The research results can be used by both investors and enterprises to better adjust their business decisions to changing market prices by using a model with a lower forecast bias.

Originality/value: The original contribution of this article is a comprehensive comparison of forecasts generated by the XGBoost and ANN algorithm, along with determining for which types of time series of the algorithms forecast future values with less error. Moreover, due to the use of simulated artificial time series, it was possible to test each algorithm for various market conditions.

Keywords: Artificial Neural Network, XGBoost, time series, forecasting, simulation.

Category of the paper: Research paper.

1. Introduction

Price forecasting of financial instruments is one of the main challenges facing investors and financial institutions. Properly determining the behavior of a given financial asset in the future can significantly increase the effectiveness of investment portfolio management and reduce the

risk associated with unsuccessful investments. The literature contains many econometric, machine learning algorithms and artificial neural networks models to forecast the future values, however, selecting the appropriate method for modeling and forecasting the market still raises many discussions.

Price forecasting is almost impossible. Many models were created to help investors achieve positive rates of return on their investments, but such models are usually very unreliable. Investors or traders who have just entered the market often do not understand the complexity of the relationships existing on the financial world, and only experienced investors are able to effectively use certain models to make business decisions using data coming from the market (Biswas et al., 2019). Current research proves that deep learning with artificial neural network was the most commonly used model for forecasting stock price trends (Mintarya et al., 2023; Ozbayoglu et al., 2020). Discussions on the applying of econometric methods to forecast prices of financial instruments lead to the conclusion that these methods, due to their characteristics and the level of market volatility, may not be suitable for market forecasting. However, some researchers state that econometric models may provide better results than other methods in the case of some non-linear time series (Li et al., 2022). For forecasting more complex non-linear financial time series, algorithms such as: support vector machine (SVR), eXtreme Gradient Boosting (XGBoost), or Multilayer Perceptron (MLP) are becoming increasingly popular (Oukhouya, El Himdi, 2023). These methods are able to detect complex non-linear dependencies in forecasting prices of financial instruments and achieve a better level of fit to real data by tuning many hyperparameters (Kim, Kim, 2019). Hyperparameter optimization or tuning in machine learning algorithms refers to selecting the most appropriate parameters for a particular learning model (Al-Thanoon et al., 2019).

Research conducted by Ariyo et al. (2014) showed that the XGBoost algorithm can be an effective tool for predicting future prices on the American stock exchange, where researchers achieved 87% effectiveness using the XGBoost algorithm to predict stock prices. Cai-Xia et al. (2021) presented that the multistep XGBoost prediction model presented a much better prediction accuracy and model stability than the multistep ARIMA model. The XGBoost model performed better in predicting complicated and nonlinear data like HFRS. Additionally, multistep models are more practical than one-step prediction models in forecasting the future values. Researchers Chung and Shin (2020) indicated that artificial intelligence models such as the ANN use predictors to a better extent to determine accurate forecasts for subsequent periods, regardless of whether the relationships are linear or non-linear, without the need to check the basic statistical assumptions. Gao et al. (2017) found that the ANN model with 20 neurons delayed by 4 periods produces forecasts with a greater RMSE error than the ARIMA model. The researcher also found that as the forecast horizon increases, both the ANN model and ARIMA model predictions become more subject to the RMSE error. Yamin et al. (2004) performed a simulation analysis of the artificial neural network ANN based on a electricity prices. The model consisted of price simulations along with forecasts for subsequent periods.

The simulation study confirmed that the ANN model perform well with price outliers occurring in the data, and the use of an appropriate model preparation and testing strategy together with appropriate features selected for price forecasting significantly improves performance of the algorithm.

Some research focuses not only on the usage of the artificial neural network algorithms or the machine learning methods, but also on the appropriate preparation of the data for the model. The proper selection of the features included in the model can significantly improve performance and the quality of the model forecasts. Researchers Chen and Hao (2017), Wang et al. (2018), Naik and Mohan (2019) created technical indicators and applied them along with the historical financial instruments to improve the quality and the efficiency of the algorithms. As the number of features included in the algorithm was expanded, some researchers used extraction or appropriate selection of data included in the model. to prevent the curse of dimensionality along with the generation of technical indicators. Many studies have applied an expanded input feature space with technical indicators. However, the scope and number of the technical indicators are not yet established, but it is worth remembering that a large set of data with many characteristics causes the problem of irrelevant and redundant information, which can significantly deteriorate the performance of learning algorithms (Yun, 2021).

Since it was noticed that there was no comprehensive analysis and comparison of forecasts created using the XGBoost algorithm and ANN artificial neural networks in terms of their errors, the aim of this article is to prepare a simulation analysis of the tested models with determining which of the method is characterized by a lower level of the forecast errors. In this article, a simulation study was carried out on a sample of 1000 artificially generated time series. The tested XGBoost algorithm and the artificial neural network ANN were intended to prepare forecasts for five periods ahead. These forecasts were then compared with the actual implementations of the time series and calculated error measures.

The original contribution of this article is a comprehensive comparison of forecasts generated by the XGBoost and ANN, along with determining for which types of time series of the algorithms forecast future values with less forecast error. Moreover, due to the use of simulated artificial time series, it was possible to test each algorithm for various market conditions.

2. XGBoost

XGBoost (Extreme Gradient Boosting), is a gradient boosting algorithm. This technique is currently one of the most popular methods in the field of data mining. The XGBoost includes a set of classifiers, which can be decision tree models. In this method, as in the case of random forests, the final decision regarding the results is influenced by all trees used to build the algorithm. The XGBoost applies an incremental strategy which is less complicated and time-consuming than training all trees at once. This method introduces a regularization component into its calculations. The general form of the XGBoost consists of two parts. The first part is the component responsible for minimizing the error, called the loss function, or cost function. The second one, called *regularizer*, helps prevent overfitting and controls the complexity of the model (Grabowska, 2019). To compensate for errors resulting from possible missing data, the algorithm tries to determine the default missing direction by calculating whether it is better for all missing values to select the left subset in the current node or to the right set of subsets of the decision tree (Zhang, 2022). Importantly, the XGBoost is an ensemble model that relies on the efficient implementation of decision trees to create a combined model whose predictive performance is better than individual techniques used alone (Jabeur et al., 2021).

The operation of the XGBoost algorithm is as follows:

1. The data set is divided into a training set and a test set.
2. The algorithm creates the first decision tree, based on which it makes predictions using training data.
3. The next tree created by the algorithm is corrected with the residuals resulting from the predictions received from the previous tree.
4. Steps 2 and 3 are repeated until the algorithm completes or until satisfactory results are obtained.
5. The quality of the algorithm is checked on the test set. If the results are satisfactory, the algorithm can be used for further prediction. Otherwise, there is a need to change the set of hyperparameters.

The output function of the algorithm is calculated as follows (Mo et al., 2019):

$$\hat{Y}_i^T = \sum_{k=1}^T f_k(x_i) = \hat{Y}_i^{T-1} + f_T(x_i) \quad (1)$$

where:

\hat{Y}_i^{T-1} is a created tree,

$f_T(x_i)$ is a new tree model,

T is the number of integer trees used in the algorithm.

3. Artificial neural network (ANN)

The artificial neural networks algorithm ANN was proposed in response to the need to create the artificial neural network algorithm which was able to effectively deal with nonlinear problems. The artificial neural networks ANN represent a non-linear approach that does not require prior strict assumption of the form of data or the type of linearity of the analyzed sample. Regardless of its inherent nonlinear nature, ANN can also effectively deal with linear problems. ANNs have accurate approximation capabilities that can fit a wide set of problems (Martinović et al., 2020). The ANN is a flexible and well-performing model that can be easily implemented for various data patterns. However, overdesign (e.g., large number of hidden nodes and repeated connections) may impose some drawbacks. Overfitting is common in complex systems that involve too many parameters. Therefore, sample data variance is built into the model design, which is not preferred.

The ANNs consist of many individual artificial neurons. The operation of the artificial neuron is basically as follows: each artificial neuron processes a certain finite number of inputs $x_i, i = 1, 2, \dots, n$ into one output y . The input signals come either from outside the network or from the outputs of other nerve cells that create a given neural network. Network synapses process input signals through appropriate weight coefficients, which are determined during the learning process of the neural network. Input signals are introduced to the artificial neuron through connections with given weight coefficients $w_i, i = 1, 2, \dots, n$, which both reflect the strength of the signals and constitute the memory of the neurons because they are able to remember the relationship between these signals and neuron output signals. Weights in the artificial neural networks can have both positive and negative values, and the sign of the weight in a given synapse may change during the learning process (Sarapata, 2011).

Based on the data entered at the input of the network, the total excitation of neuron e is calculated, most often as a linear combination of inputs, often supplemented with a free expression, which can be written as (Witkowska, 2002):

$$e = w_0 \sum_{i=1}^n w_i x_i = w_0 + w^T x \quad (2)$$

where:

x is a vector $[n \times 1]$ of input signals,

w is a vector $[n \times 1]$ of weights that express the degree of importance of information.

In the summing block, the weighted sum of inputs is determined (calculated as a linear combination of the vector of input signals x and the vectors of their corresponding weight coefficients w). Then, in the activation block, the signal representing the total activation of neuron e is transformed by a specific activation function of neuron f . The value determined by this function is the output value y of the neuron, which can be written as (Sarapata, 2011):

$$y = f(w^T x + w_0) = f(e) \quad (3)$$

The main task of the activation function is to determine the output, based on the input data and weights of a given neuron. An important condition in the use of the artificial neural networks is the requirement to apply differentiable activation functions. Many different proposals for activation functions have been considered in the literature, but the most popular ones include: a linear function (linear neuron), a sigmoid function (sigmoid neuron), a tangent function and a Gaussian function (radial neuron) (Tadeusiewicz, Szaleniec, 2015).

The artificial neural networks consist of many layers of individual neurons, in such a way that the outputs of the neurons of the previous layer create a vector fed to the input of each neuron of the next layer. The neurons of each layer always have the same number of inputs equal to the number of neurons in the previous layer + 1, while within one layer the neurons have no connections between each other (Balkin, Ord, 2000). In the ANN model, the first layer is the input layer, which can capture the signal and transmit it to subsequent layers of the network (called hidden layers). Typically, neural network models have at least one hidden layer. The last layer of the network is the output layer, in which output signals are formed in neurons.

Training of the ANN algorithm is most often performed applying the backpropagation method. The operation of the backpropagation algorithm is as follows: after preprocessing the response of the network to a given pattern, the gradient value of the error function for the neurons of the last layer is calculated. Then their weights are modified. The error is propagated to the previous (penultimate) layer. The values of the gradient function for neurons from this layer are generated based on the gradients for neurons from the next (i.e. last) layer. The weights of the next layer are modified. The procedure continues until the input layer. Therefore, a formula describing the components of the δ vector is obtained (Osowski, 2006):

$$\delta_{(i,n)} = (\sum_k \delta_{(i+1,k)} w_{(k,n)}) y_n (1 - y_n) \quad (4)$$

where:

the index i means the number of the layer (i - current, $i+1$ - next),

k the number of the neuron in the next layer,

n the number of the currently considered neuron (n -th component of the input vector for the next layer).

4. The simulation analysis

The simulation study involved generating 1000 artificial time series. Each of the generated time series contained 2352 observations imitating daily closing prices of a financial instrument. The time series was generated applying a library available in Python called *mockseries*. This library allows to prepare synthetic time series with characteristics provided by the researcher. In addition to the *mockseries* library, the *random* library was used to calculate random numbers and the *statsmodels* library was used to check the stationarity of the artificially generated time series with the ADF test. In the table 1 the possible parameters that were randomly selected for each of the artificially generated time series are presented.

Table 1.
Potential parameters for artificial time series

Parameter	Possible values to draw
Seasonality	Yes/No
Data noise	Yes/No
In case of data noise – a level of standard deviation	From 1 to 9
In case of noisy data – a level of mean	From 0 to 2
Slopes of the time series	Up/down
Trend coefficient	From 1 to 9
Amplitude coefficient	From 1 to 9
Trend change (over periods)	From 50 to 350
Seasonality (in periods)	From 50 to 350

Source: own studies.

The randomization of the parameters presented in the table 1. was done using the random number generator and the Do-While loop implemented in Python. The purpose of the script was to generate 1000 non-stationary time series. Whether a given series was classified as a non-stationary series was the result of the ADF test performed with the adopted significance level of 0.05. When the ADF test indicated that the series was stationary, the script skipped a given series and generated the next one until the assumed number of non-stationary time series was created. The study focused on non-stationary time series to be able to reflect the real financial data as closely as possible. Due to the possibility of negative prices of futures contracts for financial instrument in practice, the script had no restriction on accepting negative values. This approach allows to test the analyzed algorithms in various market conditions. Adopting random values for the parameters presented in the table 1. let to generate time series with different levels of mean value, variance, seasonality, or noise in the data. This approach allows to holistically check how different time series structure influence on algorithm accuracy. Figure 1 shows an example of six randomly generated time series.

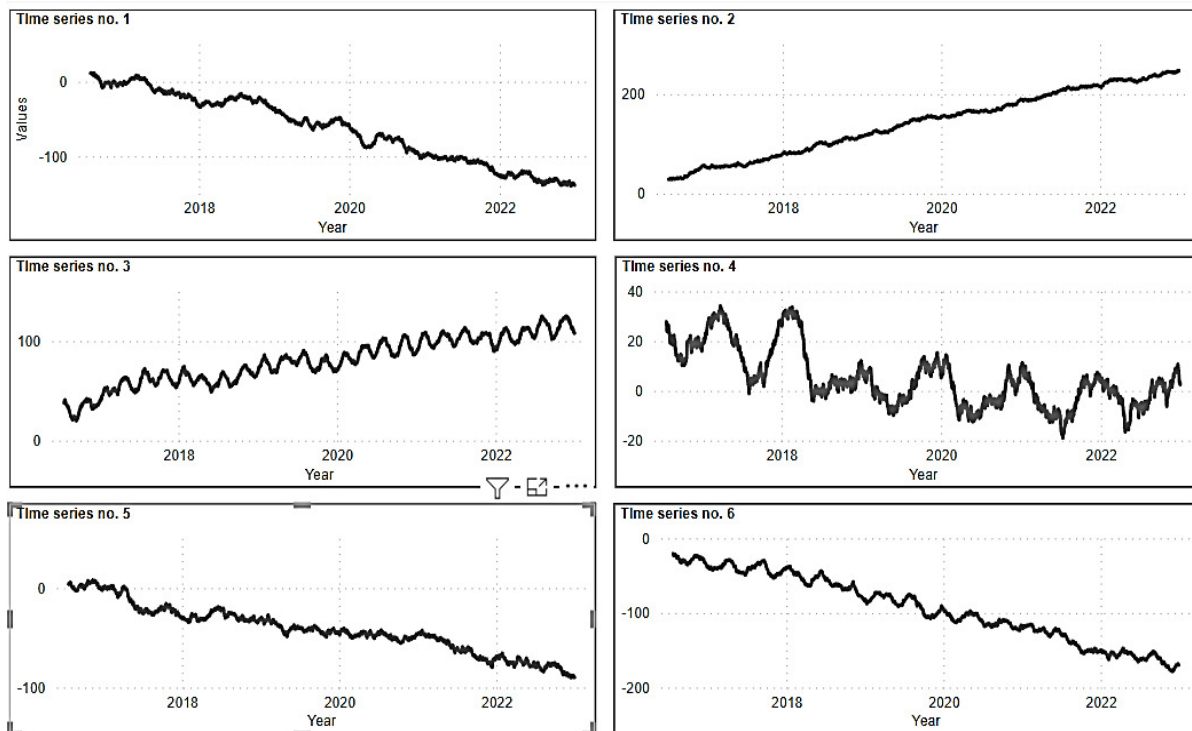


Figure 1. Six examples of randomly generated time series.

Source: own study.

5. Methodology of the simulation analysis

The data for each of the simulated time series were divided into two subsets: the training set and the prediction set. Each of the analyzed methods was intended to generate forecasts for five consecutive periods, then the obtained forecasts were compared with the actual values from the forecast set and forecast errors such as: average absolute percentage error, average absolute error and root mean square error were calculated. The last element of the study was to compare the obtained results of the tested models and check for which time series, statistically speaking, a given method forecast values with a smaller and for which ones with a larger forecast error.

In the case of the tested algorithms, the variables on the basis of which the model learned to predict prices for subsequent periods were five-, twenty-five-, fifty-, one-hundred- and two-hundred-fifty-period moving averages lagged by five periods. Moving averages were used to take into account time relationships in machine learning algorithms and the artificial neural networks. Lagging variables means that the algorithms examine the relationship that moving averages from period $t-5$ have on the forecast variable y in period t . The explanatory variables were lagged in order to be able to easily implement the data into the model in order to prepare a forecast for the next five periods. The testing procedure was as follows: the ANN and the XGBoost models were fitted to the full set of training data. The trained algorithm was then used

to make predictions using the forecast set. This approach significantly improved the simulation performance. The risk of overtraining the algorithms was reduced by each time searching the grid of defined parameters separately for each time series and by determining the first, second and third quartiles of the MAE, RMSE and MAPE errors.

In the simulation analysis, it was assumed that acceptable forecasts are considered to be forecasts for which the average absolute percentage error has values less or equal to 5%, acceptable forecasts are considered to be forecasts with an error between 5% and 10%, and unacceptable forecasts are considered to be forecasts for which whose average absolute forecast error was more than 10%.

In both the case of the XGBoost algorithm and the artificial neural network ANN, the *GridSearchCV* function from the *sklearn.model_selection* library was used to select the optimal hyperparameters of the algorithm. The *GridSearchCV* method allows you to automatically search a defined grid of hyperparameters to determine the optimal set of parameters for a given model. The study defined a variable selection strategy using triple cross-validation of data.

In the case of the XGBoost algorithm, the parameter grid searched by the *GridSearchCV* functions contained the following parameters: the number of boosting stages performed by the model (this parameter allows to limit the over-fitting of the model to the data), the alpha coefficient (affects the level of L1 regularization) and the eta coefficient (a parameter preventing over-fitting by weight correction). The searched values in the parameter grid of the XGBoost algorithm are presented in table 2.

Table 2.

Parameters of the XGBoost algorithm used in simulation studies

Parameter	Possible values to use
number of boosting stages	25, 50, 100, 250, 500
eta	0.01, 0.025, 0.05, 0.075, 0.1, 0.25, 0.5, 0.75, 1
alfa	1, 5, 10, 25, 75

Source: own studies.

In the case of the artificial neural network algorithm ANN, *keras* libraries were chosen to create the model. Using the *keras* library and the function contained in it, it was possible to prepare a neural network consisting of one input layer, one dimension reduction layer, three hidden layers and one output layer. 32 neurons were used in the input layer, 16 in the first hidden layer, 8 in the second hidden layer, 4 in the third hidden layer and 1 neuron in the output layer. The optimization function was set to "Adam", the number of test samples propagated in the network was set to 512, and the number of network iterations (epochs) was set to 200. A sequential model was applied in the study. Model loss functions set to "mape". Before training the neural network using the *StandardScaler* function available in the *sklearn* library, the data was scaled. Moreover, the *GridSearchCV* function was used to search for the optimal activation, initialization and so-called learning rate of the optimizing function.

In the table 3 the parameter grid searched by the *GridSearchCV* function for the ANN model was presented.

Table 3.

Parameters of the ANN algorithm used in simulation studies

Parameter	Possible values to use
Activation function	linear, relu, tahn, sigmoid
Initialization function	normal, uniform
Learning rate	0.0001, 0.001, 0.01

Source: own studies.

6. Results and discussion

The simulation studies carried out allowed for the preparation of forecasts for 5 subsequent periods for 1000 time series, which gave a total of 5.000 forecasts. For each simulated time series forecasts, the MAE, MAPE and RMSE errors were calculated. Table 4 presents quartile I, median and quartile III of the analyzed errors of the XGBoost algorithm.

Table 4.

XGBoost model prediction errors for the performed simulations

Prediction error	Quartile I	Median	Quartile III
MAPE	0.732%	1.547%	3.390%
MAE	0.647	1.176	2.126
RMSE	0.754	1.333	2.301

Source: own studies.

As presented in the table 4, the median level of the average absolute percentage error of the XGBoost algorithm was 1.547%. This means that 50% of the MAPE errors are lower than or equal to 1.547% and the remaining 50% of the MAPE errors are equal to or higher than 1.547%. The level of MAPE quartile I was 0.723%, while quartile III was 3.390%. This means that 25% of the MAPE errors are less than or equal to 0.723%, while 75% of the MAPE errors are higher than this value. In the case of quartile III, 75% of forecasts have an error lower than or equal to 3.390, while 25% of forecasts have a MAPE error higher than this value. The median of the mean absolute error of the MAE was 1.176. This means that for 50% of forecasts the forecast value deviates from the actual implementation of the time series by 1,176 units or less, while for the remaining 50% by more than 1,176 units. The value for quartile I of the MAE error was 0.647 units, while for quartile III it was 2.126 units. The median mean square error of the RMSE forecast was 1,333 units. This means that the midpoint value of the average expected forecast varies by plus or minus 1,333 units between the predicted value and the actual value. The value for quartile I was 0.754 units, while for quartile III it was 2.301 units. The figure 2 and figure 3 show examples of a time series for which the MAPE prediction error was less than 5% and one example of a time series for which the error was higher than 10%.

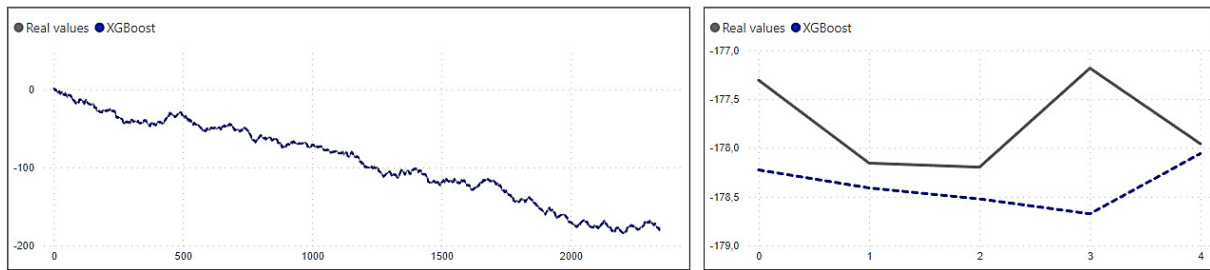


Figure 2. An example of a time series with forecast error <5% (series no. 94).

Source: own study.

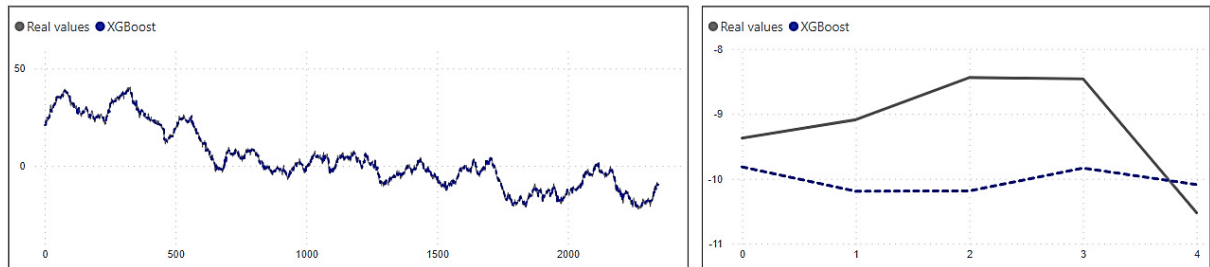


Figure 3. An example of a time series with forecast error <5% (series no. 94).

Source: own study.

The next analyzed algorithm was the artificial neural networks ANN. The results of the prediction errors of the simulation analysis of the ANN are presented in the table 5.

Table 5.

The ANN model prediction errors for the performed simulations

Prediction error	Quartile I	Median	Quartile III
MAPE	0.668%	1.490%	3.411%
MAE	0.604	1.145	2.045
RMSE	0.687	1.304	2.178

Source: own studies.

As presented in the exhibit 8 the median level of the average absolute percentage error of the ANN algorithm was 1.490%. This means that 50% of the MAPE errors are lower than or equal to 1.490% and the remaining 50% of the MAPE errors are equal to or higher than the value. The level of MAPE quartile I was 0.668%, while quartile III was 3.411%. The median of the mean absolute error MAE was 1.145. This means that for 50% of forecasts the forecast value deviates from the actual implementation of the time series by 1.145 units or less, while for the remaining 50% by more than 1.145 units. The value for quartile I of the MAE error was 0.604 units, while for quartile III it was 2.045 units. The median mean square error of the RMSE forecast was 1,304 units. This means that the midpoint value of the average expected forecast varies by plus or minus 1,304 units between the predicted value and the actual value. The value for quartile I was 0.687 units, while for quartile III it was 2.178 units. The figure4 and the figure 5 present one example of a time where the level of the MAPE error for the ANN algorithm was less than 5% and one example of a time series for which the error was higher than 10%.

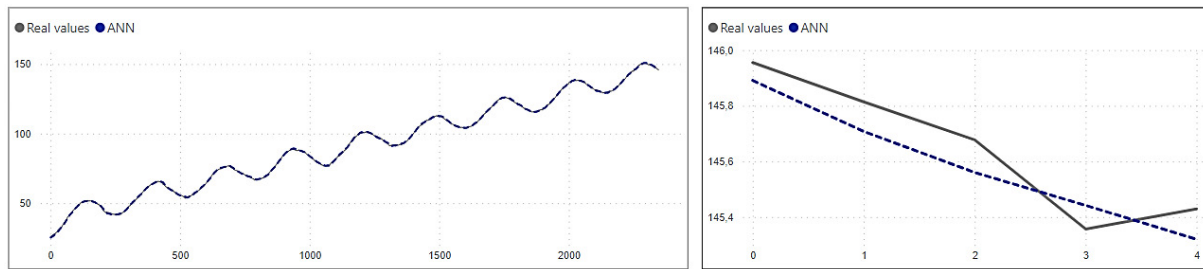


Figure 4. An example of a time series with forecast error <5% (series no. 94).

Source: own study.

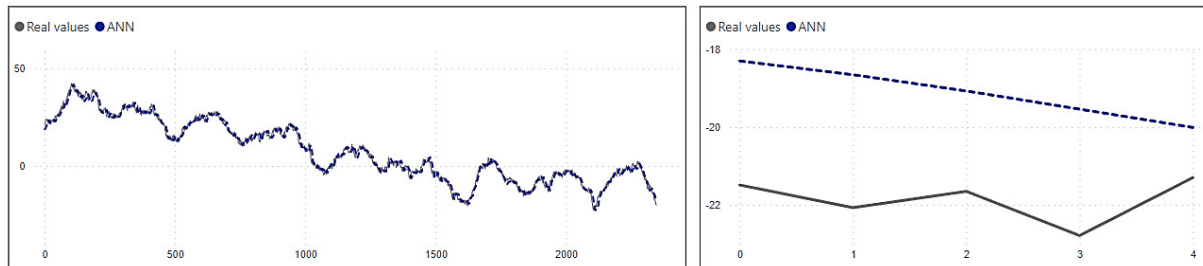


Figure 5. An example of a time series with forecast error <5% (series no. 94).

Source: own study.

Comparing the forecast errors of the XGBoost and the artificial neural networks ANN algorithms, it can be noticed that the medians of all analyzed forecast errors are lower in the case of the ANN model. The values of quartiles I and II are also at lower levels for the artificial neural networks ANN. This means that the forecasts made by the ANN model on a sample of 1,000 simulated time series are characterized by a lower level of error than the forecasts made by the XGBoost algorithm.

The next stage of the analysis was to statistically characterize the time series for which the MAPE error was lower than 5% and the time series for which this error was higher than 10%.

In the case of the ANN artificial neural network algorithm, the number of time series for which the MAPE error was lower than 5% was 839 series, the number of series with the MAPE error was than 10% was 72 series. For the XGBoost algorithm, 837 time series had a MAPE error of less than 5%, while for 75 time series this error was higher than 10%. The table 6 presents the statistical analysis of time series for which the MAPE error was lower than 5%, while the table 7 presents the characteristics of time series with MAPE error higher than 10%.

Table 6.

Characteristics of time series with MAPE forecast error <5%

Quartile	Skewness	Kurtosis	Standard deviation	Variance	Mean
Quartile I	-0,085	-1,199	16,562	274,313	-34,840
Median	-0,013	-1,124	23,523	553,314	18,177
Quartile III	0,056	-0,965	36,950	1 365,282	62,528

Source: own studies.

Table 7.*Characteristics of time series with MAPE forecast error >10%*

Quartile	Skewness	Kurtosis	Standard deviation	Variance	Mean
Quartile I	-0,130	-1,052	8,833	78,017	0,958
Median	-0,021	-0,803	10,774	116,084	6,465
Quartile III	0,188	-0,479	13,681	187,176	11,194

Source: own studies.

Analyzing the above tables, it is worth noting that the XGBoost and ANN algorithm generate lower MAPE forecast errors for time series characterized by a higher level of median variance, standard deviation and mean value than in the case of time series for which the forecast error was higher. It is also worth paying attention to the fact that the level of skewness in models with MAPE error below 5% is close to 0 in practically every quartile, while for series with MAPE error greater than 10%, a weak left-sided asymmetry of the distribution determined by quartile I and a weak right-sided asymmetry can be observed. determined by quartile III. The median kurtosis level is lower for time series with the MAPE error greater than 10%.

7. Conclusion

The aim of this article was to prepare a simulation analysis of the tested models with determining which of the method is characterized by a lower level of forecast errors. The objective was achieved by preparing 1,000 artificial time series, which were the basis for preparing forecasts by the XGBoost and the artificial neural networks ANN. For each time series, future values were forecast for five subsequent periods, then the forecasts were compared with the actual implementations of the time series and the forecast errors of MAE, MAPE and RMSE were calculated.

Simulation studies have shown that the artificial neural network model predicts future time series values with a lower error than the XGBoost algorithm. The median MAPE error of the artificial neural networks ANN was 1,490 and was 3,685% lower than for the XGBoost algorithm. Also, the median MAE and RSME error of the ANN were lower than those of the XGBoost (1.145 vs 1.176 and 1.304 vs 1.333, respectively).

Additionally, statistical characteristics of time series for which the MAPE error was below 5% and time series with a MAPE error above 10% were performed. The analysis showed that time series with a lower level of MAPE error are characterized by a higher level of the median value of the mean standard deviation and variance compared to time series for which this error was higher. The level of median skewness was at a similar level in both groups of time series, while the level of median kurtosis was slightly higher for series with MAPE forecast error above 10%.

Another possibility of conducting the research is to compare the XGBoost algorithm and the artificial neural networks ANN with other models from the group of machine learning algorithms, artificial neural networks or econometric models in order to determine which of the selected models forecasts future values with a lower forecast error.

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SOFT SKILLS OF A MANAGER IN LEADING PROJECT TEAMS

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Purpose: Within the scope of management and leadership processes, the leader of a group is responsible for ensuring the successful implementation of each endeavor (project/process) according to the defined criteria of success or failure. This article discusses the issues related to developing situational awareness among team members and the possibilities of motivating and communicating within a team using appropriate management competencies and techniques employed by individuals managing specific processes or projects. The essence of projects and processes, as well as the impact of soft skills on the effectiveness of such endeavors, are presented. Special emphasis is placed on communication techniques as fundamental tools for team leadership and creating a constructive atmosphere for achieving success.

Design/methodology/approach: The article has been developed based on observations, analysis, and experiences gained during the implementation of research and development projects. The presented conclusions and topics are supported by scientific literature.

Findings: The analysis and conclusions clearly indicate that actively improving soft skills and using a variety of communication techniques significantly improves the quality of organization, interaction and, above all, leadership of the selected project group.

Practical implications: Expanding one's skills in the area of soft skills directly enhances the effectiveness of teams managed by leaders. A well-functioning organization will achieve its goals more quickly and efficiently.

Social implications: Learning about, realizing the role of, and improving soft skills and communication techniques will significantly improve the understanding of the messages conveyed in society and influence empathetic relationship building.

Originality/value: The recipients of the paper should be primarily those in managerial, command and leadership roles in both technical project groups and any organization where effective management of personnel resources is required. The novelty of the work is primarily the presentation of the impact of soft skills on the achievement of organizational goals framed in the context of the project life cycle and the conditions of the management process.

Keywords: process and project management, leadership, communication, soft skills, situational awareness.

Category of the paper: Research paper.

1. Introduction

In the contemporary, dynamic, and stimulus business environment, effective project management serves as a pivotal element for achieving organizational success. Both design and production-service processes, including leadership, are incessantly confronted with diverse challenges, necessitating managers (commanders) to concurrently consider technical and social aspects of work within executive teams. The environment in which an executive team leader operates is influenced by external factors independent of the manager's actions and internal factors, over which the managerial individual possesses genuine control if equipped with the requisite competencies and awareness to effectively utilize them. Within such a context, an important area is the comprehensive preparation of managers, both in the substantive area of the project to be carried out, as well as the possession of appropriate communication techniques and tools.

The tools mentioned, although they may initially appear as natural, innate abilities, when appropriately and consciously refined, can create an effective team management tool by fostering the ability to perceive and understand situations and project success. Consequently, skillfully conducted conversations, as the fundamental form of team communication, enhance the informational and decision-making process carried out by the manager at every stage of the management cycle. Supported by an appropriate set of informational and persuasive techniques, along with a solid and developed repertoire of soft skills, it increases the leader's chances of understanding team members (their needs and executive capabilities) and enables the establishment of relationships based on mutual respect and empathy.

The article presents the essence of a project and process as the domain in which a team leader operates. An attempt has been made to utilize a universal approach to project and process using the "project triangle" and the UMP (Universal Process Model) as substantive tools indicating important attributes in team management. Against the backdrop of these models, the full project/process management cycle is described, emphasizing relevant competencies at each stage of project implementation. Soft skills are described as a collection of interpersonal, social, and communication abilities, as well as personality traits and social skills. In the final section, the role that the mentioned techniques, tools, and competencies can play in project and process management is discussed. It is worth noting that the issue of human resource management addressed in the article (team management and team communication processes) is one of the essential knowledge areas in project management and closely aligns with management methodologies (such as the PMI/PMBok methodology). The article is profiled with the hypothesis that the implementation of soft skills strengthens the value of the project as well as the efficiency and execution potential of project teams. In order to verify this hypothesis, the analysis and criticism of the existing literature as well as a diagnostic survey based on multiple, direct observation of project contractors and the assessment of the effectiveness of the

impact of the competences in question (creating situational awareness) in various phases of the project implementation in a systemic perspective were adopted.

2. Essence and Systemic Attributes of a Project and Process

Management is an organized and coherent process understood as a series of actions aimed at achieving a defined goal in an orderly and controlled manner. The essence of every process lies in its transformative function, which converts specified requirements and input resources into expected outcomes. Therefore, a process is a dynamic component of any operational system (project systems, production systems, service systems, leadership systems, etc.) implemented for the effective organization of activities to achieve specific organizational objectives. Human resources constitute an input resource that determines the value of the obtained results (projects, products, etc.). The optimization of repeatable processes, in the context of resource management, focuses on their coordinated and efficient utilization. Project is typically regarded as a temporary/one-time undertaking that aims to achieve a specific goal within a defined time frame and with specific resources. Each of this is characterized by its uniqueness and non-repeatability, as it differs from others in terms of objectives, resources, and duration. Project management encompasses planning, organizing, directing, and controlling activities to effectively achieve the project's goals.

In the context of these concepts, it is valuable to utilize the "project triangle" and the UMP as holistic tools for a comprehensive approach to managing projects and processes. These tools indicate systemic criteria that determine the level of goal achievement in terms of team management effectiveness. The project triangle (Project Management Institute (PMI), 2017), also known as the constraint triangle or design triangle, illustrates three main dimensions of project design and management that are interconnected and mutually influential, determining the level of quality as a generalized criterion of action. These elements are scope, costs, and time. This method is used in project management (processes/undertakings) to visualize the relationships between these three key constraints, emphasizing that a change in one element affects the others, thus influencing the entire project (the outcome/output of each process). Figure 1 shows the project management triangle.

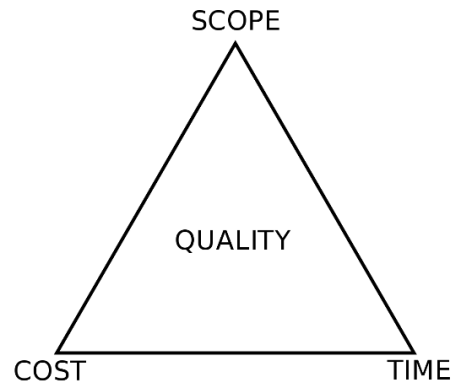


Figure 1. Project management triangle (Project management triangle, 2023).

The dimensions indicated in the project triangle include:

- **Scope**, which encompasses all tasks, objectives, and deliverables planned to be achieved within the project. It defines what exactly will be the subject of the design, and any changes to this dimension can impact costs and the time needed to complete the project.
- **Costs**, which include all financial resources required to carry out the project, including employee salaries, necessary materials, and other operational costs associated with the project. Changes in project costs can affect the scope and duration of the project.
- **Time**, which refers to the planned duration of the project according to the agreed-upon project schedule. Shortening the time can impact the project scope and costs.

The project triangle highlights the constant interaction between these three dimensions, and their values determine the level of quality. A thorough understanding of the project triangle is crucial for effective project management and achieving quality criteria in project or process management, as it enables managers to approach changes in a balanced manner and understand the resulting consequences.

The UMP model of the process is a methodological structure that focuses on three key stages: Understanding, Modeling, and Planning. The model provides a comprehensive tool to support project management and execution processes, enabling effective and purposeful operations (Project Management Institute (PMI), 2017):

1) Understanding, which includes:

- **Definition of Objectives and Requirements:** as seeking to fully understand the objectives of the project/process and any requirements associated with it.
- **Analysis of Context:** as an analysis of the broader context in which the project will be implemented, including stakeholder identification, risk analysis and understanding of the project's impact on the organizational environment.
- **Developing the Execution Strategy:** Based on the objectives and context, a project implementation strategy is created, defining the main lines of action.

2) Modeling involves:

- **Process Model Creation:** focusing on creating a detailed process model that illustrates the individual steps, dependencies, and interactions (such as workflow diagrams, schematics, etc.).
- **Resource Identification:** identifying the necessary resources, both human and material, as well as technological resources required for each project stage.
- **Process Efficiency Evaluation:** determining measures and criteria to assess process efficiency and identify potential areas for optimization.

3) Planning includes:

- **Action Plan Development:** creating a representation of the goals, process model, and available resources, reflected in the schedule, budget, and responsibilities in each phase of project implementation.
- **Monitoring and Control:** an inherent process of improvement and utilization of monitoring and control principles and systems to assess the progress of the project, identify any delays or risks, and take corrective actions.
- **Plan Adaptation:** a significant phase of managing change in the project (a common phenomenon in project management), involving flexible adjustment of the action plan to meet new requirements, limitations, and challenges.

The UMP process management model provides a structured approach to managing projects/initiatives, enabling a focus on understanding, modeling, and planning for effective goal achievement. In a holistic perspective of projects and processes, this means that project managers must simultaneously consider and manage scope, costs, and time, while also having a full understanding of the project's context and objectives. Within the project triangle, a change in one element necessitates adjustments in the others, requiring flexibility and efficient response to variable conditions. On the other hand, the UMP process model demonstrates that understanding, modeling, and planning are interconnected steps, each playing a significant role in effective project management.

An important perspective for perceiving not only the management process but also transformative processes (project, manufacturing, service, etc.) from a systemic standpoint is the substantive knowledge of artifacts and tasks that are necessary for execution, as well as the allocation of roles to performers, based on an assessment of their experience and suitability for achieving the designated goals. In the case of human resources, this entails evaluating the level of professional competence and experience in managing executive teams. A comprehensive understanding of the essence of a project and process enables managers to accurately anticipate, comprehend, and respond to challenges, ultimately leading to the effective achievement of organizational goals.

Each process and resource used in the execution of various project-production processes requires a comprehensive evaluation, which allows for the determination of the actual state of the chosen stage of process/project/product realization. This evaluation is provided by universal systemic criteria. The evaluation of coherence and completeness of actions, as well as their integrity, effectiveness/efficiency, and the quality of products/results, is particularly important. Systemic criteria constitute a key structure of analysis, enabling a holistic view of the project/process and the entire system of operation at each stage of the designated initiative's implementation. These criteria include, among others (Kossiakoff, Sweet, Seymour, Biemer, 2011; Kelly, Male, Graham, 2004; Zaskórski, 2015; 2012):

- **Usability** informs how the project or process meets user expectations, including an assessment of overall user satisfaction with the results of the given process. Functionality is an evaluation of whether the project meets its intended goals and requirements, including its potential for expansion or adaptation to constantly changing needs.
- **Reliability** is a measure of the stability and effectiveness of the project/process and its outcomes in various conditions and situations, with a focus on minimizing the risk of failures or other malfunctions.
- **Efficiency** is a criterion for achieving intended goals with minimal resource consumption, both in terms of time and cost.
- **Risk** focuses on identifying, analyzing, and managing potential threats to project implementation, as well as the need to understand and effectively control and mitigate risks.
- **Quality** is a generalized systemic criterion that has a product perspective (ex-post, quality of outcomes/results) and a process perspective (ex-ante, aspects related to the resources used, time of implementation, and project/process requirements/scope/complexity), with reference to standards.
- **Viability** is a criterion for analyzing and assessing the durability and adaptability to changes over time, with the value of a project, for example, increasing if it is oriented towards long-term benefits.
- **Readiness** is a criterion for evaluating the manner and preparedness of the organization (executive team) to adopt and effectively implement new solutions.
- **Developability** is a measure of the ability to adapt and expand solutions in response to changing environmental or technological needs.
- **Safety** is closely associated with the level of risk and ensures an adequate level of protection for the entire system of operation, including users, data, and the environment.
- **Completeness** is a systemic characteristic that confirms whether a specified component is a system, such as whether the executive team is complete to undertake a given

initiative and whether the project includes all necessary elements to effectively fulfill its goals.

- **Complexity** takes into account the complexity of the project and its interaction with the environment, which is crucial for effective management of multi-aspect projects.
- **Coherence** relates to the logical and harmonious connection of all its elements to create a cohesive whole (an absolute condition of status: a system).
- **Synergy** is a measure of the growth potential of the system (project team) through the value of relationships between component objects and allows assessing whether the project brings additional value through the integration of different elements in a way that enhances efficiency and effectiveness.

Relying on systemic criteria in the analysis of a project/process at each stage of implementation forms the foundation for a comprehensive evaluation throughout its entire life cycle, enabling a comprehensive view of effectiveness, efficiency, and value in terms of the organization of the executing entity and the need for utilizing soft skills competencies.

3. Full Management Cycle

The full management cycle encompasses a series of stages, starting with project initiation, where goals are defined and stakeholders identified, followed by the planning phase, where detailed schedules, resource allocation, costs, and risk management are developed. The next stage is execution, during which the project plan is implemented and tasks are assigned to the team, with a focus on effective quality management. Subsequently, in the monitoring and control phase, the project undergoes continuous oversight, problems are identified, and corrections are made in line with planned actions. The final stage is closure, where the project is formally concluded, results are evaluated, reports are prepared, and the product or service is handed over for use. The aforementioned stages mainly focus on the substantive dimension, which does not consider the equally important aspect of project management - the soft skills of project leaders. It is the project managers who, utilizing their competencies, guide the team throughout the full project or process lifecycle. Soft skills can be defined as a set of interpersonal, social, and communication abilities that enable individuals to effectively interact with others in various contexts. These skills include verbal and non-verbal communication, empathy, leadership abilities, conflict resolution, teamwork, and adaptability to changing situations. Soft skills are crucial for effective team management and achieving professional success (Latham, Pinder, 2005). In a different perspective, soft skills can be seen as personality traits and social abilities that influence an individual's effectiveness in interpersonal relationships and teamwork. It includes aspects such as emotional intelligence, interpersonal communication skills, stress management, empathy, assertiveness, and effective

time management. Soft skills are essential both in the context of professional career and personal development, contributing to creating a positive work environment and achieving organizational goals efficiently (Robbins, Judge, n.d.). Figure 2 illustrates an example project lifecycle (Project Management Institute (PMI), 2017; Project Management Life Cycle, 5 Project Management Phases, 2019).

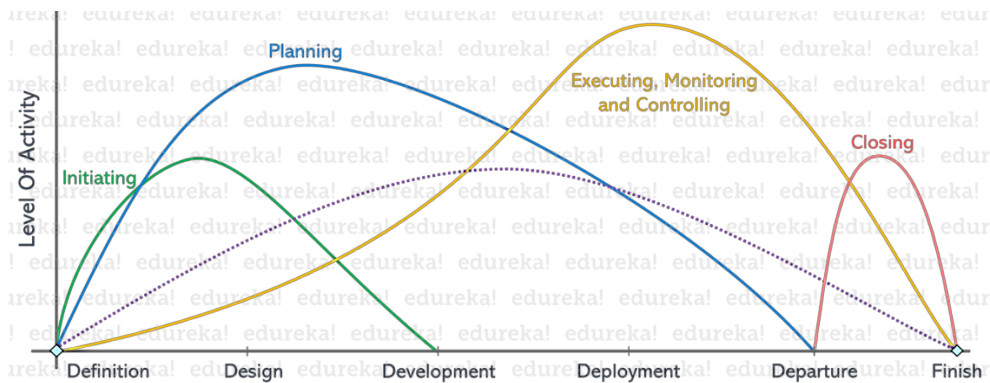


Figure 2. Project Life Cycle (Project Management Institute (PMI), 2017; Project Management Life Cycle, 5 Project Management Phases, 2019).

Therefore, it should be understood that soft skills, such as effective communication, team motivation, conflict and problem resolution, and the ability to adapt to changes, play a crucial role at every stage of the management cycle in any project. Moreover, in each stage, communication techniques and tools can be supported by processes for monitoring, recording, reporting, and standardizing team activities. This comprehensive approach enables the effective achievement of project goals and the establishment of a sustainable organizational culture.

In the first stage (*Definition*), strong soft skills in communication and relationship building are crucial. The ability to effectively monitor stakeholder expectations and record their needs forms the basis for properly defining the objectives of the project. Additionally, reporting and standardizing actions help in effectively communicating goals to the team and adapting the plan to changing needs.

In the next stage (*Design*), planning and resource allocation skills are key. Soft skills such as effective task delegation and the ability to motivate the team are essential for creating a detailed project plan. Monitoring project progress and recording key plan elements aid in aligning team actions with the established goals. Reporting is important in identifying any issues in team management.

In the third stage (*Development*), the leader should focus on aspects related to conflict management and team motivation. Monitoring work quality and documenting progress are crucial for maintaining a high standard of performance. Reporting allows for tracking the effectiveness of team management strategies, and standardizing actions influences the effectiveness of development processes based on experience (norms/standards).

In the *Deployment* stage, soft skills in change management and effectively responding to unforeseen situations. Monitoring the implementation process and recording results and any issues allow for ongoing adaptation of team actions. Reporting in this phase facilitates the communication of progress to stakeholders, and standardizing actions ensures team cohesion during dynamic situations.

In the project *Departure* stage, soft skills related to summarizing experiences, sharing knowledge, and appreciating team work play a leading role. Monitoring project results and documenting lessons learned contribute to process improvement. Reporting in this phase enables the communication of key project information, and standardizing actions supports an organizational culture conducive to continuous improvement.

In the final stage (*Finish*), soft skills related to building an organizational culture that fosters further process improvement are important. Monitoring, documenting results, and reporting effectively influence the direction of development. Standardizing actions in this phase assist in building a long-term team and organizational development strategy.

The full management cycle effectively integrates monitoring, documenting, reporting, and standardizing project activities while developing key soft skills in team management. Collaborative work on these elements allows for the effective achievement of project objectives and the establishment of a sustainable organizational culture conducive to improvement.

4. Identification of Soft Skills

The fundamental tool for every leader is communication, which allows for effective interaction among team members, both on the same level and when the level changes vertically, such as during a conversation between a superior and a subordinate, or vice versa. Conversations, or rather, communication within a team, can serve multiple functions, particularly in flat/process-oriented, networked/virtual, or even matrix structures. This article focuses on two fundamental functions: the persuasive function, where the sender aims to convince the receiver to perform a specific action, and the informative function, where the sender intends to convey a message to the listener. Figure 3 depicts the basic elements of the conversation

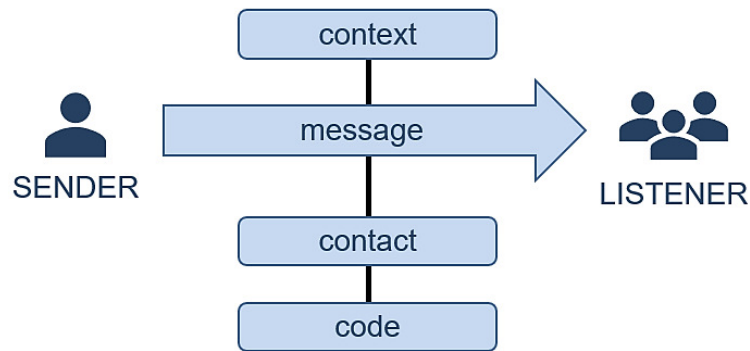


Figure 3. Basic elements of a conversation, adapted from personal observations: (Patterson, Grenny, McMillan, Switzler, n.d.; Rosenberg, n.d.).

The communication model depicted in Figure 3 consists of four fundamental elements: context, message, contact, and code.

Context refers to the awareness of the purpose and situation of both parties, including the sender, who should reflect upon and recognize and evaluate the circumstances in which the conversation will take place. Failure to consider the location, environment, and individuals involved in the conversation may result in the speaker's statements being inadequately understood or ignored by the recipient. Enhancing the effectiveness of conveyed information requires adjusting the level of conversation, language, and vocabulary to match the recipient's familiarity and accurately assessing the entire discussion situation. Evaluating the situation also involves considering the specific topic to be discussed. A thorough understanding of the topic helps to avoid unnecessary misunderstandings and facilitates the conveyance of essential information. Awareness of the emotions and tone of the conversation is another aspect, as the manner of expression can influence message reception. Additionally, adapting the speaking pace to the recipient's information assimilation capabilities, while avoiding excessively fast or slow dialogue, is important.

Furthermore, assessing the situation entails understanding the purpose of the communication and the sender's expectations of the recipient. It is crucial to ensure clarity of goals, which enables focus on relevant issues and organized information transmission. A common mistake made by conversationalists is the lack of awareness regarding the goals to be achieved in the planned conversation. This leads to misunderstandings and conflict situations. Recognizing the appropriate context allows for the creation of an atmosphere of mutual understanding and acceptance, facilitating effective information exchange. Therefore, the ability to flexibly respond to changing conversation conditions is a key element in assessing the situation, enhancing communication effectiveness.

The **message** is essentially the information conveyed during the conversation, with the understanding that the information is interpreted within a specific context. The context serves as a set of references in which the conveyed data hold specific meanings and can be understood in the manner intended by the sender. It is particularly important for the sender to be aware of their expectations from the recipient and the specific information they wish to convey.

This enables greater motivation, willingness, and empathy, which are essential elements of professional communication. Defining the data within the recognized context organizes the conveyed information into a logical whole and promotes accurate inference and the generation of useful knowledge for future interactions.

Contact facilitates the exposure of non-verbal communication. Proper behavior towards the other person allows for the creation of a good atmosphere and effectively increases the recipient's awareness, including understanding, interest, and also determines the sender's credibility. It has long been emphasized in literature that non-verbal communication is not just a backdrop for linguistic communication, as it has a greater impact on the additional value of information. The SOLER procedure is an effective technique for improving conveyed information. It is an acronym that stands for five basic principles of effective communication with another person:

- **Stand** facing the interlocutor – allows you to establish rapport with the recipient.
- **Openness** – maintains a good relationship with the speaker.
- **Lean** slightly forward – significantly arouses a sense of interest.
- **Eye contact** – ensures proper communication.
- **Relax** – allows for a comfortable conversation.

Code is the final component of conversation and is based on a vocabulary resource and the correct pronunciation presented by the message sender. Continuous improvement of skills in this area significantly enriches the language used by the interlocutor. As a result of enhancing language skills, vocabulary range, and knowledge of word meanings, not only respect but also attention and respect are gained from potential recipients. Pronunciation correctness is also crucial, and it can be shaped by independently performing a series of exercises that affect different parts of the human speech apparatus. Not every word, despite its superficially neutral character, has a positive impact on the conversation and conveyed information. Therefore, it is important to use words conservatively in the conveyed sentences, such as:

- **Why** – often assumes a hostile attitude and causes irritation.
- **But** – often contradicts the previous statement.
- **I will try** – this expression often implies failure or partial success of an endeavor.
- **No** – negatively predisposes the recipient and triggers a defensive attitude.

In addition to a fundamental understanding of communication principles, a professional leader should possess the ability to interpret basic emotional expressions presented through non-verbal communication by the other person (Kwong et al., 2018). These expressions include Joy, Fear, Sadness, Disgust, Contempt, Surprise, and Anger. Figure 4 shows the basic expressions of emotions.

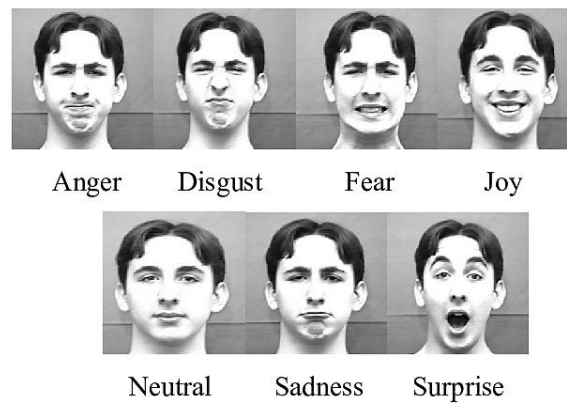


Figure 4. Seven basic expressions of emotions (Kwong et al., 2018).

This down-to-earth skill of recognizing emotions in another person allows for empathetic and effective communication, not only in conversations with individuals but also in effective team management. Despite the simplicity of this skill, it becomes apparent from the outset that it is not innate but rather requires specific intellectual preparation when attempting to decipher human emotions. Proficiently probing the current psycho-physical state of the conversation partner opens up possibilities for making various decisions that influence the implementation process of a given project. Moreover, during the evaluation phase of the management process, proper team management considering and understanding the emotions of its members will impact the effectiveness and realism of the conducted analysis.

It should also be emphasized that blatant mistakes in relationships with others include judging individuals, disregarding them, engaging in nonconstructive criticism, and making comparisons, often leading to a negative attitude towards recipients and a poor assessment of their current state and behavior. This overall impression affects the created situation (context) and translates into an ineffective form of conversation. It is important to distinguish feelings from thoughts and emotions from observations. What others do triggers our feelings, but it is not the cause of them. Unmet needs imply the emotions we experience. Proper understanding of these emotions allows for maintaining rationality and composure, which are essential elements of professional leadership behavior (Goleman, Boyatzis, McKee, 2002; Riggio, Murphy, Pirozzolo, 2012).

The synthesis of these presented skills, awareness of their significance, and the selection of appropriate communication tools by a leader constitute the foundation for effective management and leadership, directly influencing the results of undertaken actions (processes/projects, etc.). Therefore, continuous improvement of knowledge and qualifications in the field of soft skills is vital if efficient and accurate execution of assigned tasks is expected, while ensuring an adequate level of situational awareness among all synergistically cooperating entities. Soft skills significantly support such a role.

5. The role of soft skills in the performance of executive teams

A critical analysis of the literature on the subject and dedicated literature studies (points 2-4), as well as research based on direct observation of a number of project teams and a diagnostic survey confirm the following statements regarding the role of soft skills in the effective management of executive teams, with particular emphasis on interpersonal communication strengthening the potential of these teams. The research and observations have been conducted over the past three years in a variety of project teams, mostly technical. In the full cycle of project and process management, soft skills play a crucial role in managing executive teams with the assumption of internal team coherence and assessing the individual characteristics and capabilities of each team member. The effective use of these competencies has important implications in many functional areas (Pink, n.d.; The Arbinger Institute, n.d.), such as:

- **Motivation:** influencing the ability to understand team reactions and effectively motivate its members. The capability to identify individual needs and preferences allows for adapting motivational strategies, which can significantly impact engagement and work effectiveness.
- **Ensuring quality and effectiveness of actions:** enable leaders to not only evaluate current progress but also identify potential threats to the quality and effectiveness of actions. The ability to recognize warning signs, anticipate problems, and react promptly contributes to risk minimization and maintaining high standards.
- **Effective communication:** play a key role in the efficient functioning of executive teams. By employing various communication techniques, leaders can effectively convey essential information, build understanding within the team, and resolve conflicts. Their ability to clearly communicate goals and expectations creates a foundation for harmonious team functioning.
- **Creating team situational awareness:** soft skills ensure the recognition of team reactions, the analysis of motivational implications, and the assessment and understanding of team preferences, which can enhance situational awareness. The ability to perceive threats, understand them, and anticipate the needs and behaviors of the team enables effective adaptation strategies, leading to flexibility and adaptability in dynamic operating environments.
- **Conflict resolution:** encompass the ability to effectively manage conflicts, resolve disputes, alleviate tensions, and mediate between team members in a manner conducive to collaboration and team development.
- **Building interpersonal relationships:** involve recognizing the role of interpersonal relationships in effective management. Strong relationships foster open communication, mutual trust, and collaboration, thus enhancing team performance.

- **Time management:** soft skills related to prioritizing tasks, delegating responsibilities, and effective planning can influence team efficiency and the achievement of intended goals within established deadlines.
- **Innovation and creativity:** supports an open approach to new ideas, encourage experimentation, and stimulate the creativity of team members, facilitating better adaptation to changing conditions.
- **Delegation skills:** eliminate errors associated with ineffective task delegation by managers. It avoids the extremes of assuming all tasks or relinquishing control over their execution. Recognizing the strengths of individual team members allows for assigning tasks according to their abilities and potential, promoting action efficiency. Striking the right balance in decentralizing management is essential.
- **Adaptation to changes:** in dynamic project environments soft skills, such as flexibility, openness, and willingness to learn, enable leaders and teams to effectively respond to unpredictable situations.
- **Perception of threats:** managerial competencies enable the identification of potential threats and challenges during project implementation, analyzing the environment, anticipating potential difficulties, and evaluating risk factors. This allows for the effective development of remedial strategies and the implementation of preventive actions, minimizing the impact of potential challenges on project progress.
- **Assessment and understanding of team preferences:** competencies related to assessing and understanding the preferences of the entire team and the competencies of each team member. A conscious leader can recognize individual predispositions, needs, and expectations of team members and adjust management approaches, tasks, and communication, creating a work environment that enhances individual strengths within the team.
- **Forecasting team needs and behaviors** using appropriate tools and analysis: Leaders can anticipate changes in team dynamics, anticipate potential difficulties or development needs, and adjust management strategies accordingly. The ability to forecast allows for flexible and effective adaptation of team actions to variable project conditions.

The role of soft skills is closely linked to creating an appropriate level of situational awareness within the team and the ability to respond to threat and crisis situations.

6. Summary

Analysis of the essence of soft skills in managing executive teams leads to the conclusion about the important role these skills play in shaping appropriate interactions between the team leader and its members. This article focuses on the significance of effective project management in a dynamic business environment, highlighting the importance of simultaneously considering technical and social aspects in working with executive teams. Communication skills play a crucial role in the project and process management, supporting leaders in understanding team needs and building relationships based on mutual respect and empathy.

The limitation of the conducted research was the observation of various project groups, primarily technical and engineering ones. There are plans to expand the discussed topic to include other social groups in the future. The analysis conducted unequivocally indicates that despite the widespread and readily available knowledge on soft skills among most leaders, the described skills and techniques are rarely utilized. Leaders often remain unaware of their skill development areas and rarely invest in enhancing these competencies. The primary goal of the research is to raise awareness among future and current project group leaders about the opportunities to learn and apply the described techniques and skills related to utilizing soft skills in managing project teams.

The article extensively discusses the essence of project and process management, drawing attention to the project triangle that illustrates the interdependencies between scope, cost, and time in relation to the planned level of quality outcomes. The full cycle of project management includes stages of initiation, planning, execution, monitoring, control, and closure, and soft skills contribute to the materialization of the principles of effective functioning of executive teams throughout the management cycle. Leaders, possessing desired competencies, effectively motivate the team, ensure the quality and effectiveness of actions, and communicate efficiently, contributing to the harmonious functioning of the group. The role of the leader also encompasses creating situational awareness, resolving conflicts, building interpersonal relationships, and skillful time management. Innovation, task delegation, and adaptability to change are key in a dynamic project environment. Additionally, the leader's ability to perceive threats, assess team preferences, and forecast needs contributes to flexible adaptation of team actions to variable project conditions.

Effective communication with the team, developed emotional intelligence, leadership capabilities, and tools are necessary for successful management of any endeavor. The lack of these skills can lead to misunderstandings, conflicts, and loss of trust within the team, directly affecting the accurate assessment of actions and, consequently, the success of their implementation. Therefore, it is important for the team to not solely rely on purely technical procedures but also develop their soft skills. Placing significant emphasis on awareness and development of these skills allows for effective collaboration with the team and achieving

success in various projects. Furthermore, even the most comprehensive understanding of the essence of projects and processes, conscious application of the models and tools mentioned in the article, may be insufficient if the project team leader has not developed soft skills and is not aware of their usefulness.

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MAG DISSIMILAR WELDING OF S355JR WITH DOCOL 1200 M STEEL FOR THE STRUCTURES OF CAR BODY

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Purpose: Main novelty and the aim of the paper is to analyses possibility of dissimilar MAG welding of two various grades of steel with significantly different structure.

Design/methodology/approach: Two various metals have been checked in welding in order to obtain a high-quality joint of car body elements. The properties of the joint were checked by NDT (Non Destructive Test) and DT (Destructive Tests).

Findings: Relations between MAG welding process parameters and the quality of joint.

Research limitations/implications: In the future, it can be tested the effect of micro addition of nitrogen or oxygen in gas shielding mixtures of the MAG process.

Practical implications: Suggested materials and innovation will not cause problems in the production process provided that the technological regime will be respected.

Social implications: Modifying the welding materials and method will not affect the environment and production management methods. Producing of dissimilar welds must translate into production savings.

Originality/value: The paper is addressed to manufacturers of low-alloy and advanced high-strength steel for automotive industry.

Keywords: dissimilar welding, S355JR, DOCOL 1200 M, transport, shielding gas mixture, production savings.

Category of the paper: Research paper.

1. Introduction

The paper shows the results of dissimilar MAG welding parameters of low-alloy S355JR steel with advanced high-strength steel (AHSS) DOCOL 1200 M. These various grades of steel could be used in automotive industry. Other applications in the transport means and other industrial branches are also recommended. The use of various dissimilar joints is actually

checked in various laboratories because of economic reasons (Jaewson et al., 2011; Darabi et al., 2016; Hadryś, 2015). The weldability of low alloy steel is rather easy, because of the dominant soft alpha ferrite structure, but weldability of AHSS is much more difficult because of the hard martensite structure (Golański et al., 2018; Skowrońska et al., 2017). Dissimilar welding is much more complicated due to the different structure of both materials and their properties. Theoretically, it is difficult to imagine how a joint made of soft ferrite and hard martensite will behave. It turns out that there is a great demand for such connectors, although they cause great problems and welding challenges. A main problem in 355JR and DOCOL 1200 M welding steel is the tendency to various welding cracks. Therefore it is very important to determine welding parameters separately for each structure made of a dissimilar joint. To avoid cracks, welding parameters must be selected very carefully, taking into account the thermodynamic features of the process (Silva et al., 2019; Krupicz et al., 2020):

- welding voltage and current,
- welding speed,
- type of electrode wires,
- composition of gas mixtures,
- beveling method,
- pre-heating temperature.

Dissimilar welding of low-alloy with AHSS steel is difficult because of different chemical composition and serious differences in metallographic structure (Fydrych, Łabanowski et al., 2013; Shwachko et al., 2000). Preheating could be recommended for proper steel welding, but there is a distinct lack of information about dissimilar welding (Szymczak, 2020).

2. Materials and methods

For dissimilar MAG welding of S355JR with DOCOL 1200 M the UNION X90 and UNION X96 wires (EN ISO 16834-AG 89 6 M21 Mn4Ni2CrMo) were chosen. There were used and a gas mixture of CO₂ and small amount of nitrogen. It was decided to check welding process with preheating at temperature of 110° C and without pre-heating. A thickness of both elements was 3 mm. Table 1 presents the mechanical properties of the S355JR and DOCOL 1200 M.

Table 1.
Tensile strength of tested materials

Steel	YS, MPa	UTS, MPa	A5, %
S690 QL	590	605	12
DOCOL 1200 M	950	1200	6

The table data shows that both materials have totally different mechanical properties. DOCOL 1200 M has twice the strength, but at the same time two times lower relative elongation. These large differences in mechanical properties depend on the metallographic structure, which in turn depends on the chemical composition, as shown in the table 2.

Table 2.

Chemical composition of S690 QL [6]

Steel	C	Si	Mn	P	S	Al	Cr	Nb	Ni	Ti
S355JR	0.19	0.4	1.5	0.028	0.025	0.02	1.55	0.06	2.1	0.05
DOCOL 1200 M	0.12	0.21	0.21	0.01	0.002	0.03	0.03	0.13	0.3	0.23

Both types of steel differ significantly in their chemical composition. The two tested electrode wires are much more similar chemically. Composition of UNION X90 and UNION X96 electrode wires is given in Table 3.

Table 3.

Electrode wires–composition [10]

UNION	C%	Si%	Mn%	P%	Cr%	Mo%	Ni%	Ti%
X90	0.11	0.81	1.82	0.01	0.35	0.61	2.3	0.005
X96	0.12	0.87	1.88	0.01	0.29	0.46	3.3	0.005

The MAG welding process parameters were as follows:

- diameter of both electrode wires: 1 mm,
- voltage: 19.5 V,
- welding current: 114.5 A,
- welding speed: was 340 mm/min,
- shielding gas flow: 16.5 dm³/min
- the nature of the weld: single-pass.

The MAG (135) process was used in the down position (PA) according to the requirements of EN 15614-1 norm. The preparation of the single stitch made from AHSS/low-alloy steel with thickness of 3 mm are presented on the Fig. 1.

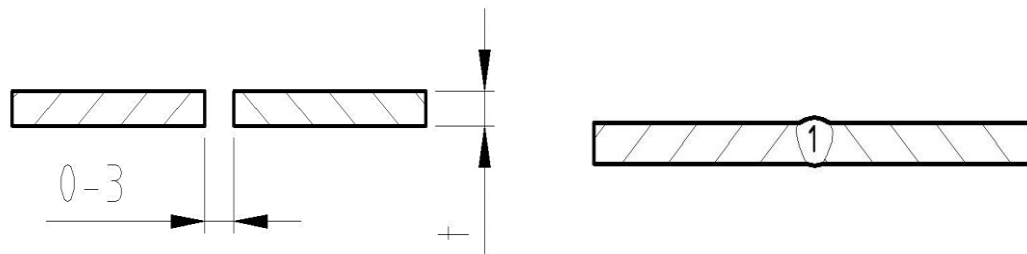


Figure 1. Weld shape.

Two different sheets of metal welded on a macro scale are shown in Figure 2.



Figure 2. View on the MAG welding (own study).

The joints were made with a drying pre-heating to the temperature of 110° C and without pre-heating. The shielding gas was changed 3 times:

- CO₂,
- CO₂-1%N₂,
- CO₂-2% N₂.

After welding, some non-destructive tests (NDT) and further destructive tests were realized. NDT examination generally based on VT(visual) and MT (magnetic particle) tests:

- VT: the observation was carried out with the accordance with PN-EN ISO:17638 standard with criteria of evaluation based on EN ISO 5817,
- MT: the observation was carried out with the PN-EN ISO:17638 standard, the observation was assessed in accordance with EN ISO 5817 using detector REM - 230.

The dissimilar welds were also structurally examined (destructive tests) using a light microscope (LM). The observation was carried out in accordance with the PN-EN ISO 9016 2021 standard. Amount of nitrogen content in the weld metal was performed on the LECO ONH836 analyzer. A bending test was taken in accordance with EN ISO 7438 standard. A tensile strength was performed with EN-10088 standard.

3. Results and discussion

The dissimilar joints were made with six different variants (shielding gas/pre-heating) using only electrode wire UNION X90:

- CO₂ without preheating – sample B1,
- CO₂ - 1% N₂ without preheating– sample B2,
- CO₂ - 2% N₂ without preheating– sample B3,

- CO₂ with preheating (110°C) – sample B4,
- CO₂ - 1% N₂ with preheating (110° C) – sample B5,
- CO₂ - 2% N₂ with preheating (110° C) – sample B6.

The result of non-destructive test is presented in Table 4.

Table 4.

NDT results for tested dissimilar welds

Sample	Welding with pre-heating up to 105°C
B1	No cracks
B2	No cracks
B3	Cracks in weld
B4	No cracks
B5	No cracks
B6	Cracks in heat effected zone

On this stage of research it has not been found yet that preheating before dissimilar steel welding S355JR with DOCOL 1200 M is recommended. It was noticed that too high a nitrogen content in the CO₂ mixture should be treated as unfavorable, because after welding with such a mixture, cracks were found in the weld (fusion zone) or in the heat affected zone, depending on the welding conditions (preheating effect).

The second part of the investigation was to count the nitrogen content in the fusion zone. Measurements were carried out on the LECO ONH836 tester. The test results are shown in Table 5.

Table 5.

Nitrogen in the weld

Sample	Nitrogen in WMD, ppm
B1	50
B2	57
B3	65
B4	50
B5	57
B6	65

It is possible to notice that after welding only in CO₂ shield (without N₂), the weld metal deposit had the lowest nitrogen amount: 50 ppm. The usage of shielding gas containing 1% N₂ translated into a increase in the nitrogen content in the weld to the 57 ppm. The amount of a shielding gas containing CO₂ and 2% N₂ translated into increase in nitrogen content in weld metal deposit on the level of 65 ppm%. This high amount of nitrogen (65 ppm) concentration in the weld metal and this may correspond to the cracks observed in table 4 (NDT results).

For destructive tests such as microstructure and tensile strength, only 4 joints were analyzed (samples B1, B2, B4, B5). Initially, observations were made under a light and scanning microscope. The structure was typical, high amount of martensite, bainite, ferrite and non-

metallic inclusions. Observations using a scanning microscope allowed for a more precisely results regarding inclusions. Mainly were observed:

- carbides; mainly TiC, NbC, NbC,
- carbonitrides; mainly Ti(N, C),
- nitrides; mainly TiN,
- oxides; mainly TiO,
- sulfides; mainly MnS.

The last part of the research was to check the tensile strength. Table 6 shows the mechanical properties of dissimilar welds (tensile strength UTS).

Table 6.
Tensile strength of joints

Sample	UTS, MPa	Elongation, %
B1	432	6.4
B2	457	6.2
B4	443	6.9
B5	465	6.4

The table shows that the tensile strength is rather at a similar level everywhere, but sample B4 has the best relative elongation, and therefore plastic properties. The highest tensile strength is for joints made in CO₂-1%N₂ shielding gas mixture. Therefore, based on this part of the research, it can be concluded that both protective gas mixtures containing nitrogen and preheating should be used to get the best mechanical properties of the dissimilar weld. It was decided to make welds using UNION X-96 electrode wire with a higher carbon content (sample C5: pre-heating and gas mixture with 1% N₂) compared to the tested joint previously made only with UNION X90 wire. Strength for conditions corresponding to sample B5. Changing the electrode wire did not cause any major difference in the mechanical values, Table 7.

Table 7.
Tensile strength of joints

Sample	UTS, MPa	Elongation, %
B5	465	6,4
C5	462	6,3

The last part of the research was the realize of bending tests, which were made from the face and root (ridge) side of the dissimilar weld. Next, the bending test of the created joints was performed. For the test a sample with thickness of $a = 3$ mm, width of $b = 25$ mm, mandrel of $d = 25$ mm and support spacing of 30 mm was taken, the required bending angle was at the level of 150° and 180°. Five bending tests measurements were carried out both on the face side and on the root side of the weld. The test result of bending test is presented in Table 7.

Table 7.*Bending test of dissimilar weld*

Sample	Face side	Root side
B1	No cracks	No cracks
B2	No cracks	No cracks
B4	No cracks	No cracks
B5	No cracks	No cracks
C5	No cracks	No cracks

The bending test result was positive in all tested cases. No welding incompatibilities were found. It was decided to check the behavior of the joints after bending by 150 degrees and 180 degrees. In both cases, no cracks were found, which proves that the joint was made correctly. For additional purposes, it was decided to straighten the joints again and bend them to 150 degrees, but again no cracks appeared.

4. Summary

In the article, it was decided to check the possibility of welding unalloyed S355JR steel with DOCOL 1200 M steel. These are materials with different structures and different mechanical properties. There was a fear that making such joints would be very difficult. Research was carried out, mainly focusing on the gas mixture and the preheating temperature. Preheating should ensure better plastic properties, while adding nitrogen to carbon dioxide should translate into higher joint strength. It was initially determined what the nitrogen content should be, which improves strength but does not impair plastic properties. Preheating has been observed to give good results. In the examined dissimilar welding, the selection of the shielding gas mixture is more important than the type of electrode wire. The following conclusions were made:

1. Preheat (110°C) is strongly recommended in dissimilar S355JR QL/DOCOL 1200 M welding.
2. It is possible to obtain the tensile strength of the dissimilar joint S355JR QL/DOCOL 1200 M 1400 M at the level over 465 MPa.
3. In the weld, it was observed martensite, bainite, ferrite and various nonmetallic inclusions
4. On the basis of the research it can be concluded that the CO₂ + 1% N₂ gas mixture is more appropriate for the dissimilar welding of S355JR QL/DOCOL 1200 M.

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NEURODIVERSITY IN ORGANIZATIONAL MANAGEMENT IN POLAND – EXPERT PERSPECTIVE

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Purpose: This study aims to determine the areas of influence of the neurodiversity concept on the management of organizations in Poland.

Design/methodology/approach: We evaluated the above-mentioned areas on the basis of a qualitative analysis of the content of the expert panel entitled "Neurodiversity in management" which took place during the 15th International Scientific Conference "Knowledge - Economy - Society" CMQ2023 - May 25, 2023 at the Cracow University of Economics.

Findings: Having studied the opinions of experts, we found that the concept of neurodiversity may influence the following areas in the management of Polish organizations: talent management, recruitment and selection methods, sensory accessibility, inclusive organizational culture and training policy, support for professional activation and career counseling.

Research limitations/implications: The limitation of the conducted research is the number of experts who took part in the discussion. It needs to be emphasized that due to the assumptions of the qualitative study, the selection of experts was guided by the criterion of knowledge of autism issues and the diversity of experiences in cooperation with neurodivergent people.

Practical implications: The practical rationale for undertaking research in this area is the five times lower employment rate of neurodiverse people in Poland compared to the average for the European Union. Taking into account the experts opinions about mentioned issues allows for institutional and organizational solutions to be prepared thus to increase the employment of these people. Conducted panel, in which the academic community participated, contributes to raising awareness of neurodiversity and may be the basis for further research. Furthermore, the findings are relevant to managers since they suggest the use of effective strategies that could design solutions tailored to the needs of neurodivergent people and thus increase their employment.

Originality/value: This article organizes the existing knowledge about neurodiversity and specifies the areas in the organization's activities that may be particularly influenced by it. Findings from this study may be of interest to various groups, including neurodiverse people, organizations, state institutions and other researches.

Keywords: neurodiversity, autism, employment, customization of products and services, public policy.

Category of the paper: Research paper.

1. Introduction

The term neurodiversity currently refers to many neurodevelopmental differences, but its original understanding (Singer, 1999, after Jaarsma, Welin, 2012), adopted in this article, is related to the autism spectrum. The validity of separating neurodiversity, considered in relation to the autism spectrum, from other dimensions of human diversity results from its specificity, which is revealed in all spheres of human development and its strong impact on the functioning of a given person in society.

Moreover, the topic of neurodiversity is a relatively under-researched field of research in relation to other dimensions of diversity, developed within the framework of diversity management, which is well-established in management and quality sciences.

The issue of neurodiversity is a current and important issue in the practice of managing organizations due to the growing dynamics of autism diagnoses and the extremely low employment rate of neurodiverse people in Poland, which states at only 2% (Polish Economic Institute, JIM Foundation, 2022, p. 4). The participation of neurodiverse people in organizations includes not only their employment but also their role as stakeholders, including customers of the organization. In management practice, there are difficulties in adapting the way products and services are offered to the needs of neurodivergent people. Due to the above premises, the following research question can be asked: in what areas can the neurodiversity perspective influence the management of Polish organizations?

The aim of the article is to identify the areas of influence of the neurodiversity concept on the management of organizations in Poland. To achieve this goal, the opinions of experts in the field of neurodiversity are presented on:

- opportunities and challenges in employing neurodivergent people in Poland,
- the role of state institutions in the professional activation of these people,
- preparing managers and employees to cooperate with neurodiverse people and taking into account their perspective as stakeholders in the organization's activities.

The research is innovative in its use of a qualitative approach within the context of Polish organizations. This approach facilitated a thorough analysis of management areas that are pertinent to neurodiversity. Considering that research on neurodiversity is at a relatively early stage and that the employment of people on the autism spectrum in Poland is at a much lower level than the average for EU countries, the authors felt that the research should take into account this particular context and subject it to in-depth analysis. The empirical material was collected through qualitative content analysis of the expert panel entitled: "Neurodiversity in management", which took place during the 15th International Scientific Conference "Knowledge - Economy - Society" CMQ2023 - May 25, 2023 at the Krakow University of Economics.

2. Literature review

The term neurodiversity was first used in relation to autism (Singer, 1999, after Jaarsma, Welin, 2012) and then also included other neurodevelopmental differences, such as ADHD, Tourette syndrome, dyslexia, dyspraxia. The authors of this article express the view that the mentioned neurodevelopmental differences are so distinctive that they should be considered separately. However, this assumption does not deny that all these differences reflect the essence of neurodiversity. Therefore, when relating the concept of neurodiversity to the autism spectrum, it is necessary to determine what makes this approach unique.

The concept of autism as a diagnostic category within pervasive developmental disorders was used in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (Diagnostic and Statistical Manual of Mental Disorders – DSM) of the American Psychiatric Association in 1980 (Grandin, Panek, 2021). Research on autism was initiated and then presented in the article *Autistic Disturbances of Affective Contact* in 1943 by Leo Kanner. In current medical classifications, the term pervasive developmental disorders has been abandoned and replaced by the term Autism Spectrum Disorder – ASD. The term was used in the fifth edition of the Diagnostics and Statistics of Mental Disorders Manual (Diagnostic and Statistical Manual..., 2013) and in the International Statistical Classification of Diseases ICD-11, developed by the World Health Organization which is applied in Poland (ICD-11 for Mortality and Morbidity Statistics). It is worth noting that the usage of the term "disorder" emphasizes the area of difficulties experienced by autistic people. This is supported by the diagnostic criteria for both classifications, which include persistent deficits in the ability to initiate and maintain reciprocal social interactions and communication and a range of restricted, repetitive and inflexible patterns of behaviour, interests or activities that are clearly atypical or excessive for the individual given his or her age and context sociocultural.

In contrast with this approach, the concept of neurodiversity draws attention to the strengths of people on the autism spectrum, treating it as "naturally occurring types of cognitive mechanisms with specific advantages that have contributed to the development of technology and culture" (Silberman, 2017, p. 23). It should therefore be emphasized that the concept of neurodiversity applies to high-functioning people with autism, i.e. those with the ability to communicate verbally (Jaarsma, Welin, 2012).

The current research problem in management and quality sciences is the perspective of neurodiversity. However, it is important to note that the state of research is still at an early stage, as evidenced by the limited number of scientific publications on this issue (Wiater, 2022). Additionally, most of the empirical research conducted on this topic is based on qualitative methods (Walkowiak, 2021; Whelpley et al., 2021; Richards et al., 2019; Carrero, Krzeminska, Härtel, 2019; Richards, Sang, 2016; Mellifont, 2020; Austin, Pisano, 2017; Mpofu et al., 2019). This may be due to the specificity of the phenomenon under study. The autism spectrum

encompasses a range of differently manifested behaviours (Silberman, 2017), which limits the generalisation and comparisons characteristic of quantitative methods. Qualitative research may be a more appropriate approach in this case. Additionally, it should be noted that the adoption of a qualitative research perspective may be related to the strategy used to gain access to the sample. Current publications include a framework for future research and recommendations for wider mainstreaming in organisational management (Doyle, McDowall, 2021; Whelpley, Perrault, 2021; Szulc et al., 2021; Roberson et al., 2021).

3. Research methodology

Considering the preliminary stage of research on neurodiversity, the authors of this article sought the opinions of experts in Poland who deal with the issue of neurodiversity. During the XV International Scientific Conference 'Knowledge - Economy - Society' CMQ2023, held on 25th May 2023 at the Cracow University of Economics, an expert panel was consulted on the topic of 'Neurodiversity in Management'. The study was conducted with the involvement of three experts and last about 1,5 hours. The discussion focused on the four issues introduced in the beginning, concerning the integration of a neurodiversity approach in modern organisations.

The study was conducted using a qualitative approach (Flick, 2010; Jemielniak, 2012; Kostera, 2015; Lune, Berg, 2017; Silverman, 2008). This approach is appropriate for exploring the research field of neurodiversity from a management and quality science perspective.

The method of obtaining empirical material is in the form of a focus group interview (Gillham, 2000; Kvale, 2023) conducted with a sample of experts. The role of the authors of the article during the interview, in addition to designing the interview in advance, amounted to moderating the discussion in which the invited experts participated, taking care to maintain an appropriate group dynamic (Gudkova, 2012) by directing the conversation in such a way as to organise the statements and give all experts the opportunity to speak on the issues raised.

Conducting the study in the form of a group interview allowed the researchers to benefit from its advantages (Fontana, Frey, 2009), i.e.: low cost of implementation; the possibility of obtaining cumulative data with a high degree of complexity; the possibility of stimulating panel participants by the researchers; and the flexibility of the formula used, which is extremely important for the course of the study. This is directly linked to the digital form of the expert panel used. As far as the advantages of the chosen strategy for obtaining empirical data are concerned, it is worth mentioning the possibility of direct confrontation between the participants of the survey and the possibility of including valuable comments from experts among the audience, which provides an opportunity to obtain additional information. On the other hand, weaknesses include the limited opportunities for deepening the topic for the duration of the panel and the negative effects of the presence of the audience, e.g. related

pressure or tendency to over-presentation. At the same time, it should be borne in mind that the use of digital techniques limits the experts' contact with the audience.

The selection of experts for the sample also requires comment. It was done in a purposive way, based on the knowledge of organisations working on neurodiversity in Poland. This approach overcomes problems related to access to the research sample, mainly due to the limited number of available experts. At the same time, the influence of the evaluative nature of the panel (due to the participation of the audience) on the selection of the sample should be emphasised. At the same time, it should be pointed out that the selection of experts was guided by the criterion of familiarity with the issue of autism and the diversity of experience in working with neurodiverse people invited to the study.

The study was conducted using a pre-designed interview scenario. It included open questions on the areas outlined in the introduction. The survey also provided an opportunity to explore the issues raised by the experts by formulating additional questions.

During the panel, the experts presented their opinions one after the other and listened to each other's answers. During the panel, the experts were able to engage in discussion with each other and ask their own questions. The panel was videotaped and the resulting material was then subjected to a process of transcription, coding and analysis. The coding was open-ended. Subsequent codes were created on a snowball basis as new information became available. In order to increase the reliability of the study, triangulation was used at the researcher level. This means that two researchers were involved in both the interview process and the coding of the empirical material. Furthermore, in accordance with the art of qualitative research, a process of validation of the results obtained was carried out.

4. Results

A number of difficulties related to the implementation of the concept of neurodiversity are observed in management practice. The problem of employing neurodiverse people should be considered one of the key ones. It is reflected in the extremely low employment rate of people on the autism spectrum, which in Poland is only 2%, while in European Union countries it is five times higher (Polish Economic Institute, JIM Foundation, 2022). The search for the reasons for the low professional activity of autistic people in our country has been the subject of analyses by the Supreme Audit Office, which found, among other things, a lack of adequate preparation for work and independent living, an insufficient number of vocational activity centers and insufficient support by occupational therapy workshops (Supreme Audit Office, 2020). In contrast, a report by the JIM Foundation and the Polish Economic Institute sees opportunities to use the potential of neurodiverse people for the benefit of the Polish economy

by raising awareness and introducing appropriate public policy tools (Polish Economic Institute, JIM Foundation, 2022).

In Poland, the number of people on the autism spectrum is estimated at 45,000, but these figures may not reflect the scale of the phenomenon because autism spectrum disorders were not taken into account in the disability adjudication system until 2010 (Supreme Audit Office, 2020). The scale of the phenomenon is certainly growing, as indicated by data from the Educational Information System, according to which the number of special educational needs statement issued for autism is increasing annually by about 20% (from 16,098 in the 2017/2018 school year to 36,189 in the 2021/2022 school year) (Domagała-Szymonek, 2022). Due to the lack of accurate information on the total number of people with autism in our country, it is considered crucial for the professional activation of this group to create and unify the base of neurodiverse people, systematically collect information on their needs and establish facilities that provide adequate support for them (Polish Economic Institute, JIM Foundation, 2022).

Experts on the panel unanimously emphasized the great opportunities for the professional activation of neurodiverse people. In this regard, they pointed to the special abilities, skills and predispositions of neurodiverse people, which correspond to those identified in the literature. These include:

- the ability to perceive details in an isolated way and to focus attention on them more (Lorenz, Heinitz, 2014, after Roberson et al., 2021),
- the ability to remember and analyze large amounts of data, and above-average mathematical aptitude (Austin, Pisano, 2017),
- associative thinking, creativity, predisposition for routinized work (Grandin, Panek, 2021),
- strict adherence to rules (Baron-Cohen et al., 2009).

At the same time, however, the experts participating in the panel recognized that their potential is not sufficiently exploited. Opinions in the described area are contained in the following Table 1.

Table 1.

Experts opinions about abilities, skills and predispositions of neurodiverse people

Experts	Opinion
Expert 1	‘Adults on the autism spectrum possess competencies that can be effectively integrated into various industries and activities. These competencies may be challenging for neurotypical individuals to manage or incorporate due to the annoyance associated with repetitive tasks. However, for individuals on the spectrum, these tasks can be a fantastic opportunity to showcase their skills, and we can have confidence in their ability to perform them perfectly’.
Expert 3	‘It is a well-known fact that individuals on the autism spectrum often work below their qualifications, despite possessing a high level of knowledge and expertise. This is due to challenges with pro-social skills. It is important to note that this is not unique to individuals on the spectrum, as many highly qualified individuals may face similar challenges’.

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

Neurodiverse people, despite having high qualifications, may experience difficulties that may prevent them from presenting them to a potential employer. For this reason, experts agreed, it is important to take into account the needs of neurodiverse people in the recruitment and selection process. Experts opinions is presented in Table 2.

Table 2.

Experts opinions about difficulties in the recruitment and selection process experience by neurodiverse people

Experts	Opinion
Expert 1	‘In the area of autism spectrum disorders, communication skills are typically impaired. Therefore, individuals on the spectrum may not be able to effectively demonstrate their competence, soft skills, or empathy during a job interview’.
Expert 2	‘Individuals on the autism spectrum may have a different perspective on job interviews and may hold different expectations regarding the process. For instance, a neurotypical interviewer may pose abstract and incomprehensible questions such as ‘Where do you see yourself in 10 years within our company?’ Job interviews are often viewed as an opportunity to present oneself in a positive light. However, individuals on the autism spectrum may find this task challenging and incomprehensible’.
Expert 3	‘From our experience, we recommend that job applicants are asked their preferred method of contact, such as telephone, email, or another form. Additionally, it may be beneficial to conduct initial interviews online to provide a sense of security before coming to the company headquarters’.

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

The employment of neurodiverse people requires the provision of appropriate working conditions. Adjustments in the aforementioned area should especially take into account difficulties with sensory integration or unusual interest in sensory aspects of the environment, which affect more than 90% of people with autism (Chang et al., 2014). In addition, it is necessary to provide a choice of how to perform the work and reduce the number of social interactions (Prizant, Fields-Meyer, 2017), Confirming these conclusions from the literature, the opinion of an expert participating in the discussion is presented below in Table 3.

Table 3.

Expert opinion about appropriate working conditions for neurodiverse people

Experts	Opinion
Expert 2	‘The workplace environment is a crucial consideration, particularly for neurodiverse individuals. Visual, auditory, and olfactory stimuli can negatively impact their work performance and even prevent them from carrying out their duties. Therefore, it is essential to ensure that our company is accommodating and welcoming to all employees, regardless of their neurodiversity. (...) The workplace can be reimagined, beginning with the desk, to reduce visual, olfactory, and auditory stimuli. This can be achieved through the implementation of open-plan workspaces. (...) For managers and employers, it may be challenging to adjust to new methods of communicating responsibilities and managing employees' work. For instance, providing more written information. (...) Some individuals on the autism spectrum may find hybrid or remote work more suitable due to the flexibility it offers in terms of breaks and scheduling. It is important to consider the needs of all employees when determining the form of work that is most appropriate for a given situation’.

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

In the context of the discussion on the possibility of professional activation of neurodivergent people, the issue of support from state institutions was raised.

The experts unanimously agreed that there is an urgent need to provide systemic support in employment, which in particular should cover the areas of career counseling and an appropriate system of public subsidies.

According to the experts, offering career counseling to neurodiverse people should include comprehensive preparation for professional roles, support of tutors and job coaches in the process of employee adaptation, and use of good practices of other countries in the field of vocational activation of neurodiverse people. Experts opinions is presented in Table 4.

Table 4.
Experts opinions about the career counseling

Experts	Opinion
Expert 3	'I suggest beginning with career counselling. This involves discussing the nature of work, how to work, and identifying personal talents and needs. This approach will also draw job coaches and tutors into our system. It is important to provide families with information that diverse individuals can work'.
Expert 2	'It is worthwhile to conduct research and transfer proven practices, such as the sensible programs in Germany. These programs involve activating professionals with autism to create guides that can be sent to various companies. The guides provide information on the autism spectrum, how to work with individuals on the spectrum, and how to prepare the work environment. In the UK, there is an intriguing project for individuals aged between eighteen and twenty-five with autism. The project focuses on knowledge, including training, apprenticeships, traineeships, and support in maintaining employment'.

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

The issue of government subsidies can be applied to various aspects raised by experts related to supporting the vocational activation of neurodiverse people. Areas of special state activity are mainly seen in subsidizing the system of collecting information on the number of neurodiverse people, regulations on the employment of tutors and assistants, the operation of vocational activation centers, as well as training and courses for employers. Table 5 contains the abovementioned opinions.

Table 5.
Experts opinions about the system of public subsidies

Experts	Opinion
Expert 2	'It would be beneficial to establish a database that accurately records the number of neurodiverse individuals in need of more comprehensive support, beyond just job placement assistance, but also job retention. Currently, such a system does not exist in Poland and funding is necessary for its development. Professional activation centers, such as occupational therapy, should receive stronger subsidies. Without these measures, progress may be hindered. New job opportunities for tutors and assistants who can support individuals in need should be created. Companies should also receive subsidies for training new recruits and management'.

Cont. table 5.

Expert 1	‘Certainly, there should be a clear definition of the role, form of employment, and possibilities of job coaches, tutors, and mentors. It is important to establish a systemic support system in this area, as well as a system of necessary and subsidized courses for supporting neurodiverse individuals’.
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Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

Apart from the topic of institutional support, the discussion was also devoted to the preparation of organizational participants to employ a neurodiverse person.

5. Discussion

The expert opinions presented in the panel discussion align with the conclusions drawn from the literature, particularly with regards to the need for adjusting recruitment and selection methods (Carrero et al., 2019) and designing office spaces that consider sensory sensitivity (Szulc et al., 2021). These opinions are also consistent with findings from institutions that focus on neurodiversity. The aforementioned in the context of the analysis of the Polish Economic Institute and the JIM Foundation - the low awareness of neurodiversity, which determines the employment opportunities for these people (Polish Economic Institute, JIM Foundation, 2022, pp. 4, 5, 29), means that both management staff and those employed in organizations in our country are not prepared to work with neurodiverse individuals. In addition to low employment and difficulties in working with neurodiverse people, there are also perceived difficulties in incorporating a neurodiversity perspective into an organization's operations by adapting the way it offers products and services to the needs of these people. Practical applications i.e. sensory-friendly cinema in Cinema City or quiet hours in selected retail establishments are still exceptions and are examples of social innovation of a process nature (Wiater, 2022).

The importance of social awareness about neurodiversity and shaping an inclusive organisational culture in organisations was a topic addressed by all experts in the panel discussion on preparing for cooperation with neurodiverse people. With regard to social awareness, the issue of difficulties in processing sensory stimuli and the need to take them into account in the process of preparing for this cooperation and adapting the way of offering products and services to the needs of neurodiverse people was also raised. This is in response to the difficulties with sensory integration described in the literature, or the unusual interest in sensory aspects of the environment experienced by over 90% of neurodiverse individuals (Chang et al., 2014). Ensuring sensory accessibility is crucial for the participation of neurodiverse people in market processes and to play the role of organisational stakeholders. These statements are quoted in the Table 6.

Table 6.

Experts opinions about the importance of social awareness, shaping an inclusive organisational culture and ensuring sensory accessibility

Experts	Opinion
Expert 3	<p>‘To successfully hire and accommodate a neurodiverse individual in the workplace, it is crucial for managers to have a clear understanding of what neurodiversity entails. To successfully hire and accommodate a neurodiverse individual in the workplace, it is crucial for managers to have a clear understanding of what neurodiversity entails. Additionally, co-workers should also be educated on the topic to ensure a welcoming and inclusive environment. So, in my opinion, preparation for collaboration is aided by knowledge. This knowledge should come from all levels of the organization, from top management to co-workers. This approach will lead to a safer, more attentive, and accepting work environment. (...) If sensitivity and friendliness are not taken into account, clients may leave and not receive the services they need. Therefore, it is crucial to prioritize these aspects. This is my perspective on the matter’.</p>
Expert 1	<p>‘It appears that public awareness is crucial in this matter. If we were more informed, we would not be as apprehensive and would approach employment of individuals on the spectrum more naturally. Currently, we do not employ such individuals due to fear and lack of knowledge on how to communicate and interact with them. Therefore, sensory accessibility is of utmost importance. In Poland, there is increasing discussion about sensory disorders and their impact on neurodiverse individuals. However, there is still limited awareness of this issue. It is important to recognise how these disorders can affect individuals with neurodiversity. Sometimes, small things like ensuring proper ventilation and reducing noise can greatly impact the success and inclusion of neurodiverse individuals in certain activities. It is important to have knowledge and social awareness to accommodate sensory sensitivities’.</p>
Expert 2	<p>‘To create a neurodiversity-friendly culture for neuroatypical employees, it is worth implementing different strategies. Although it can be challenging, there are companies in Poland that have successfully implemented such projects. Neurodiversity can bring numerous benefits, not only to the employees but also to the company itself. By introducing new assumptions, rules, and procedures, we can create a culture that values diversity and inclusivity. It is important to maintain a formal tone and use unambiguous language to ensure clarity and coherence. Additionally, we should adhere to specific language standards and use precise word choices to convey meaning accurately. Finally, we must ensure that the text is free from grammatical errors, spelling mistakes, and punctuation errors, and that we strictly adhere to metrics and units. This can help us learn how to work with neurodiverse individuals and improve our overall practices. As the number of neuroatypical individuals in society increases (15-30% of the population), it is important that we know how to effectively communicate with them, both in the workplace and with clients. By understanding how to communicate with neuroatypical individuals, we can improve our overall communication skills’.</p>

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

The conclusion that emerges from the expert statements on the crucial importance of social awareness of neurodiversity is the need to provide participants with accurate and comprehensive information about it. In this respect, experts stressed the role of all kinds of training, which is presented in Table 7.

Table 7.*Experts opinions about the role of training*

Experts	Opinion
Expert 2	‘Trainings, webinars, and e-meetings can effectively educate employees on neurodiversity and the functioning of the brain of individuals with autism or Asperger's syndrome. It is important to provide such training not only to employees but also to recruiters. Job advertisements should accurately reflect the requirements of the position, avoiding generic phrases such as 'ability to work in a team' when seeking a programmer who may not have extensive social interaction as part of their role. (...) It may be beneficial to consider training self-advocates. The self-advocacy movement in Poland is currently strong. In fact, an audit conducted with the participation of self-advocates would be ideal. They can identify areas that require improvement and provide valuable feedback. (...) People often struggle to comprehend the implicit meaning behind words (...). Providing training in soft skills for individuals on the autism spectrum, along with education on neurodiversity for neurotypical individuals, could potentially enhance communication between the two groups’.
Expert 3	‘At every location where a trained person was present, I had to wait for an hour before the person who could guide me arrived. What surprised me was that both the organizers and the person present at each stage asked similar questions: what should I do and when? What does it mean...? Should I be concerned about anything...?’

Note. To ensure the anonymity of the experts, they were marked as Expert 1, Expert 2, Expert 3.

Source: Own elaboration based on the qualitative content analysis of the expert panel entitled: "Neurodiversity in management".

These aspects related to the formation of social awareness seem to be crucial for taking into account the perspective of neurodiversity in the area of functioning of organisations operating in Poland. This aspect should be seen as the basis for solutions both for the internal policies of individual companies and for broadly defined social and economic policies geared to harnessing the potential of neurodiversity.

6. Conclusions

The article is devoted to identifying areas of influence of the concept of neurodiversity on the management of organisations in Poland. To achieve this objective, a qualitative analysis of the content of the expert panel entitled: “Neurodiversity in Management”, which took place at the Cracow University of Economics. The mentioned areas of influence were seen in relation to the issues of employment, institutional support for professional activation, preparation for cooperation with neurodiverse people and taking into account their needs in the activities of the organisation. Based on the analysis of experts’ opinions, the following areas of impact of the concept of neurodiversity on the management of Polish organisations have been identified:

1. Talent management – it is a process that is supposed to enable the use of the potential of employees with special abilities (Kopeć, 2012). During the panel, experts drew attention to the special, distinctive skills, abilities and predispositions of neurodiverse people. According to experts, those skills can be successfully used in different organizations and constitute a complement to the competences of neurotypical people.

For this reason, talent management in an organisation should take into account the perspective of neurodiversity.

2. Recruitment and selection – a process related to talent management (Skuzza, 2018) and requiring appropriate matching of talent (Ingram, 2011). According to experts, the neurodiversity of job candidates should prompt employers to rethink their recruitment and selection methods. In particular, this concerns the precise formulation of requirements in job advertisements and the form and process of the interview.
3. Sensory accessibility - the need to create appropriate working environment conditions, as well as to adapt the way of offering products and services results from the difficulty of processing sensory stimuli experienced by neurodiverse people and determines their participation in market processes.
4. Inclusive organizational culture – based on awareness of neurodiversity and openness to distinctiveness. Training policy can play a key role in this area.
5. Supporting professional activation – firstly, experts see the role of public organisations in providing support in preparing neurodiverse people for work and creating appropriate legal regulations in this area. In addition, it should be noted that this area will have an impact on organisations providing career guidance, which, according to experts, currently do not sufficiently take into account the perspective of neurodiversity.

Identifying areas of influence of the concept of neurodiversity on the management of organizations can contribute to the increase of social awareness and for specific organizations can be a starting point for building competitive advantage based on shaping an inclusive culture of the organization.

It is important to acknowledge the limitations of the survey conducted. A fundamental limitation is the number of experts who participated in the discussion. Increasing their number could lead to more examples of good practice as well as new themes. In addition, the survey does not directly take into account the opinions of neurodiverse people. Their inclusion should also add depth to the findings. In planning the study, the authors took into account the postulate "nothing about us without us", but the aim set criteria for the selection of the sample (an expert with experience in neurodiversity practice, objectivity, not acting as a stakeholder). Due to the time constraints of the panel and the multifaceted nature of the issue, it was not possible to address the industry context. Therefore, future research should take into account that the suitability of the skills of neurodiversity practitioners, the adaptability of the work environment, etc. may vary depending on the specifics of the organisation and the industry in which it operates.

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WORK ENGAGEMENT AND WORK LIFE-BALANCE ACROSS EUROPEAN UNION COUNTRIES

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Purpose: The aim of this paper is to explore the link between WE and WLB at the country level in European countries.

Design/methodology/approach: The current paper uses data from several sources. The theoretical part of the paper is based on the literature review. The empirical part is based on the data collected through secondary data analysis. The secondary data were mainly collected through related research articles, reports and websites.

Findings: The main finding of the research is that there are differences between EU countries in terms of both levels of work engagement and work-life balance. European employees are the most satisfied with the level of work-life balance and at the same time they are the least engaged compared to other regions of the world. One explanation for the low level of engagement with a high level of work-life balance indicator is the inadequate leadership in European companies.

Research limitations/implications: The current paper is limited in that it only discusses the link between the levels of WE and WLB across EU countries without explaining the reasons for the relationship. Therefore, further research is needed to identify the factors that shape this mutual relation.

Practical implications: The article is interesting from the practical point of view, as low employee engagement is a significant challenge, with one in five workers worldwide planning to quit their jobs. The situation appears to be even worse in Europe, where one in three workers are considering leaving their company. For this reason it is crucial to analyze the reasons of low engagement.

Social implications: The paper refers to very important social issue of employees' well-being. It helps in better understanding the meaning of work-life balance for work engagement. It might affect the quality of life by promoting more balanced work-environment and the idea of corporate social responsibility.

Originality/value: Currently, studies are limited and often examine WE and WLB separately. So the novelty of the article is that the author discusses the link between WE and WLB. Additionally the article presents cross-national studies on relationship between WE and WLB. The results presented in the article can be important for the scientific discussion on the cross-country differences in WE and WLB.

Keywords: work-life balance, work engagement, EU countries.

Category of the paper: research paper.

1. Introduction

Work engagement is a term that is defined in various ways in the literature leading to a conceptual confusion with regard to the meaning of the term. The literature uses several associated terms such as: employee engagement, work involvement, job involvement, job satisfaction, organizational citizenship behavior and organizational commitment either synonymously or non-synonymously to define engagement (Iddagoda, Opatha, 2015). Some authors use the terms interchangeably (Luthans, Perterson, 2002; Robertson, Cooper 2009; Guest 2014). Others believe that employee engagement, work involvement, job involvement, job satisfaction, organizational citizenship behavior or organizational commitment are not the same ideas (Saks, 2006; Robbins, Judge, 2013; Armstrong, 2009). For the purposes of this paper the author assumes that the terms: ‘work engagement’ and ‘employee engagement in job’ are synonyms closely linked to job/work involvement and satisfaction as well as with organizational commitment and behavior.

Work engagement means ‘a positive, fulfilling, work-related state of mind’ (Schaufeli, Bakker, Salanova, 2006, p. 702) and is ‘ (...) something given by employee which can benefit the organisation through commitment and dedication, advocacy, discretionary effort, using talents to the fullest and being supportive of the organisation’s goals and values’ (Robertson-Smith, Markwick, 2009, p. V). Engaged employees are those who are involved in, enthusiastic and satisfied with work (Seigts, Crim, 2006; Harter, Schmidt, Hayes, 2002). However there are three levels of employee engagement: engaged, not-engaged and actively disengaged (Figure 1).

engaged	not-engaged	actively disengaged
<ul style="list-style-type: none"> • work with passion • feel a connection to the company they work for • drive innovation • move organization forward • have an intention to stay with the company for a long term • client oriented • go an extra mile in order to achieve organizational goals 	<ul style="list-style-type: none"> • put time but not energy or passion into work • do what they need to but nothing more • do not identify with the organization or the team • if there is another offer of the job the employee is ready to quit the organization 	<ul style="list-style-type: none"> • unhappy at work • act out their unhappiness to others • do not identify with the organization or the team • is ready to leave the organization as soon as possible

Figure 1. Levels of employee engagement.

Source: own study based on (Gallup, 2006; Iddagoda, Opatha, 2015).

Moreover, to foster engagement, a reciprocal relationship between the organization and employees is necessary (Markos, Sridevi, 2010). It is important to note that engagement is mutually beneficial for both employees and organizations. The table 1 presented below outlines the most prevalent advantages of engagement.

Table 1.

Advantages of engagement for employees and organizations

Advantages for employees	Advantages for organization
<ul style="list-style-type: none"> • decreases burnout syndrome, • reduces stress and feeling of anger at work, • creates the feeling of belonging in the workplace, • creates the feeling that the work is valued, • creates the intent to stay in the company, • may enable individuals to invest themselves fully in their work. 	<ul style="list-style-type: none"> • engagement is a strategic asset and a source of competitive advantage, • higher productivity, • lower turnover at the employee level, • increased customer satisfaction, • reduced employee absenteeism, • increases organizational profit, • higher employee loyalty, • employees act as advocates of the organization.

Source: own study.

Employee engagement is crucial for long-term retention and has a significant impact on organisational productivity, profit, and turnover. Therefore, it is an essential aspect of modern human resources management. However, the question remains: how can organisations create a high level of employee engagement while also maintaining a healthy work-life balance? Research indicates that engagement may have positive health effects and positive feelings towards work and the organisation (Mauno, Kinnunen, Ruokolainen, 2007; Rothbard, 2001). However, work engagement can also lead to work-family conflicts as it requires time and energy. Therefore, work-life balance is an important factor associated with work engagement (Björk-Fant, Bolander, Forsman, 2023).

In recent years, there has been a great deal of attention directed towards the well-being of employees. Work-life balance refers to the ‘overall interrole assessment of compatibility between work and family roles’ (Allen, 2013, p. 703). The aim of working individuals is to achieve a balance between work and other spheres of their lives (Burke, 2023). Consequently, research into the areas of employee work engagement and work-life balance has gained increasing interest in the fields of human resource management.

2. Method

The concepts of work engagement (WE) and work-life balance (WLB) are not entirely new, as many researchers have conducted theoretical and empirical studies on both. However, the relationship between WE and WLB is not clear. Some authors suggest that WE is an antecedent of WLB, while others argue that WLB is a key factor in WE. Additionally there

is a great need for cross-national studies on relationship between WE and WLB. Currently, studies are limited and often examine WE and WLB separately. Hence, the aim of this paper is to explore the link between WE and WLB at the country level in European countries.

This paper analyses the relationship between work engagement (WE) and work-life balance (WLB) based of the literature. It discusses the empirical evidence of WE and WLB in Europe Union (EU), and analyses the relationship between WE and WLB in EU countries.

The current paper uses data of multiple sources. The theoretical part of this paper is based on a literature review with the Web of Science Core Collection, EBESCO and SpringerLink databases serving as the main sources. The author conducted a topic search between September and November 2023 to identify publications related to the phrases ‘work engagement’, ‘employee engagement and ‘work-life balance’. The empirical section is based on the data collected from the secondary sources, including research articles, reports, and websites.

3. Results

3.1. Work engagement and its relations with work-life balance – the literature review

Multiple studies suggest that WE and WLB are related to each other. For example Sivapragasam and Raya (2017) showed that employee well-being has an influence on employee engagement. In another study the relationship between well-being and job commitment of an employee was explored (Harter, Schmidt, Hayes, 2002; Wright, 2006). Therefore, the issue of work-life balance is receiving a great attention as it helps to promote employees’ well-being. A deeper understanding of the relationship between work engagement (WE) and work-life balance (WLB) is necessary to comprehend these two concepts better. The table 2 provides an overview of some of the research conducted on WE and WLB.

Table 2.

The overview of research on WE and WLB

Research field	Authors	The main findings
WLB to work engagement directional focus		
Organizational climate/ organizational culture/ organizational policy	Joshi, Sodhi (2011)	WLB, job content, monetary benefits, team orientation are important drivers of WE
	Evans, Redfern (2010)	WLB, communication, remuneration support the creation of WE
	Peeters et al. (2009)	Supportive work-family culture enhances WE and reduces burnout
	Mauno (2010)	There is a link between managerial work-family support and WE
	Scanlan et al. (2012)	Family-friendly policy develop WLB and is associated with lower turnover and WE
	Fiksenbaum (2014)	Availability of work-family benefits promotes work-family culture while work-family conflict contributes negatively to work-family culture and in consequence to WE
	Itam, Singh (2012)	There is a positive correlation between work and personal life, stress and training, and WE

Cont. table 2.

Accumulation/ enrichment of resources	Timms et al. (2015)	Positive experiences of work that contribute to a positive mood and sense of confidence in family life are associated with WE
	Chen, Powell (2012)	WLB helps to be more engaged in work through work-family role enrichment
Work-family conflict Family-work conflict	Montgomery et al. (2003)	Work-home demands create a pressure and decrease WE, while availability of work-home resources brings greater WE
	Rothbard(2001)	Multiple demands of work and family affect the fulfilment of roles negatively due to limited amount of employee's time and energy
	Li et al. (2014)	Social support has a positive effect on WE with moderating effect of proactive personality, while work-family conflict has a negative effect on WE
	Opie, Hemm (2013)	Personality plays role in moderating the relationship between work-family conflict and WE
Well-being	Chambel (2017)	Part-time work helps to prevent burnout and promotes well-being (also WE) at work
Work engagement to WLB directional focus		
Organizational climate/ organizational culture/ organizational policy	Chen, Huang (2016)	Charismatic leadership style, team support, self-esteem are important indicators of WE, which, in turn, has a positive relationship with innovative behavior and work-family conflict
Accumulation/ enrichment of resources	Culberston et al. (2012)	Daily WE has a positive effect on family life (the effect is moderated by work-family capitalization, or the sharing of positive work experiences)
	Karatepe, Demir (2014)	Employees who are engaged at work are more capable of integrating their work (family) and family (work) roles with success
	Marais (2014)	There is a mediating relationship between work resources and WE, while family-work enrichment mediates the relationship between home resources and family engagement
	Ilies et al. (2017)	Individuals' daily WE experiences relate positively to work-family interpersonal capitalization, which, in turn, relate positively to satisfaction from family life and to work-family balance
	Chen, Powell (2012)	Work role engagement affects work role resources gains positively and in consequence leads to work-to-family enrichment
Work-family conflict Family-work conflict	Bakker (2012, 2014)	Work-related overload affect home domain and then crosses over to the partner through social interaction. WE is positively related to work-family facilitation, and this in turn, leads to higher employee's/partner's family satisfaction
	Rantanen et al. (2013)	Over-engagement (high weekly working hours, insufficient personal time) is related to harmful levels of work-family conflict
	Chernyak-Hai, Tziner (2016)	WE is statistically and positively associated with the risk of burnout and higher experiences of work-family conflict
	Halbesleben et al. (2009)	Highly engaged employees have lower levels of work-family conflict
Well-being	Burke et al. (2013)	WE is related to job satisfaction and lower levels of role conflicts

Source: own study based on: (Wood, Oh, Park, Kim, 2020).

In summary, a body of literature has examined the relationship between WE and WE constructs. Some of the researchers highlight that WLB could be analyzed as the antecedent of work engagement while others present the correlative influences of work engagement and WLB. The analysis identifies various fields of the research on WE and WLB relations, including organizational culture (policies, procedures, systems and structures), accumulation/enrichment of resources perspective (work-family enrichment, family-work

enrichment), roles conflict perspective (work-family conflict, family-work conflict, burnout) and well-being (job satisfaction, life satisfaction, health). To improve understanding of the issue of WE, it is important to consider the perspective of work-life balance (WLB) and vice versa. Research has shown that highly engaged employees are more satisfied with their family life and experience fewer role conflicts.

3.2. Work engagement and work life balance across EU – the key findings

Work engagement in European Union countries

In 2021, only 14% of European employees were engaged at work, compared to the global average of 21% (Gallup, 2022). The situation in Europe has worsened in 2022, with only 13% of workers being engaged, compared to the global average of 23% (Gallup, 2023). Furthermore, there are significant differences in engagement levels across the world. The most engaged employees are from the USA and Canada, while the least engaged are from Europe (table 3).

Table 3.

The level of employee engagement

Ranking	Region	Engaged in 2022 (%)	Engaged in 2023 (%)
1	United States and Canada	33	31
2	South Asia	27	33
3	Southeast Asia	24	26
4	Latin American and the Caribbean	23	31
5	Sub-Saharan Africa	21	20
6	Commonwealth of Independent States	20	27
7	East Asia	17	17
8	Australia and New Zealand	17	23
9	Middle East and North Africa	15	15
10	Europe	14	13

Source: based on: (Gallup, 2022; 2023).

Table 4 shows that work engagement is related not only to the region of the world but also to other factors such as age, job level, work location, and gender.

Table 4.

The level of employee engagement depending on age, job level, work location, gender and country

	Global	Europe
The average level of engagement	23%	13%
Age	<40 – 23% >40 – 24%	<40 – 13% >40 – 13%
Job level	Managers 31% Individual contributors 20%	Managers 17% Individual contributors 11%
Work location	Fully remote 30% Hybrid 24% On-site 21%	Fully remote 15% Hybrid 12% On-site 13%
Gender	Female 25% Male 22%	Female 13% Male 13%
Country	The highest engagement: Mali 47% The lowest engagement: Japan 5%, Italy 5%	The highest engagement: Romania 35% The lowest engagement: Italy 5%

Source: Based on: (Gallup, 2023).

The data indicates that managers and fully remote workers are the most engaged employees. Additionally, women tend to be more engaged than men on a global scale. However, there is a lower level of employee engagement in Europe across all demographics when compared to global indicators. It is worth noting that both European men and women, as well as younger and older employees, exhibit similarly low levels of engagement. On the other hand, significant disparities can be observed among European countries. For instance, over one-third of Romanians are engaged, while only 5% of Italians are engaged.

Low employee engagement is a significant challenge, with one in five workers worldwide planning to quit their jobs, according to The Best Workplaces. The situation appears to be even worse in Europe, where one in three workers are considering leaving their company (table 5). Low engagement has a significant impact on the global economy, costing \$7.8 trillion.

Table 5.

Likelihood that respondents will leave their current jobs in the next 3-6 months

Country	Likelihood %
Poland	50
France	35
Switzerland	34
Spain	32
Portugal	30
Italy	29
Germany	28
Belgium	27
Austria	26

Source: based on: (McKinsey, 2022).

Work-life balance in European Union countries

The work-life balance is a crucial aspect of EU policy. The European Pillar of Social Rights (European commission, 2021) and the Directive (EU) 2019/1158 on work-life balance for parents and carers emphasize the importance of improving the work-life balance of parents and carers. The directive aims to promote equality between men and women in terms of labor market opportunities, equal treatment at work, and promoting a high level of employment in the EU by making it easier for working parents and carers to balance work and private life (Biuletyn Informacji Publicznej RPO). The labour market situation is monitored through various surveys, including the European Quality of Life Survey (EQLS), the European Enterprise Survey (EES), and the European Working Conditions Survey (EWCS), conducted by the European Foundation for the Improvement of Living and Working Conditions. The surveys compare countries based on their ability to balance work and family life, flexible working arrangements, and the provision of high-quality care services. The most recent research, conducted in 2021, focused primarily on the relationship between the COVID-19 pandemic and working conditions. The report's key findings, according to Burke (2022), are as follows:

1. 81% of European employees (from 27 EU countries) confirm that their working hours fitted in with family and social commitments outside work (the Dutch reported the best while Romanian reported the poorest fit between work and commitment outside work).
2. Women more often than men reported that their work-life balance is good.
3. The fit between working hours and family/social commitments differed by occupation, sector and employment status.
4. People working from home enjoyed better work-life balance than people working on-site.
5. Employees aged 35-44 years old perceived their work-life balance as poor, while the best work-life balance was observed for people aged 56 and older.
6. Having children increases the share of respondents (both women and men) reporting poor work-life balance.
7. 27% of all European employees suffer from work-life conflict.
8. 24% of respondents are always or very often too tired to fulfill household duties.

In summary, the report indicates that employees from the European Union continue to experience work-life imbalance and conflict. The research suggests that employees who experience lower levels of tension and have greater resources available are more likely to report that their professional and personal lives are in alignment. Therefore, the quality of work and the balance between work and personal life are interdependent. Additionally, conflicts that arise at the intersection of work and personal life can be mitigated by providing more resources, as employees are less likely to think about work outside of working hours and feel less fatigued from their roles.

4. Discussion

In 2011 Organisation for Economic Co-operation and Development (OECD) created so called the Better Life Index as a part of the Better Life Initiative that allows understanding ‘what drives the well-being of people and nations and what needs to be done to achieve greater progress for all’ (OECD). The index is based on 11 topics: housing, income, jobs community, education, environment, civic engagement, health, life satisfaction, safety and work-life balance. Work-life balance is considered an essential indicator of living conditions and quality of life. The work-life balance index is based on the length of working hours (the amount of time that people spent on work) and time devoted to leisure and personal care. The table 6 presents the ranking for 22 out of 27 EU countries in 2020, as well as the level of employee engagement in the European Union for 2020 and 2022.

Table 6.*EU countries ranked highest for the quality of their work-life balance in 2020*

Country	Work-life balance index in 2020	Engagement in 2020 (%)	Engagement in 2022 (%)
Austria	6	10	11
Belgium	7.7	12	11
Czechia	7	16	15
Denmark	8.6	20	20
Estonia	7.3	24	25
Finland	7.3	10	14
France	8.1	7	7
Germany	8	15	16
Greece	7	9	12
Hungary	7.6	19	21
Ireland	6.2	13	11
Italy	9.4	5	5
Latvia	7.5	17	24
Lithuania	7.7	19	25
Luxemburg	7.4	8	10
Netherlands	8.3	12	14
Poland	6.5	12	14
Portugal	6.7	18	19
Slovak	7.1	13	17
Slovenia	6.7	16	16
Spain	8.4	8	10
Sweden	8.1	18	21

Source: based on: (OECD, 2020; Gallup, 2021; 2023).

In the OECD's Work-Life Balance Index, European countries rank highly compared to other areas of the world. Out of the 41 countries studied, the top 8 are European. Italy, Denmark, and Spain have the highest levels of work-life balance, while Austria, Ireland, and Poland have the highest imbalance. Despite Europeans rating their lives highly, with European countries topping the list of happiest places on Earth and eight of the world's happiest countries being located in Europe (Helliwell et al., 2022), they report feeling less satisfied with their workplaces than other nations (Gallup, 2022). This has resulted in low employee engagement in Europe, which varies between countries. In 2020, the highest levels of work engagement were observed in Estonia and Denmark. In 2022, Estonia, Latvia, and Lithuania showed the highest levels of work engagement, with Latvia and Lithuania making the most progress in the past two years. Conversely, employees in Belgium, Czechia, and Ireland were less engaged than they were two years ago. Italian and French employees consistently showed the lowest levels of work engagement.

Schaufeli's (2018) research demonstrates that engagement levels are higher in productive and economically active countries where people work less, such as Northern and Northwestern Europe, compared to less productive and active countries like Eastern and Southern Europe. Interestingly, despite having the highest work-life balance score of 9.4, Italy has the least engaged employees. However, it should be noted that Lithuania, Latvia, and Estonia, which have highly engaged employees and a good balance between work and social/family commitments, are located in Eastern Europe. Therefore, Schaufeli's research results do not fully explain the relationship between work engagement and work-life balance in EU countries.

In turn according to Björk, Bolander, Forsman (2023) work–life balance can be associated with positive aspects of mental well-being at work, such as work engagement and the relation between WLB and WE across European countries can be explained by welfare regime. The study found that employees in the Southern Europe welfare regime, as well as male employees in the Central and Eastern Europe welfare regime, were less likely to report satisfactory work-life balance compared to employees in the Nordic welfare regime. Again it is not fully truth for the present research, as Italy (Southern Europe) is the most work-life balanced according to OECD index, Latvia, Lithuania, Hungary (Eastern Europe) and Spain (Southern Europe) are more work-life balanced than Finland (Nordic).

Consequently, a growing body of the evidence demonstrates that the relationship between work engagement (WE) and work-life balance (WLB) in European countries is influenced by factors beyond cultural, economic or political contexts. One possible explanation for the poor engagement despite high levels of work-life balance indicators in Europe is the inadequate leadership in European companies. According to a Gallup survey conducted in 2013, 97% of German managers believed they were proficient in managing their teams. However, only 69% of German employees agreed with this assessment, stating that they worked under incompetent managers. The top reasons for this perception were workload, unclear communication from managers, lack of support from managers, and time pressure. These factors contribute to unfair treatment at work, which can reduce employee engagement, regardless of work-life balance. Therefore, it is crucial to address these issues and create a supportive working environment. Work engagement is a multi-faceted construct. To create deeply engaged human resources, it is important to consider various aspects. While work-life balance is a significant issue for work engagement, it does not fully explain it. Similarly, to understand the level of work-life balance in Europe, it is not sufficient to focus solely on work engagement. Work-life balance is associated with work engagement and this association is shaped by different macro (economic, cultural, political) and micro (organizational, personal) factors.

5. Summary

This paper aims to investigate the relationship between work engagement and work-life balance among employees in the European Union. Based on the research conducted for this paper, it is evident that there is a variation in the levels of work engagement and work-life balance among EU countries. Italians report the highest level of work-life balance satisfaction, while Austrians report the lowest. Furthermore, the most engaged employees are found in Estonia, Latvia, and Lithuania. Contrary to popular belief, Italians are the least frequently

engaged in their jobs. Additionally, EU employees exhibit lower levels of engagement, but higher satisfaction with their work-life balance compared to other regions of the world.

The low employee engagement across EU countries cannot be fully explained by the welfare regime or the type of economy. This issue is complex and requires further analysis. The current paper is limited in that it only discusses the link between the levels of WE and WLB across EU countries without explaining the reasons for the relationship. Therefore, further research is needed to identify the factors that shape this mutual relation.

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ANALYZING CUSTOMER BEHAVIOR – EMPLOYING BUSINESS ANALYTICS WITHIN INDUSTRY 4.0 ECOSYSTEMS

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Purpose: The purpose of this publication is to present the applications of usage of business analytics in customer behaviour analysis.

Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

Findings: The integration of business analytics with customer behavior analysis in Industry 4.0 environments offers businesses a transformative opportunity to gain profound insights into customer preferences, trends, and behaviors. Through the utilization of state-of-the-art technologies and data-driven methodologies, organizations can attain unprecedented levels of precision and detail in understanding customer behavior. Real-time data collection and analysis facilitate agile responses to evolving market dynamics, enabling personalized customer experiences across various channels. Additionally, advanced analytics tools such as predictive modeling and sentiment analysis empower businesses to forecast future trends, address churn, and enhance customer satisfaction. However, businesses may encounter challenges like data quality issues, privacy concerns, and resource limitations. Overcoming these obstacles necessitates a comprehensive approach, involving investments in data governance, talent acquisition, and technology infrastructure. By surmounting these challenges, businesses can harness the full potential of business analytics to drive strategic decisions, refine marketing strategies, and elevate overall business performance within Industry 4.0 environments.

Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage of business analytics in the case of smart manufacturing.

Keywords: business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; customer behavior analysis.

Category of the paper: literature review.

1. Introduction

At its core, customer behavior analysis in Industry 4.0 environments involves leveraging cutting-edge technologies and data-driven approaches to gain actionable insights into customer preferences, trends, and behaviors. By harnessing the power of business analytics, businesses

can sift through vast volumes of customer data generated by interconnected devices, sensors, social media platforms, and digital touchpoints.

One of the key benefits of employing business analytics in customer behavior analysis within Industry 4.0 environments is the ability to achieve unprecedented levels of granularity and precision in understanding customer behavior. Through advanced analytics techniques such as predictive modeling, machine learning, and natural language processing, businesses can uncover hidden patterns, correlations, and trends within their customer data. Moreover, Industry 4.0 technologies enable real-time data collection and analysis, allowing businesses to gain insights into customer behavior instantaneously. This real-time visibility into customer interactions empowers businesses to respond promptly to changing preferences, market dynamics, and competitive pressures. By leveraging real-time analytics, businesses can personalize customer experiences, optimize marketing campaigns, and drive customer engagement in ways that were previously unimaginable.

Another significant advantage of integrating business analytics with Industry 4.0 environments is the ability to achieve seamless omni-channel customer experiences. With customers interacting with businesses through a myriad of channels, including websites, mobile apps, social media platforms, and physical stores, it is essential for businesses to have a unified view of customer behavior across these channels. Business analytics enables businesses to aggregate and analyze data from disparate sources, allowing for a holistic understanding of the customer journey and facilitating personalized, omni-channel experiences (Bakir, Dahlan, 2022).

The purpose of this publication is to present the applications of usage of business analytics in customer behavior analysis.

2. The selected aspects of business analytics usage in customer behavior analysis

Business analytics has emerged as a pivotal tool in deciphering and understanding customer behavior, offering businesses invaluable insights into consumer preferences, tendencies, and trends. Through the strategic application of data analysis techniques, businesses can unlock a wealth of information that shapes marketing strategies, enhances customer experiences, and drives revenue growth. One primary application of business analytics in customer behavior analysis is customer segmentation. By leveraging demographic, psychographic, and transactional data, businesses can categorize their customer base into distinct segments with similar characteristics and behaviors (Akundi et al., 2022). This segmentation allows for targeted marketing efforts, personalized communication, and tailored product offerings, thereby maximizing customer engagement and satisfaction. Furthermore, business analytics enables

businesses to delve deep into purchase patterns and trends. By analyzing historical transaction data, businesses can identify correlations between product purchases, seasonal fluctuations, and customer preferences. Such insights empower organizations to optimize inventory management, pricing strategies, and product placements, ensuring that offerings resonate with customer needs and preferences (Zeng et al., 2022; Pech, Vrchota, 2022).

Predictive analytics plays a crucial role in customer behavior analysis by forecasting future trends and outcomes (Gajdzik, Wolniak, 2022; Gajdzik et al., 2023). Through sophisticated modeling techniques, businesses can predict customer churn, anticipate future purchasing behavior, and identify opportunities for cross-selling or upselling. Armed with this foresight, organizations can proactively implement retention strategies, personalized marketing campaigns, and targeted promotions to mitigate churn and maximize customer lifetime value (Ghibakholl et al., 2022).

Sentiment analysis, another facet of business analytics, mines customer feedback, reviews, and social media interactions to gauge consumer sentiment towards products or services (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022). By analyzing language patterns and sentiment scores, businesses can identify areas of strength and weakness, address customer concerns, and refine their offerings to better align with customer expectations (Scappini, 2016). Recommendation systems powered by business analytics leverage machine learning algorithms to deliver personalized product recommendations to customers (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Gajdzik, Wolniak, 2023; Swarnakar et al., 2023). By analyzing past behavior, preferences, and similarities with other customers, recommendation engines enhance the customer shopping experience, increase conversion rates, and foster brand loyalty (Cillo et al., 2022).

Finally, business analytics facilitates the evaluation of campaign effectiveness by measuring key performance indicators such as click-through rates, conversion rates, and return on investment. By assessing the impact of marketing initiatives on customer behavior and sales outcomes, businesses can optimize marketing spend, refine targeting strategies, and improve overall marketing efficiency. Table 1 contains descriptions of how business analytics is used in the case of customer behavior analysis.

Table 1.

The usage of business analytics in customer behavior analysis

Aspect of Customer Behavior Analysis	Description of Usage of Business Analytics
Customer Segmentation	Business analytics is utilized to segment customers based on various attributes such as demographics, purchasing behavior, and psychographics. Analytics tools help in identifying distinct customer groups with similar characteristics, enabling targeted marketing strategies and personalized offerings.

Cont. table 1.

Purchase Patterns Analysis	Business analytics examines historical transaction data to identify patterns in customer purchases. This analysis helps in understanding which products or services are frequently bought together, seasonal trends, and customer preferences. By leveraging this insight, businesses can optimize their inventory, pricing strategies, and product recommendations.
Churn Prediction	Through predictive analytics, businesses forecast the likelihood of customers churning or discontinuing their relationship with the company. By analyzing factors such as usage patterns, engagement metrics, and customer feedback, businesses can proactively implement retention strategies to prevent churn, such as personalized offers, loyalty programs, or improved customer service.
Customer Lifetime Value (CLV) Analysis	Business analytics calculates the CLV of customers by estimating the net profit attributed to the entire relationship with a customer. By analyzing past behavior and spending patterns, businesses can predict future revenue potential from each customer, guiding decisions related to customer acquisition, retention, and resource allocation.
Sentiment Analysis	Utilizing text mining and natural language processing techniques, business analytics extracts insights from customer feedback, reviews, and social media conversations. Sentiment analysis helps in understanding customer perceptions, opinions, and emotions towards products or services. By identifying sentiment trends, businesses can address issues, improve products, and enhance customer satisfaction.
Recommendation Systems	Business analytics powers recommendation engines that suggest relevant products or services to customers based on their past behavior, preferences, and similarities with other customers. By employing machine learning algorithms, businesses can deliver personalized recommendations through various channels such as websites, emails, or mobile apps, thereby increasing sales and enhancing customer experience.
Campaign Effectiveness Analysis	Business analytics evaluates the performance of marketing campaigns by analyzing metrics such as click-through rates, conversion rates, and return on investment (ROI). By measuring the impact of different campaigns on customer behavior and sales, businesses can optimize marketing strategies, allocate resources effectively, and improve overall marketing efficiency.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020; Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

3. Software used in customer behavior analysis in Industry 4.0 conditions

Business analytics software plays a crucial role in understanding and analyzing customer behavior, offering businesses valuable insights to drive strategic decision-making and enhance customer experiences (Adel., 2022). These software applications leverage advanced analytics techniques to process vast amounts of data, enabling businesses to uncover patterns, trends, and correlations within their customer base. By utilizing these insights, organizations can segment customers based on various attributes, such as demographics, behaviors, and preferences, allowing for targeted marketing efforts and personalized communication (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecula, Wolniak, 2022; Olkiewicz et al., 2021). Moreover,

predictive analytics capabilities enable businesses to forecast customer behavior, anticipate churn, and identify opportunities for upselling or cross-selling. Real-time analytics functionality provides businesses with up-to-date insights into customer interactions across multiple channels, enabling prompt responses and tailored engagement strategies. Additionally, advanced data visualization tools allow businesses to create interactive dashboards and reports, facilitating the exploration and communication of insights derived from customer data. By harnessing the power of business analytics software, organizations can gain a deeper understanding of their customers, optimize marketing strategies, improve customer satisfaction, and drive sustainable business growth (Du et al., 2023; Fjellström, Osarenkhoe, 2023; Castro et al., 2014; Wang et al., 2023).

Table 2 highlighting examples of software and applications used in customer behavior analysis, along with descriptions of their usage.

Table 2.

The usage of business analytics software in customer behavior analysis

Software/ Application	Description	Key Features
IBM Watson Analytics	IBM Watson Analytics is a cloud-based analytics platform that offers advanced analytics capabilities for businesses. It allows users to explore and analyze data through intuitive visualizations and predictive analytics tools.	<ul style="list-style-type: none"> • Advanced data visualization: Interactive dashboards and visualizations facilitate the exploration of customer data and trends. • Predictive analytics: Enables businesses to forecast customer behavior, identify patterns, and make data-driven decisions. • Natural language processing (NLP): Allows users to ask questions in natural language and receive insights, making data analysis more accessible to non-technical users.
Salesforce Einstein Analytics	Salesforce Einstein Analytics is an AI-powered analytics platform integrated with Salesforce CRM, designed to provide actionable insights and recommendations to improve customer experiences.	<ul style="list-style-type: none"> • Integration with CRM data: Seamlessly integrates with Salesforce CRM to analyze customer data, including sales, service, and marketing interactions. • Predictive analytics: Utilizes machine learning algorithms to forecast customer behavior, predict churn, and identify cross-selling opportunities. • AI-driven insights: Generates automated insights and recommendations to guide sales and marketing strategies, enhancing customer engagement and retention.
Google Analytics	Google Analytics is a web analytics service offered by Google that tracks and reports website traffic and user interactions. While primarily used for website analysis, it also provides valuable insights into customer behavior.	<ul style="list-style-type: none"> • Website traffic analysis: Tracks customer interactions on websites, including page views, session durations, and conversion rates, to understand user behavior and preferences. • E-commerce tracking: Provides insights into online purchase behavior, including product performance, transaction values, and shopping cart abandonment rates. • Audience segmentation: Allows businesses to segment website visitors based on demographics, interests, and behaviors, enabling targeted marketing and personalized content delivery.

Cont. table 2.

Tableau	Tableau is a powerful data visualization tool that allows businesses to create interactive and shareable dashboards for analyzing customer behavior.	<ul style="list-style-type: none"> • Interactive dashboards: Enables users to visualize and explore customer data through interactive charts, graphs, and maps, facilitating deeper insights into customer behavior. • Data blending: Integrates data from multiple sources, such as CRM systems, social media platforms, and transactional databases, to provide a comprehensive view of customer interactions. • Predictive analytics: Offers predictive modeling capabilities to forecast customer behavior, identify trends, and make data-driven decisions.
SAS Customer Intelligence	SAS Customer Intelligence is a comprehensive suite of analytics solutions designed to help businesses understand and engage with customers effectively.	<ul style="list-style-type: none"> • Customer segmentation: Utilizes advanced analytics techniques to segment customers based on demographics, behaviors, and preferences, enabling targeted marketing campaigns and personalized communications. • Real-time analytics: Provides real-time insights into customer interactions across multiple channels, allowing businesses to respond promptly to customer needs and preferences. • Campaign optimization: Optimizes marketing campaigns by analyzing campaign performance, identifying the most effective channels and messages, and optimizing marketing spend to maximize ROI.
Adobe Analytics	Adobe Analytics is a web analytics solution that provides businesses with insights into customer interactions across digital channels, including websites, mobile apps, and social media platforms.	<ul style="list-style-type: none"> • Omnichannel analytics: Tracks customer interactions across multiple digital touchpoints, allowing businesses to understand the customer journey and identify opportunities for engagement and conversion. • Segmentation and targeting: Enables businesses to segment customers based on behavior, demographics, and other attributes, and target them with personalized content and offers. • Attribution modeling: Provides insights into the effectiveness of marketing channels and campaigns, helping businesses allocate resources effectively and optimize marketing ROI.
Microsoft Power BI	Microsoft Power BI is a business analytics tool that allows businesses to visualize and analyze data from various sources, including databases, spreadsheets, and cloud services.	<ul style="list-style-type: none"> • Data visualization: Offers a range of visualization options, including charts, graphs, and maps, to help businesses explore and communicate insights from customer data effectively. • Natural language queries: Allows users to ask questions in natural language and receive insights from the data, making it easier for non-technical users to analyze and understand customer behavior. • Integration with Microsoft products: Seamlessly integrates with other Microsoft products, such as Excel, SharePoint, and Dynamics 365, to provide a unified analytics platform for businesses.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

4. Advantages and problems of business analytics usage in customer behavior analysis

Utilizing business analytics in customer behavior analysis offers a multitude of advantages for businesses seeking to thrive in today's competitive landscape. By harnessing the power of data-driven insights, organizations can gain a deeper understanding of their customers, optimize their marketing strategies, and enhance overall business performance. One of the primary advantages of leveraging business analytics in customer behavior analysis is the ability to enhance customer segmentation. By analyzing vast amounts of customer data, businesses can segment their customer base more accurately based on demographics, behaviors, preferences, and purchasing patterns. This allows for targeted marketing efforts, personalized communication, and tailored product offerings, ultimately leading to higher customer engagement and satisfaction. Furthermore, business analytics enables data-driven decision-making processes. Instead of relying on guesswork or intuition, businesses can make informed decisions backed by empirical evidence and insights derived from customer behavior analysis. This results in more effective strategies, better allocation of resources, and improved business outcomes (Charles et al., 2023).

Predictive analytics capabilities offered by business analytics tools allow businesses to forecast future trends and behaviors. By analyzing historical data and using sophisticated algorithms, businesses can anticipate customer needs, predict churn, identify cross-selling opportunities, and optimize pricing strategies. This proactive approach helps businesses stay ahead of the competition and capitalize on emerging opportunities in the market. Moreover, business analytics facilitates personalized marketing campaigns. By analyzing customer behavior data, businesses can create targeted marketing campaigns tailored to the preferences and interests of specific customer segments. This not only increases the effectiveness of marketing efforts but also enhances customer engagement and loyalty.

Real-time insights provided by business analytics tools enable businesses to respond promptly to changing market conditions and customer preferences. By monitoring customer interactions in real-time, businesses can identify trends, detect anomalies, and take immediate action to address issues or capitalize on opportunities. This agility gives businesses a competitive edge in today's fast-paced business environment (Nourani, 2021).

The advantages of using business analytics in customer behavior analysis are manifold. From enhanced customer segmentation and data-driven decision-making to predictive analytics and personalized marketing campaigns, businesses can leverage analytics to gain a deeper understanding of their customers, drive business growth, and maintain a competitive edge in the market. Table 3 contains the advantages of using business analytics in customer behavior analysis within Industry 4.0 conditions, along with descriptions for each advantage. This table showcases how business analytics in smart manufacturing offer various advantages across

different facets of operations, ultimately driving efficiency, reducing costs, and enhancing competitiveness (Greasley, 2019).

Table 3.

The advantages of using business analytics in customer behavior analysis

Advantage	Description
Enhanced Customer Segmentation	Business analytics allows for more accurate and detailed segmentation of customers based on demographics, behaviors, and preferences. This enables targeted marketing efforts and personalized experiences.
Data-Driven Decision Making	By analyzing customer behavior data, businesses can make informed decisions backed by data rather than relying on assumptions or intuition. This leads to more effective strategies and better outcomes.
Improved Customer Retention	Business analytics helps in identifying churn patterns and predicting which customers are at risk of leaving. By implementing targeted retention strategies, businesses can improve customer retention rates and loyalty.
Personalized Marketing Campaigns	With insights gained from customer behavior analysis, businesses can create personalized marketing campaigns tailored to the preferences and interests of specific customer segments. This increases engagement and conversion rates.
Optimal Resource Allocation	By understanding customer preferences and behaviors, businesses can allocate resources more effectively, whether it's marketing budgets, product development efforts, or customer service initiatives. This ensures maximum return on investment (ROI).
Enhanced Customer Experience	Analyzing customer behavior helps businesses identify pain points, preferences, and opportunities to enhance the overall customer experience. By addressing these areas, businesses can improve satisfaction and loyalty.
Competitive Advantage	Businesses that leverage business analytics to analyze customer behavior gain a competitive edge by understanding market trends, customer preferences, and emerging opportunities better than their competitors.
Real-Time Insights	Business analytics provides real-time insights into customer interactions and behaviors, allowing businesses to respond promptly to changing market conditions, customer needs, and competitive threats.
Increased Revenue Generation	Ultimately, the insights gained from customer behavior analysis lead to increased revenue generation through improved targeting, higher conversion rates, increased customer lifetime value, and better overall business performance.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

Table 4 contains the problems of using business analytics in customer behavior analysis within Industry 4.0 conditions, along with descriptions for each advantage. These problems highlight some of the key challenges that businesses may encounter when using business analytics for customer behavior analysis. Overcoming these challenges requires a holistic approach, including addressing data quality issues, investing in talent and technology, and ensuring alignment with strategic objectives.

Table 4.

The problems of using business analytics in customer behavior analysis

Problem	Description
Data Quality Issues	One of the primary challenges in using business analytics for customer behavior analysis is poor data quality. Inaccurate or incomplete data can lead to erroneous insights and flawed decision-making processes.
Data Integration Challenges	Businesses often struggle with integrating data from various sources such as CRM systems, social media platforms, and transactional databases. Incompatible data formats and structures can hinder the analysis process.

Cont. table 4.

Privacy and Compliance Concerns	With the increasing focus on data privacy regulations such as GDPR and CCPA, businesses must ensure that they handle customer data ethically and comply with relevant regulations. This can limit the scope of data available for analysis.
Complexity of Analytics Tools	Business analytics tools often come with a steep learning curve and require specialized skills to use effectively. This can pose a challenge for businesses lacking in-house expertise or resources to implement and manage these tools.
Interpretation and Actionability	While business analytics can provide valuable insights into customer behavior, interpreting these insights and translating them into actionable strategies can be challenging. Businesses may struggle with prioritizing initiatives and implementing changes based on analytics findings.
Lack of Alignment with Business Goals	Another common problem is the disconnect between analytics initiatives and broader business goals. Without clear alignment with strategic objectives, analytics efforts may fail to deliver meaningful outcomes or drive tangible business results.
Overreliance on Historical Data	Business analytics often relies on historical data to analyze customer behavior and make predictions. However, relying solely on past data may not accurately capture changing market dynamics or emerging trends, leading to suboptimal decision-making.
Resource Constraints	Implementing and maintaining business analytics solutions requires significant investment in terms of time, money, and resources. Small and medium-sized businesses may face challenges in allocating sufficient resources to support analytics initiatives.
Technology Limitations	Rapid advancements in technology can outpace businesses' ability to adopt and leverage the latest analytics tools and techniques. Legacy systems and outdated infrastructure may limit the capabilities of business analytics solutions.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

5. Conclusion

The integration of business analytics with customer behavior analysis in Industry 4.0 environments presents a transformative opportunity for businesses to gain deeper insights into customer preferences, trends, and behaviors. By leveraging cutting-edge technologies and data-driven approaches, businesses can achieve unprecedented levels of granularity and precision in understanding customer behavior. Real-time data collection and analysis enable businesses to respond promptly to changing market dynamics and deliver personalized experiences across multiple channels. Moreover, advanced analytics techniques such as predictive modeling and sentiment analysis empower organizations to anticipate future trends, mitigate churn, and enhance customer satisfaction.

Despite the numerous advantages offered by business analytics in customer behavior analysis, businesses may encounter challenges such as data quality issues, privacy concerns, and resource constraints. Addressing these challenges requires a holistic approach, including investment in data governance, talent development, and technology infrastructure. By overcoming these obstacles, businesses can unlock the full potential of business analytics to drive strategic decision-making, optimize marketing strategies, and improve overall business performance in Industry 4.0 environments.

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SMART MANUFACTURING – THE UTILIZATION OF BUSINESS ANALYTICS IN INDUSTRY 4.0 ENVIRONMENTS

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Purpose: The purpose of this publication is to present the applications of usage of business analytics in smart manufacturing.

Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

Findings: The integration of business analytics in smart manufacturing within the framework of Industry 4.0 marks a significant stride in industrial processes, offering manifold advantages alongside notable challenges. Throughout this study, we delve into the expansive realm of business analytics applications, encompassing predictive maintenance, quality control, supply chain optimization, and real-time decision-making. Leveraging business analytics yields palpable benefits in smart manufacturing, exemplified by proactive equipment maintenance, stringent quality standards adherence, and streamlined supply chain operations. Additionally, analytics-driven enhancements in production optimization, energy management, demand forecasting, and asset performance management contribute to heightened productivity, cost reduction, and sustainability improvement. Challenges including data integration complexities, implementation intricacies, security concerns, scalability limitations, model interpretability issues, and skill gaps necessitate concerted efforts for effective resolution. Collaboration among stakeholders—manufacturers, software developers, policymakers, and educational institutions—is imperative. Joint initiatives aimed at bolstering data integration capabilities, providing specialized training, fortifying cybersecurity measures, and fostering a culture of continuous improvement are crucial for successful business analytics deployment.

Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage of business analytics in the case of smart manufacturing.

Keywords: business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; smart manufacturing.

Category of the paper: literature review.

1. Introduction

Smart manufacturing, under the umbrella of Industry 4.0, epitomizes the fusion of advanced technology with traditional industrial processes. At its core lies the seamless integration of business analytics, empowering manufacturers to harness the full potential of data-driven insights in optimizing operations, enhancing efficiency, and driving innovation.

In the Industry 4.0 landscape, business analytics serves as a cornerstone, revolutionizing the way manufacturers operate. Predictive maintenance stands out as a prime example, leveraging historical data from sensors embedded in machinery to predict and preempt potential failures. By proactively scheduling maintenance tasks, manufacturers minimize downtime, optimize resource allocation, and ultimately reduce operational costs (Zeng et al., 2022; Pech, Vrchota, 2022).

The purpose of this publication is to present the applications of usage of business analytics in smart manufacturing.

2. The selected aspects of business analytics usage in smart manufacturing

Business analytics plays a pivotal role in the realm of smart manufacturing, revolutionizing traditional industrial processes through data-driven insights and decision-making. In this era of interconnected devices and sensor-laden machinery, businesses leverage analytics to unlock a plethora of opportunities across various facets of manufacturing operations. One of the foremost applications of business analytics in smart manufacturing is predictive maintenance. By scrutinizing historical data collected from sensors embedded in machinery and equipment, manufacturers can predict potential failures and schedule maintenance proactively, thereby minimizing downtime and optimizing maintenance costs (Bakir, Dahlan, 2022).

Quality control receives a significant boost through analytics-driven approaches. By analyzing data from different stages of the manufacturing process, anomalies or patterns indicative of defects can be identified promptly. This empowers manufacturers to intervene swiftly, maintaining stringent quality standards and reducing the likelihood of defective products reaching the market. Supply chain optimization benefits immensely from analytics, as businesses analyze data pertaining to inventory levels, demand forecasts, supplier performance, and logistics. Such insights enable streamlined inventory management, efficient resource allocation, and timely delivery of materials, ultimately enhancing supply chain efficiency.

Moreover, analytics optimize production processes by analyzing real-time production data to identify inefficiencies, bottlenecks, or improvement opportunities. This leads to optimized production schedules, streamlined workflows, and maximized resource utilization, driving up production efficiency and cutting costs. Energy management is another area ripe for optimization through business analytics. By monitoring and analyzing energy consumption data, manufacturers can pinpoint energy-intensive processes, detect waste, and optimize energy usage, leading to cost savings and improved sustainability (Ghibakholl et al., 2022).

The integration of business analytics in smart manufacturing enables real-time decision-making, empowering manufacturers to respond swiftly to changing market conditions, production disruptions, or other operational challenges (Gajdzik, Wolniak, 2022; Gajdzik et al., 2023). This fosters business agility, competitiveness, and sustainable growth in the dynamic landscape of modern manufacturing (Akundi et al., 2022). Asset performance management is also revolutionized through analytics, as businesses monitor and analyze the performance of manufacturing assets in real-time. This involves tracking key performance indicators, identifying patterns of asset failure or degradation, and optimizing maintenance strategies to maximize uptime and extend asset lifespan (Scappini, 2016).

Demand forecasting is enhanced by analytics techniques, which analyze historical sales data and market trends to predict future demand accurately. Manufacturers can then adjust production levels and inventory management strategies accordingly, ensuring optimal response to market dynamics (Cillo et al., 2022).

Table 1 contains descriptions of how business analytics is used in the case of smart manufacturing.

Table 1.
The usage of business analytics in smart manufacturing

Aspect of Smart Manufacturing	Description of Business Analytics Usage
Predictive Maintenance	Business analytics are employed to analyze historical data from machinery and equipment sensors to predict when maintenance is required. This helps in reducing downtime and optimizing maintenance schedules, resulting in cost savings and improved productivity.
Quality Control	Analytics are utilized to monitor and analyze data from various stages of the manufacturing process to identify patterns or anomalies that may indicate potential defects or quality issues. This enables proactive measures to be taken to maintain product quality standards and minimize defects.
Supply Chain Optimization	Business analytics are applied to analyze data related to supply chain processes, including inventory levels, demand forecasting, supplier performance, and logistics. This facilitates optimized inventory management, efficient resource allocation, and timely delivery of materials, ultimately enhancing overall supply chain efficiency.
Production Optimization	Analytics are used to analyze production data in real-time to identify inefficiencies, bottlenecks, or opportunities for improvement in manufacturing processes. This enables manufacturers to optimize production schedules, streamline workflows, and maximize resource utilization, leading to increased production efficiency and reduced costs.
Energy Management	Business analytics are employed to monitor and analyze energy consumption data from manufacturing operations. This helps in identifying energy-intensive processes, detecting energy waste, and optimizing energy usage to reduce costs and improve sustainability.

Cont. table 1.

Demand Forecasting	Analytics techniques are utilized to analyze historical sales data, market trends, and other relevant factors to forecast future demand for products. This enables manufacturers to anticipate market fluctuations, adjust production levels accordingly, and optimize inventory management to meet customer demand while minimizing excess inventory.
Asset Performance Management	Business analytics are used to monitor and analyze the performance of manufacturing assets such as machinery, equipment, and facilities. This includes tracking key performance indicators (KPIs), identifying patterns of asset failure or degradation, and optimizing asset maintenance strategies to maximize uptime and extend asset lifespan.
Real-time Decision Making	Analytics capabilities enable real-time monitoring and analysis of manufacturing operations data, providing decision-makers with actionable insights to make informed decisions quickly. This facilitates agile responses to changing market conditions, production disruptions, or other operational challenges, thereby improving overall business agility and competitiveness.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022; Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

3. Software used in smart manufacturing in Industry 4.0 conditions

Business analytics software is an indispensable tool in the realm of smart manufacturing, facilitating the integration of data-driven insights into various aspects of production processes. This software enables manufacturers to harness the vast amounts of data generated by interconnected devices and sensors, transforming it into actionable intelligence for informed decision-making. One of the key applications of business analytics software in smart manufacturing is predictive maintenance. By analyzing historical data collected from sensors embedded in machinery, this software can predict potential equipment failures before they occur. By identifying patterns and anomalies indicative of impending issues, manufacturers can schedule maintenance proactively, minimizing downtime and optimizing maintenance costs (Adel, 2022).

Quality control is another critical area where business analytics software shines. Manufacturers utilize this software to monitor and analyze data from different stages of the production process, identifying anomalies or patterns that may indicate defects (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022). With this insight, they can intervene swiftly to maintain stringent quality standards, thereby safeguarding brand reputation and customer satisfaction. Supply chain analytics software plays a pivotal role in optimizing supply chain processes. By analyzing data related to inventory management, demand forecasting, supplier performance, and logistics, manufacturers gain insights into streamlined operations, efficient resource allocation, and timely delivery of materials. This enables them to optimize inventory levels, minimize stockouts, and enhance overall supply chain efficiency (Nourani, 2021).

Furthermore, production optimization software enables manufacturers to maximize efficiency and productivity across their production processes. By analyzing real-time production data, this software identifies inefficiencies, bottlenecks, or improvement opportunities. With this insight, manufacturers can optimize production schedules, streamline workflows, and maximize resource utilization, ultimately driving down costs and increasing profitability (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecula, Wolniak, 2022; Olkiewicz et al., 2021). Energy management software is also instrumental in smart manufacturing, helping manufacturers monitor and analyze energy consumption data from their operations. By identifying energy-intensive processes, detecting waste, and optimizing energy usage, this software enables manufacturers to reduce operating costs and minimize their environmental footprint (Du et al., 2023; Fjellström, Osarenkhoe, 2023; Castro et al., 2014; Wang et al., 2023).

Demand forecasting software is essential for manufacturers to anticipate market trends and adjust production levels accordingly. By analyzing historical sales data, market trends, and other relevant factors, this software predicts future demand for products. With this insight, manufacturers can optimize inventory management strategies, minimize stockouts, and maximize customer satisfaction (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Gajdzik, Wolniak, 2023; Swarnakar et al., 2023). Asset performance management software enables manufacturers to monitor and analyze the performance of their manufacturing assets in real-time. By tracking key performance indicators and identifying patterns of asset failure or degradation, this software optimizes maintenance strategies to maximize asset uptime and extend asset lifespan. Lastly, real-time decision-making software empowers manufacturers to respond swiftly to changing market conditions, production disruptions, or operational challenges. By monitoring and analyzing manufacturing operations data in real-time, this software provides actionable insights and decision support tools, enabling manufacturers to make informed decisions and maintain agility in the face of uncertainty.

Table 2 highlighting examples of software and applications used in global supply chain coordination, along with descriptions of their usage.

Table 2.*The usage of business analytics software in smart manufacturing*

Software/ Application	Description	Key Features
Predictive Maintenance	Predictive maintenance software analyzes historical data from machinery sensors to predict potential equipment failures. By identifying patterns and anomalies, it enables proactive maintenance scheduling, minimizing downtime and optimizing maintenance costs.	<ul style="list-style-type: none"> • Data analysis for predictive modelling • Real-time monitoring of equipment health • Automated maintenance scheduling
Quality Control	Quality control software monitors and analyzes data from various stages of the manufacturing process to ensure product quality. It detects anomalies or patterns indicating defects, allowing for swift intervention to maintain stringent quality standards.	<ul style="list-style-type: none"> • Statistical process control (SPC) • Defect detection and classification • Automated inspection and quality assurance
Supply Chain Analytics	Supply chain analytics software optimizes supply chain processes by analyzing data related to inventory management, demand forecasting, supplier performance, and logistics. It provides insights for streamlined operations, efficient resource allocation, and timely delivery of materials.	<ul style="list-style-type: none"> • Inventory optimization • Demand forecasting • Supplier performance analysis • Logistics optimization
Production Optimization	Production optimization software analyzes real-time production data to identify inefficiencies, bottlenecks, or improvement opportunities. It enables manufacturers to optimize production schedules, streamline workflows, and maximize resource utilization.	<ul style="list-style-type: none"> • Real-time production monitoring • Workflow optimization • Resource utilization analysis • Production scheduling optimization
Energy Management	Energy management software monitors and analyzes energy consumption data from manufacturing operations. It identifies energy-intensive processes, detects waste, and optimizes energy usage to reduce costs and improve sustainability.	<ul style="list-style-type: none"> • Energy consumption tracking • Identification of energy waste • Energy usage optimization • Renewable energy integration
Demand Forecasting	Demand forecasting software analyzes historical sales data, market trends, and other factors to predict future demand for products. It enables manufacturers to adjust production levels and inventory management strategies accordingly.	<ul style="list-style-type: none"> • Sales data analysis • Market trend analysis • Demand prediction modelling • Inventory management optimization
Asset Performance Management	Asset performance management software monitors and analyzes the performance of manufacturing assets such as machinery, equipment, and facilities. It tracks key performance indicators (KPIs) and identifies patterns of asset failure or degradation, optimizing maintenance strategies to maximize uptime and extend asset lifespan.	<ul style="list-style-type: none"> • Real-time monitoring of asset performance • KPI tracking • Predictive analytics for maintenance • Asset lifecycle management
Real-time Decision Making	Real-time decision-making software provides actionable insights by monitoring and analyzing manufacturing operations data in real-time. It enables decision-makers to respond swiftly to changing market conditions, production disruptions, or operational challenges.	<ul style="list-style-type: none"> • Real-time data monitoring • Predictive analytics -

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022; Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

4. Advantages and problems of business analytics usage in smart manufacturing

Business analytics in smart manufacturing offer a myriad of advantages, revolutionizing traditional industrial processes and driving efficiency, productivity, and competitiveness to new heights. One key advantage lies in predictive maintenance, where analytics analyze historical data from machinery sensors to forecast potential equipment failures. This proactive approach minimizes downtime, optimizes maintenance schedules, and reduces maintenance costs significantly. Moreover, analytics-driven quality control ensures adherence to stringent standards by monitoring and analyzing data from various production stages. By swiftly identifying defects or anomalies, manufacturers can intervene promptly, safeguarding brand reputation and enhancing customer satisfaction (Charles et al., 2023).

Supply chain optimization is another crucial benefit of business analytics. By analyzing data related to inventory management, demand forecasting, supplier performance, and logistics, manufacturers streamline operations, allocate resources efficiently, and ensure timely delivery of materials. This enhances supply chain efficiency, minimizes lead times, and boosts overall operational performance. In terms of production efficiency, analytics optimize processes by analyzing real-time production data, identifying inefficiencies, bottlenecks, or improvement opportunities. This leads to optimized production schedules, streamlined workflows, and maximized resource utilization, resulting in increased efficiency and reduced costs.

Energy management is also significantly enhanced through analytics, enabling manufacturers to monitor and analyze energy consumption data. By identifying energy-intensive processes and detecting waste, analytics facilitate optimized energy usage, leading to reduced operating costs and improved sustainability. Furthermore, analytics enable accurate demand forecasting by analyzing historical sales data, market trends, and other relevant factors. Manufacturers can adjust production levels and inventory management strategies accordingly, minimizing stockouts, reducing excess inventory, and maximizing customer satisfaction (Nourani, 2021).

Asset performance management benefits from analytics as well, with real-time monitoring and analysis of asset performance data. By tracking key performance indicators and identifying patterns of asset failure or degradation, analytics optimize maintenance strategies, maximize asset uptime, and extend asset lifespan, ultimately maximizing return on investment. Lastly, real-time decision-making is facilitated by analytics, providing actionable insights into manufacturing operations data. This enables swift responses to changing market conditions, production disruptions, or operational challenges, fostering agility in decision-making, optimal resource allocation, and maintaining competitiveness in dynamic environments (Greasley, 2019).

Table 3 contains the advantages of using business analytics in smart manufacturing within Industry 4.0 conditions, along with descriptions for each advantage. This table showcases how business analytics in smart manufacturing offer various advantages across different facets of operations, ultimately driving efficiency, reducing costs, and enhancing competitiveness.

Table 3.

The advantages of using business analytics in smart manufacturing

Advantage	Description
Predictive Maintenance	Business analytics enable predictive maintenance by analyzing historical data from machinery sensors, predicting potential equipment failures before they occur. This proactive approach minimizes downtime, optimizes maintenance schedules, and reduces maintenance costs.
Quality Control	Analytics-driven quality control monitors and analyzes data from various production stages to identify defects or anomalies. Swift intervention based on these insights ensures adherence to stringent quality standards, safeguarding brand reputation, and enhancing customer satisfaction.
Supply Chain Optimization	Business analytics optimize supply chain processes by analyzing data related to inventory management, demand forecasting, supplier performance, and logistics. This leads to streamlined operations, efficient resource allocation, and timely delivery of materials, ultimately enhancing supply chain efficiency.
Production Efficiency	Analytics optimize production processes by analyzing real-time production data, identifying inefficiencies, bottlenecks, or improvement opportunities. This leads to optimized production schedules, streamlined workflows, and maximized resource utilization, resulting in increased production efficiency and reduced costs.
Energy Management	Analytics help monitor and analyze energy consumption data from manufacturing operations, identifying energy-intensive processes and detecting waste. This leads to optimized energy usage, reduced operating costs, and improved sustainability through the integration of energy-saving measures.
Demand Forecasting	Business analytics analyze historical sales data, market trends, and other factors to predict future product demand accurately. This enables manufacturers to adjust production levels and inventory management strategies accordingly, minimizing stockouts, reducing excess inventory, and maximizing customer satisfaction.
Asset Performance Management	Analytics monitor and analyze the performance of manufacturing assets in real-time, tracking key performance indicators and identifying patterns of asset failure or degradation. This leads to optimized maintenance strategies, maximized asset uptime, and extended asset lifespan, ultimately maximizing return on investment.
Real-time Decision Making	Analytics provide real-time monitoring and analysis of manufacturing operations data, enabling swift responses to changing market conditions, production disruptions, or operational challenges. This fosters agility in decision-making, ensuring optimal resource allocation and maintaining competitiveness in dynamic environments.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022; Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

Table 4 contains the problems of using business analytics in smart manufacturing within Industry 4.0 conditions, along with descriptions for each advantage. These problems underscore the importance of addressing data quality, integration, skill development, and change management to successfully harness the benefits of business analytics in global supply chain coordination.

Table 4.*The problems of using business analytics in smart manufacturing*

Problem	Description
Data Integration Challenges	Smart manufacturing involves the collection of vast amounts of data from various sources, leading to challenges in integrating disparate data types and formats. Inconsistent data quality, compatibility issues, and data silos hinder the seamless aggregation and analysis of data, impeding the effectiveness of business analytics initiatives.
Complexity of Analytics Implementation	Implementing business analytics solutions in smart manufacturing environments requires specialized expertise in data analytics, machine learning, and software development. The complexity of integrating analytics platforms with existing systems, configuring algorithms, and interpreting results poses challenges, requiring significant time, resources, and investment.
Security and Privacy Concerns	The interconnected nature of smart manufacturing systems increases susceptibility to cybersecurity threats and data breaches. Concerns regarding data security, privacy, and intellectual property protection arise due to the transmission and storage of sensitive information across networks, necessitating robust cybersecurity measures and compliance with regulatory requirements.
Scalability and Performance Limitations	Scaling business analytics solutions to accommodate the growing volume and velocity of data in smart manufacturing environments poses challenges. Performance bottlenecks, latency issues, and resource constraints may arise, impacting the real-time processing and analysis of data and limiting the scalability and responsiveness of analytics systems.
Interpretability and Explainability of Models	The adoption of machine learning and artificial intelligence (AI) models in business analytics introduces challenges related to model interpretability and explainability. Complex algorithms may produce results that are difficult to interpret or lack transparency, hindering stakeholders' ability to understand the rationale behind decisions and undermining trust in analytics outcomes.
Maintenance and Upkeep of Analytics Systems	Business analytics systems require regular maintenance, updates, and optimization to ensure their effectiveness and reliability. Challenges related to system downtime, software updates, and compatibility issues may disrupt operations, necessitating continuous monitoring, support, and investment in maintenance activities to mitigate risks and ensure system stability.
Skill Gaps and Training Needs	The successful implementation and utilization of business analytics in smart manufacturing require a skilled workforce proficient in data analysis, statistics, and software development. Skill gaps and training needs may arise, hindering the adoption and effectiveness of analytics initiatives and necessitating investment in training programs to upskill existing personnel.
Return on Investment (ROI) Uncertainty	Despite the potential benefits of business analytics in smart manufacturing, uncertainties regarding return on investment (ROI) may pose challenges for stakeholders. Determining the tangible ROI of analytics initiatives, quantifying the value of insights generated, and justifying investments in analytics infrastructure and talent acquisition require careful evaluation and strategic planning.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022; Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

5. Conclusion

The integration of business analytics in smart manufacturing within the framework of Industry 4.0 represents a significant advancement in industrial processes, offering a multitude of benefits while also presenting certain challenges. Throughout this paper, we have explored

the diverse applications of business analytics, ranging from predictive maintenance and quality control to supply chain optimization and real-time decision-making.

The advantages of leveraging business analytics in smart manufacturing are evident, with predictive maintenance enabling proactive equipment upkeep, quality control ensuring stringent adherence to standards, and supply chain optimization streamlining operations for enhanced efficiency. Moreover, analytics-driven production optimization, energy management, demand forecasting, and asset performance management contribute to increased productivity, reduced costs, and improved sustainability.

However, the implementation of business analytics in smart manufacturing is not without its hurdles. Challenges such as data integration complexities, analytics implementation intricacies, security and privacy concerns, scalability limitations, interpretability of models, maintenance requirements, skill gaps, and uncertainties regarding return on investment need to be addressed effectively. Addressing these challenges requires a concerted effort from stakeholders, including manufacturers, software developers, policymakers, and educational institutions. Collaborative initiatives aimed at enhancing data integration capabilities, providing specialized training programs, bolstering cybersecurity measures, and fostering a culture of continuous improvement are essential for the successful deployment and utilization of business analytics in smart manufacturing.

Despite the challenges, the potential benefits of business analytics in smart manufacturing are undeniable. By harnessing the power of data-driven insights and decision-making, manufacturers can achieve unprecedented levels of efficiency, productivity, and competitiveness in the dynamic landscape of modern industry. As technology continues to evolve and new advancements emerge, the integration of business analytics will undoubtedly play a pivotal role in shaping the future of manufacturing, driving innovation, and fostering sustainable growth.

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THE CARBON DIOXIDE EMISSIONS' WORLD FOOTPRINT: DIAGNOSIS OF PERSPECTIVES

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Purpose: The purpose of the article is to elucidate the multifaceted nature of the carbon dioxide emissions dilemma and underscore the urgent need for concerted action to mitigate their adverse effects.

Design/methodology/approach: This paper elucidates the methodology of footprint research, outlining its key components, approaches and principles. It encompasses a multidisciplinary approach, drawing on various methodologies and tools to explore alternative futures and identify strategic opportunities. Combining multiple methods has provided a more complete and detailed understanding of complex interactions.

Findings: This study aims to analyse the main indicators of the impact of the ecological footprint on the state of the environment, to determine their dynamics over time, to assess the prospects of the negative impact of humanity on nature. Emissions of greenhouse gases are of particular importance in this analysis.

Research limitations/implications: Ultimately, the goal is to inspire action and advocacy for policies and practices that prioritize environmental stewardship, social equity and resilience in the face of climate change. The implications of this study underscore the importance of stakeholder engagement and adaptive management for effective integration.

Originality/value: The footprint of carbon dioxide emissions encompasses a broad spectrum of impacts, spanning environmental, economic, and social dimensions. At its core, the rise in atmospheric carbon dioxide levels, largely attributed to human activities such as the combustion of fossil fuels and widespread deforestation, triggers a cascade of consequences with far-reaching implications. These results could be especially interesting for researchers whose studies are interdisciplinary.

Keywords: ecological footprint, economic development, carbon dioxide emissions, growth, sustainable development, deforestation.

Category of the paper: Research paper.

JEL: Q54, F60, Q57, F55, F64.

1. Introduction

In the contemporary discourse on climate change, few issues loom as large or have as pervasive an impact as carbon dioxide emissions. The global rise in carbon dioxide levels, primarily driven by human activities such as burning fossil fuels and deforestation, has become emblematic of the environmental challenges facing our planet. This article delves into the intricate web of consequences spawned by carbon dioxide emissions, exploring their far-reaching footprint across various spheres of the environment, economy, and society. From altering atmospheric composition to influencing weather patterns, from jeopardizing biodiversity to shaping geopolitical dynamics, the footprint of carbon dioxide emissions extends across myriad dimensions, underscoring the urgent need for concerted action to mitigate their detrimental effects. Through a comprehensive examination of these impacts, we aim to deepen our understanding of the multifaceted nature of the carbon dioxide dilemma and illuminate pathways towards a more sustainable future.

The footprint of carbon dioxide emissions encompasses a broad spectrum of impacts, spanning environmental, economic, and social dimensions. At its core, the rise in atmospheric carbon dioxide levels, largely attributed to human activities such as the combustion of fossil fuels and widespread deforestation, triggers a cascade of consequences with far-reaching implications. Environmental repercussions of carbon dioxide emissions are profound and pervasive. Elevated levels of atmospheric carbon dioxide contribute significantly to global warming, driving changes in climate patterns, including rising temperatures, altered precipitation regimes, and increased frequency of extreme weather events. Furthermore, carbon dioxide emissions exacerbate ocean acidification, threatening marine ecosystems and coral reefs, while also accelerating the loss of biodiversity on land and at sea.

The economic ramifications of carbon dioxide emissions are equally significant. The reliance on carbon-intensive fuels for energy production not only perpetuates environmental degradation but also engenders economic vulnerabilities, as nations grapple with the costs of climate-related disasters, diminished agricultural yields, and disruptions to vital ecosystems. Moreover, carbon dioxide emissions perpetuate social inequalities, disproportionately impacting marginalized communities who bear the brunt of environmental degradation and climate-related disasters.

Addressing the challenge of carbon dioxide emissions requires concerted action on a global scale. Transitioning to renewable energy sources, implementing sustainable land-use practices, and fostering innovation in clean technologies are imperative steps towards mitigating the detrimental effects of carbon dioxide emissions. Additionally, promoting international cooperation and equitable policies can facilitate the transition to a low-carbon future while ensuring social justice and resilience in the face of climate change.

The primary objective of this article is to elucidate the multifaceted nature of the carbon dioxide emissions dilemma and underscore the urgent need for concerted action to mitigate their adverse effects. By exploring the extensive footprint of carbon dioxide emissions across various spheres of the environment, economy, and society, the article aims to deepen understanding of the interconnectedness of these impacts and illuminate pathways towards a more sustainable future. Through a comprehensive examination of the environmental, economic, and social ramifications of carbon dioxide emissions, the article seeks to raise awareness about the pressing need for global cooperation and innovative solutions to address the challenges posed by climate change. Ultimately, the goal is to inspire action and advocacy for policies and practices that prioritize environmental stewardship, social equity, and resilience in the face of climate change.

2. An overview of the literature

Many scientists of the world offer valuable insights into the methodologies, implications, and challenges associated with assessing and mitigating humanity's footprint on the planet. They serve as foundational literature for understanding the complexities of sustainability and guiding future research and policy interventions.

The role of footprint examined by Le C. Quéré et al. (2018). This paper provides an extensive analysis of global carbon emissions, sinks, and trends. It offers insights into the main drivers of carbon dioxide emissions, such as fossil fuel combustion and land-use changes, and assesses their implications for climate change mitigation strategies.

The authors M.Wackernagel and W.Rees (1996) introduce the concept of the ecological footprint as a measure of humanity's demand on nature and its ecosystems. This foundational work explores the methodology behind calculating ecological footprints and its relevance for sustainability assessments. Another investigation, highlights areas where resource consumption exceeds ecological limits and proposes strategies for achieving ecological balance (Wackernagel et al. (2004). The scientists' study focuses on evaluating the ecological footprint and biocapacity of the United States, providing valuable insights into the country's sustainability challenges and opportunities.

The concept of the ecological footprint, pioneered by Mathis Wackernagel and William Rees, provides a comprehensive measure of humanity's impact on the environment by quantifying the amount of biologically productive land and water required to sustain human activities and absorb waste. As human populations grow and consumption patterns intensify, the ecological footprint expands, placing increasing pressure on natural resources and ecosystems. Factors contributing to a larger ecological footprint include unsustainable consumption habits, overexploitation of natural resources, habitat destruction, and land-use change.

The G.P. Peters and E.G. Hertwich (2008) present a pioneering analysis of the carbon footprint of nations, considering not only domestic emissions but also emissions embodied in international trade. Their findings reveal the interconnected nature of global carbon emissions and highlight the importance of addressing emissions embedded in global supply chains.

Another investigator, M.A. Curran (2013) examines various methods for calculating carbon footprints and discusses factors influencing their accuracy and reliability. The paper also explores practical applications of carbon footprint assessments in industry, policy, and consumer behavior. A group of scientists with A. Galli conducted a comparative analysis of ecological footprints and biocapacity across European countries, shedding light on regional disparities in resource consumption and environmental impact. The study identifies key drivers of ecological overshoot and offers recommendations for sustainable resource management (Galli et al., 2012).

M. Lenzen and others (2012) insist that there is the relationship between ecological footprints and water scarcity, emphasizing the need for integrated water and land management strategies to ensure sustainable resource use. The paper offers insights into the complex interplay between human activities, resource consumption, and environmental degradation.

According to the literature review and what the author was able to find, there are no studies referring and reporting on carbon dioxide emissions as a paramount concern, reflecting their widespread influence on our planet. That is why it is so important to analyse the main indicators of the impact of the ecological footprint on the state of the environment, to determine their dynamics over time, to assess the prospects of the negative impact of humanity on nature. This article investigates the intricate ramifications stemming from carbon dioxide emissions, delineating their extensive footprint across environmental, economic, and societal domains. By exploring the extensive footprint of carbon dioxide emissions across various spheres of the environment, economy, and society, the article aims to deepen understanding of the interconnectedness of these impacts and illuminate pathways towards a more sustainable future. Through a comprehensive examination of the environmental, economic, and social ramifications of carbon dioxide emissions, the article seeks to raise awareness about the pressing need for global cooperation and innovative solutions to address the challenges posed by climate change.

3. Research methods

The main methods that were used during the conduct of this study to assess the ecological footprint of humanity and greenhouse gas emissions are as follows: literature review, data collection and analysis, case studies, synthesis and Interpretation, policy implications and recommendations. The research methodology is based on the system method, analysis and

synthesis, economic analysis and the dialectical method. For example, the methodology of this article begins with an extensive review of existing literature on carbon dioxide emissions and their impacts. This includes scholarly articles, reports from international organizations, and relevant policy documents. By synthesizing information from diverse sources, the author aims to provide a comprehensive overview of the subject matter.

Data Collection and Analysis – data pertaining to carbon dioxide emissions, atmospheric concentrations, climate trends, economic indicators, and societal impacts are collected from reputable sources such as the Intergovernmental Panel on Climate Change (IPCC), the World Bank, Statista and national environmental agencies. Statistical analysis and modeling techniques may be employed to elucidate trends and patterns in the data.

The analysis of practical cases is also the basis of this study - how successful countries solve the problem of ecological footprint within their economies, so that it does not negatively affect the well-being and health of the population. In order to illustrate the real-world implications of carbon dioxide emissions, case studies from different regions and sectors have been examined. These case studies provide valuable insights into the specific challenges and opportunities associated with mitigating carbon dioxide emissions and adapting to climate change.

The findings from the literature review, data analysis, case studies, and expert interviews are synthesized to provide a holistic understanding of the footprint of carbon dioxide emissions. Key themes, trends, and implications are identified and interpreted in the context of current debates and policy discussions surrounding climate change.

Finally, based on the synthesized findings, the article offers policy implications and recommendations for mitigating carbon dioxide emissions and addressing their impacts. These recommendations are informed by evidence-based research and aim to contribute to ongoing efforts to combat climate change at local, national, and global levels.

Various methods and formulas based on the results of the analysis of footprint indicators, can be used to help evaluate various aspects of future development and reduce negative environmental impacts on nature and the population, below are some of them:

1. Greenhouse Gas Emissions (CO₂, CH₄, N₂O):

$$E = P \times E_F \times (1 - E_R) \quad (1)$$

where:

E – greenhouse gas emissions;

P – production or consumption volume (e.g., amount of fuel used);

E_F – emission factor for the specific source (grams per unit of production or consumption);

E_R – emission reduction factor due to energy-efficient technologies or emission reduction programs.

2. Carbon Footprint (F_c):

$$F_c = \sum (E \times P_{GWP_s}) \quad (2)$$

where:

F_c – carbon footprint (expressed in amount of CO₂ equivalent emitted);

E – greenhouse gas emissions (CO₂, CH₄, N₂O);

P_{GWP_s} – global warming potentials for each gas.

3. Natural Resource Use (U_{NR}):

$$U_{NR} = \sum (U \times F_E) \quad (3)$$

where:

U_{NR} – natural resource use (measured in hectares or water areas);

U – amount of resources used (e.g., amount of land used for urbanization);

F_E – equivalence factor reflecting the environmental impact of using each resource.

4. Ecological Footprint (F_E):

$$F_E = \sum (P \times E_{Fp}) \quad (4)$$

where:

F_E – ecological footprint (measured in hectares);

P – amount of production or consumption (e.g., amount of land used);

E_{Fp} – functioning equivalence reflecting the ecological impact of each type of land use.

These formulas aid in quantitatively assessing the impact of human activities on the environment and determining which aspects of consumption and production need improvement to reduce the footprint.

4. Main Results

In recent decades, the world has witnessed escalating environmental degradation, manifested in phenomena such as climate change, deforestation, loss of biodiversity, and pollution. This deterioration of the environment is driven by a complex interplay of human activities, including industrialization, urbanization, intensive agriculture, and fossil fuel combustion. Among the key contributors to this degradation are the ecological footprint – the measure of humanity's demand on nature – and greenhouse gas emissions, which trap heat in the Earth's atmosphere, leading to global warming and climate disruption. Understanding the relationship between these factors is crucial for devising effective strategies to mitigate environmental degradation and ensure a sustainable future for generations to come.

The concept of humanity's "footprint" refers to the cumulative impact that human activities have on the environment, typically measured in terms of resource consumption, land use, and environmental degradation. When discussing carbon dioxide emissions and their connection to humanity's footprint, it pertains to the amount of greenhouse gases, particularly CO₂, released into the atmosphere as a result of human activities such as burning fossil fuels for energy, industrial processes, transportation, and deforestation.

To illustrate this concept, consider the following examples what tools do countries use to reduce their environmental footprint (tab. 1). The burning of fossil fuels, such as coal, oil, and natural gas, for electricity generation, heating, and transportation, releases significant amounts of carbon dioxide into the atmosphere. The more energy-intensive our lifestyles and industries become, the larger our carbon footprint grows. The widespread use of cars, trucks, airplanes, and other forms of transportation that rely on fossil fuels contributes substantially to carbon dioxide emissions. For instance, a single international flight can produce as much carbon dioxide as an average person emits in a year through other activities. Forests serve as vital carbon sinks, absorbing CO₂ from the atmosphere through photosynthesis. However, deforestation, driven by agricultural expansion, logging, and urbanization, reduces the Earth's capacity to sequester carbon dioxide. When forests are cleared, the stored carbon is released back into the atmosphere, exacerbating climate change. Various industrial activities, including manufacturing, cement production, and chemical processes, release carbon dioxide. These emissions contribute to the overall carbon footprint of human civilization, particularly in regions heavily reliant on industrial production. Agricultural practices such as livestock farming and rice cultivation produce methane and nitrous oxide, potent greenhouse gases that contribute to global warming. Additionally, the use of synthetic fertilizers releases nitrous oxide, further adding to humanity's carbon footprint.

In essence, humanity's footprint encompasses the full spectrum of activities that release greenhouse gases into the atmosphere, exacerbating climate change and its associated impacts. By understanding and mitigating this footprint through sustainable practices, renewable energy adoption, afforestation efforts, and policy interventions, we can work towards reducing our collective impact on the planet and fostering a more sustainable future. These examples illustrate the varying levels of impact different countries have on the environment through their footprints.

Table 1.*The content of the ecological footprint instruments in different countries of the world*

Direction	The content of the ecological footprint	Countries	Financial instruments and initiatives
Energy consumption	The burning of fossil fuels for electricity generation, heating, and transportation.	USA, China, India	Green bonds, carbon pricing, renewable energy subsidies
	Increased energy-intensive lifestyles and industries lead to larger carbon footprints.	EU, Japan, South Korea	Energy efficiency incentives, clean energy investments
Transportation	Widespread use of cars, trucks, airplanes, and other fossil fuel-dependent transportation.	USA, Germany, Brazil	Investment in public transportation, electric vehicles
	A single international flight can produce as much CO ₂ as an average person emits in a year through other activities.	UAE, Australia, Canada	Aviation emissions trading, fuel efficiency standards
Deforestation	Deforestation due to agricultural expansion, logging, and urbanization.	Brazil, Indonesia, Democratic Republic of Congo	REDD+ initiatives, forest conservation programs
	Reduced capacity of forests to absorb CO ₂ , leading to increased atmospheric carbon.	Malaysia, Papua New Guinea	Forest restoration projects, sustainable land management
Industrial processes	Industrial activities like manufacturing, cement production, and chemical processes.	China, United States, Germany	Carbon capture and storage projects, clean technology investments
	Emissions of CO ₂ as a byproduct contribute significantly to the global carbon footprint.	India, Japan, South Africa	Emissions trading schemes, carbon offset programs
Agriculture	Agricultural practices such as livestock farming and rice cultivation.	Argentina, Nigeria, Vietnam	Sustainable agriculture initiatives, methane capture projects
	Production of methane and nitrous oxide, potent greenhouse gases, exacerbating climate change.	Australia, Mexico, Kenya	Agroforestry programs, soil carbon sequestration projects
	Use of synthetic fertilizers also contributes to the release of nitrous oxide.	France, China, Ethiopia	Fertilizer efficiency programs, organic farming subsidies

Source: The data is based on the latest available statistics from Galli et al., 2012; European Commission, 2024; Le Quéré et al., 2018; Wackernagel, Rees, 1996; Yakymchuk et al., 2020; Curran, 2013; Peters, Hertwich, 2008; Lenzen et al., 2012.

Global warming is largely caused by increased emissions of carbon dioxide and other greenhouse gases into the atmosphere. Temperature anomalies are generally more important in the study of climate change than absolute temperature, as they are less affected by factors such as station location and elevation. Annual anomalies in global land and ocean surface temperature from 1880 to 2023, based on temperature departure in degrees Celsius has been represented in fig. 1.

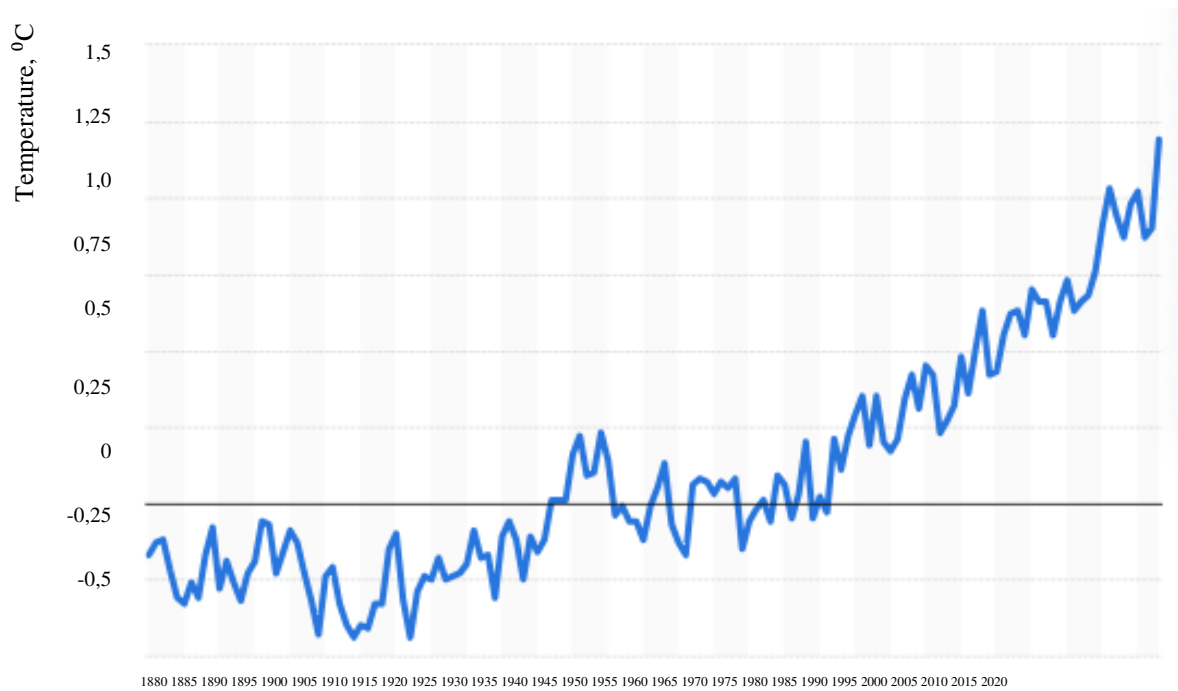


Figure 1. Global land and ocean temperature anomalies, 1880-2023.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2023.

Positive anomalies show that the observed temperature was warmer than the baseline. Land surface temperature anomalies are generally higher than ocean anomalies, although the exact reasons behind this phenomenon are still under debate. The annual temperature departure from average since the 1980s has been consistently positive. In 2023, the global land and ocean surface temperature anomaly stood at 1.19 degrees Celsius above the 20th century average, the largest recorded across the displayed period. The highest temperature anomaly was observed in 2023. Such climate changes are evidenced by the melting of sea ice areas in the Northern Hemisphere. As a result, temperature increases and weather changes become characteristic of other world regions, and therefore the level of warming increases. Today, warming and ice loss are most evident in the Arctic region compared to Antarctica (Statista, 2024).

Ecological footprint per capita worldwide in 2017, by region (in global hectares per capita) has been presented in fig. 2.

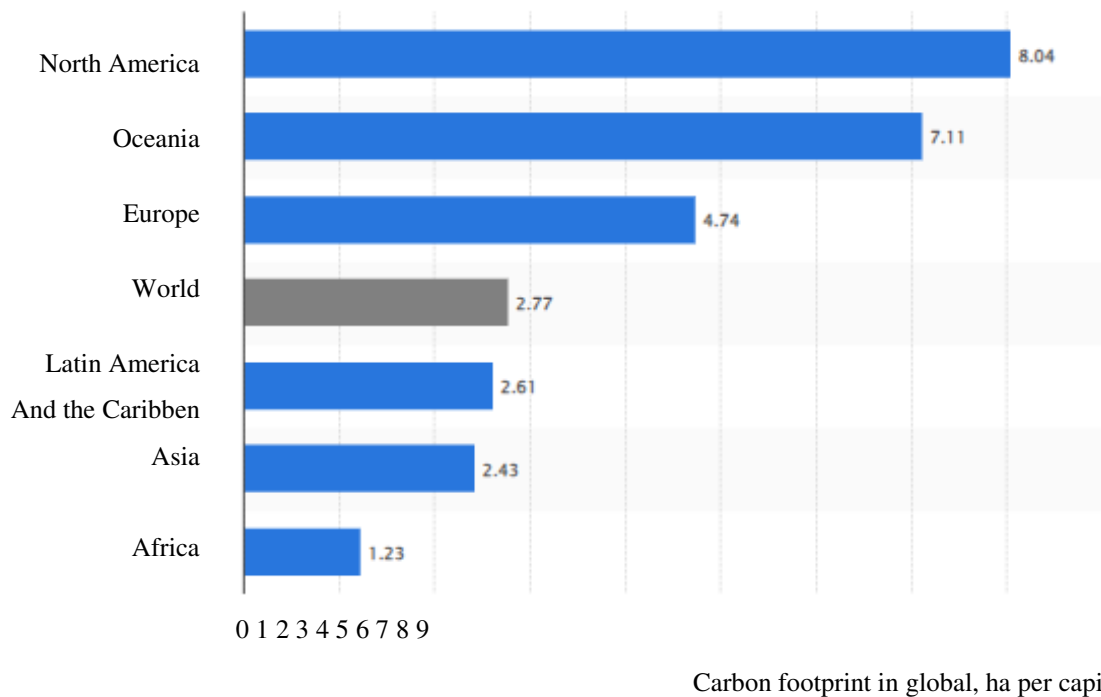


Figure 2. Global per capita ecological footprint, 2017.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2024.

As shown in Fig. 2, the average resident of North America had the largest ecological footprint – more than eight hectares per capita according to 2017 data. By comparison, the average person living in Africa had an ecological footprint of only 1.36 hectares. Oceania and Latin America are the only regions of the world where the estimated biocapacity has exceeded the ecological footprint. This includes the Caribbean. Africa occupies marginal indicators. Since 1970, the world has experienced a net global deficit (Statista, 2024).

It is worth noting that according to official data, global carbon dioxide emissions from fossil fuels and industry amounted to 37,15 billion metric tons in 2022. Experts believe that emissions will increase by an average of 1,1% in the future. It is worth mentioning that since 1990, global CO₂ emissions have increased by more than 60% (fig. 3).

China is the largest contributor to global greenhouse gas emissions, followed by the United States. Since 1990, CO₂ emissions in China have more than quadrupled. The spread of COVID-19 caused global CO₂ emissions to decrease by approximately 5.5% in 2020 (Statista, 2024).

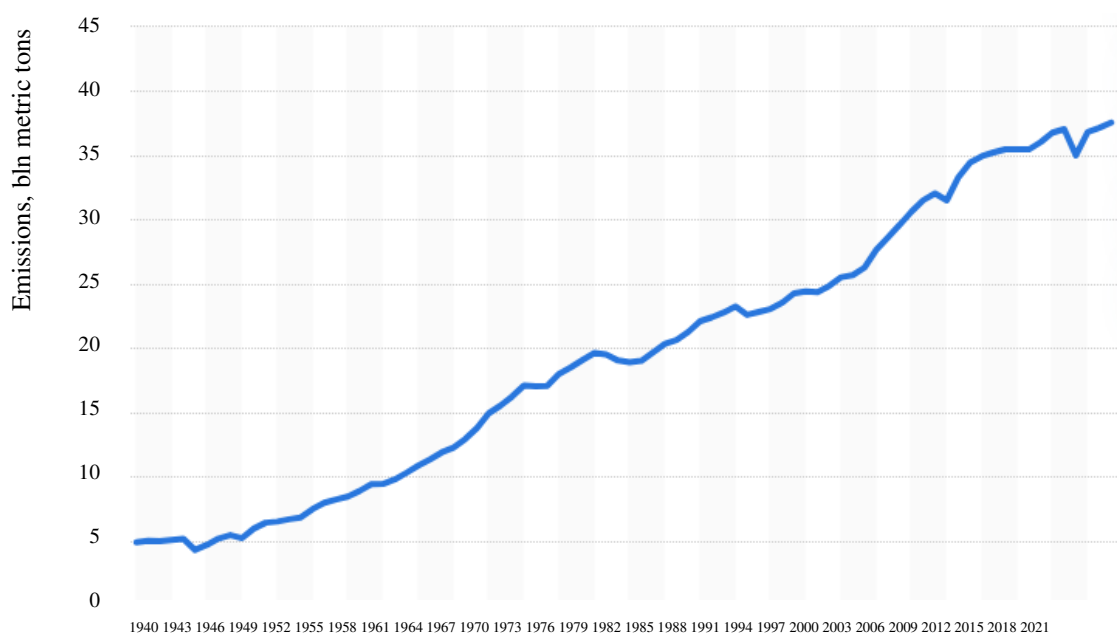


Figure 3. Annual carbon dioxide (CO₂) emissions worldwide, 1940-2021.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2023.

The volume of CO₂ emissions in Ukraine was analysed on the basis of official statistics. It is worth noting that emissions decreased by 15% compared to 2008. This is due to the consequences of the global economic crisis of 2008. During this time, the production of cement, ammonia and metal decreased significantly. In 2010-2013, the growth of CO₂ emissions was characterized by a general recovery of the economy. During this period, the consumption of solid fossil fuels in the energy sector increased. In 2014-2015, a sharp reduction in emissions was observed, caused by the decline of the economy due to the occupation of the Autonomous Republic of Crimea and the city of Sevastopol, as well as the beginning of hostilities in the Donetsk and Luhansk regions. In 2016-2019, fluctuations in CO₂ emissions were observed at the level of 337-362 million tons of CO₂-equivalent. This period is characterized by the beginning of the active implementation of the energy efficiency policy (the "Warm Credits" program is being implemented) and the gradual bringing of tariffs for electricity, hot water and heat to market values. However, in 2020, emissions fell by 11% compared to 2019 levels, because of COVID-19 pandemic and measures taken to combat the virus. In 2021, the recovery of the country's economy led to an increase in greenhouse gas emissions by 7.5% compared to 2020.

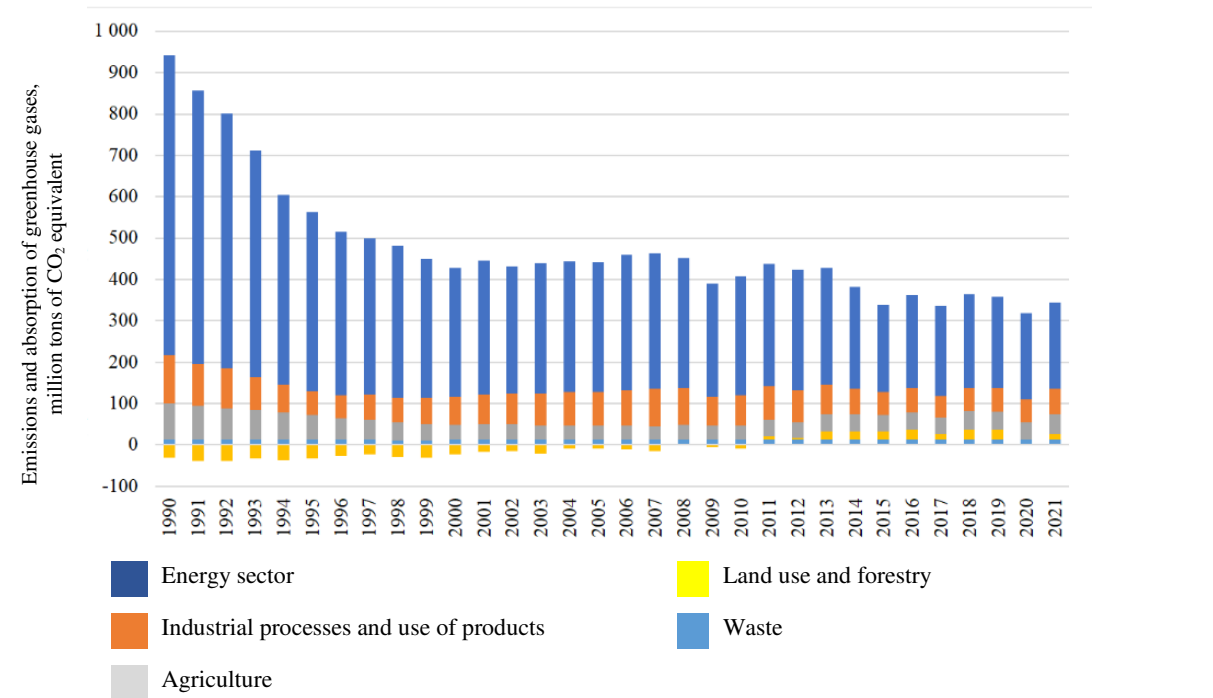
Table 2.*Emissions and absorption of CO₂ in 1990-2021 in Ukraine, tys. tons*

Sphere of the national economy	Years					Deviation of data 2021 to 1990 (+; -)	Growth rate (decrease) of emissions in 2021 to the base year 1990, %
	1990	2015	2017	2019	2021		
1	2	3	4	5	6	7	8
Energy sector	725,3	210,8	217,8	219,2	209,7	-515,6	-71,1
Industrial processes and use of products	118,2	56,4	51,8	57,6	61,5	-56,7	-48,0
Agriculture	86,8	39,4	40,9	44,8	47,0	39,8	-45,9
Land use and forestry	31,4	19,7	13,4	23,3	14,2	-17,2	-145,3
Waste	12,4	12,6	12,7	12,6	12,2	-0,2	-2,3
Total	911,4	33,9	336,7	357,5	344,6	-566,8	-62,2

Source: The data is based on the latest available statistics from Povidomlennia pro opryliudnennia 2022; Statista, 2024; European Commission, 2024.

According to the data of the Ministry of Environment, in 2021, GHG emissions in the "Energy" sector amounted to 209.74 million tons of CO₂-equivalent, or approximately 64% of all GHG emissions in Ukraine. During the entire period of 1990-2021, these emissions decreased by 71,1% compared to the base level. In the Industrial Processes and Product Use sector, GHG emissions increased by 9,8 % in 2021 compared to 2020. This growth occurred in all key categories: "Manufacturing of mineral products", "Metallurgy" and "Chemical industry". The main factor behind this increase in GHG emissions is the recovery process of Ukraine's economy after quarantine restrictions in 2020. At the same time, GHG emissions in the sector in 2021 decreased significantly (by 48 %) compared to the base year of 1990, which is associated with a decrease in industrial production in the metallurgical industry by 50% and the chemical industry by 43% (Povidomlennia pro opryliudnennia, 2022; Ministry of Ecology, 2024).

The author in this article did a comparative analysis on carbon footprint and ecological footprint with data for different countries (tab. 2). In United States greenhouse gas emissions (CO₂) amount to approximately 5 billion metric tons per year, primarily due to the use of coal and oil in energy production and transportation. China is the world's largest emitter of greenhouse gases – CO₂ emissions exceed 10 billion metric tons per year, a result of intensive industrial activity and growing energy consumption. Sweden has one of the lowest carbon footprints per capita in the world. The carbon footprint per capita in Sweden is approximately 4 tons per year, thanks to high levels of renewable energy use and energy-efficient technologies. The United States have one of the highest carbon footprints per capita in the world. The carbon footprint per capita in the United States can reach up to 16 tons per year due to high energy consumption and reliance on coal and oil (Statista, 2024).



Source: The data is based on the latest available statistics from Povidomlennia pro opryliudnennia, 2022; Statista, 2024; European Commission, 2024; Ministry of Ecology, 2024.

Australia has one of the largest ecological footprints per capita in the world. The ecological footprint per capita in Australia reaches up to 8 hectares per year, mainly due to extensive land use for agricultural purposes and high levels of greenhouse gas emissions. Netherlands has a relatively small ecological footprint per capita. The ecological footprint per capita in the Netherlands is approximately 3 hectares per year, thanks to high levels of energy efficiency and waste management.

Table 3.
Comparative analysis on carbon footprint and ecological footprint data for different countries

Country	Carbon Footprint (tons CO ₂ /capita)	Ecological Footprint (global hectares/capita)	Population (millions)	Renewable Energy Usage (%)	GDP per Capita (USD)	Human Development Index (HDI)
United States	16	8	331	11	62,606	0,926
China	8	6	1441	26	10,262	0,758
Sweden	4	7	10	54	54,947	0,937
Australia	17	8	25	17	55,060	0,944
Netherlands	10	5	17	11	52,331	0,944

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2024; Le Quéré et al., 2018; Wackernagel, Rees, 1996; Curran, 2013; Galli et al., 2012; Peters, Hertwich, 2008; Lenzen et al., 2012; Yakymchuk, Baran-Zgłobicka, 2023.

This table provides a comparative analysis of carbon footprint and ecological footprint data for different countries. Human Development Index (HDI) ranges from 0 to 1, where higher values indicate higher levels of human development. The United States has the highest carbon footprint per capita at 16 tons CO₂, indicating a significant contribution to global greenhouse gas emissions. Sweden exhibits the lowest carbon footprint among the listed countries, reflecting its commitment to sustainability and low-carbon policies. Australia and the United

States have the highest ecological footprints, suggesting high levels of resource consumption and environmental impact per capita. Sweden, despite its low carbon footprint, has a relatively high ecological footprint, possibly due to its large land area per capita and high consumption patterns.

China stands out with the largest population among the listed countries, significantly higher than the others. Sweden has the smallest population, which may contribute to its comparatively lower environmental impact. Sweden leads in renewable energy usage, with 54% of its energy derived from renewable sources, reflecting its commitment to clean energy transition. China also shows a significant percentage of renewable energy usage, indicating efforts to reduce dependence on fossil fuels.

The United States and Australia exhibit higher GDP per capita compared to Sweden and the Netherlands, indicating greater economic output per person. Despite China's large population, its GDP per capita is relatively lower, suggesting disparities in economic development within the country. Sweden and the Netherlands have the highest HDI values among the listed countries, indicating high levels of human development in terms of education, health, and income. While China has made significant progress in human development, its HDI value is lower compared to the other countries in the table. Overall, the analysis highlights the complex interplay between environmental impact, economic performance, and human development across different countries. It underscores the importance of sustainable development strategies to balance economic growth with environmental conservation and human well-being.

Greenhouse gas emissions, primarily carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), are major drivers of climate change, exacerbating global warming and its associated impacts. The combustion of fossil fuels for energy production, industrial processes, transportation, and deforestation releases vast quantities of greenhouse gases into the atmosphere, leading to the enhanced greenhouse effect. The consequences of climate change include rising temperatures, melting polar ice caps, sea-level rise, altered weather patterns, extreme weather events, and disruptions to ecosystems and agriculture. The relationship between ecological footprint and greenhouse gas emissions is complex and intertwined, with each exacerbating the impacts of the other. Increased resource consumption, driven by a larger ecological footprint, leads to higher emissions of greenhouse gases, further intensifying climate change. Conversely, climate change-induced disruptions, such as droughts, floods, and habitat loss, can amplify resource scarcity and environmental degradation, exacerbating humanity's ecological footprint.

5. Conclusions

In this study, the author summarized the main points presented in the article, proved the essential importance of estimation of influence of carbon dioxide emissions in world economy. The main results are:

1. The footprint of carbon dioxide emissions permeates every aspect of our interconnected world, necessitating urgent and comprehensive efforts to mitigate its impacts. By acknowledging the multifaceted nature of the carbon dioxide dilemma and embracing sustainable solutions, we can chart a course towards a more resilient and equitable future for generations to come. The analysis highlights the complex interplay between environmental impact, economic performance, and human development across different countries. It underscores the importance of sustainable development strategies to balance economic growth with environmental conservation and human well-being.
2. The data illustrates significant disparities in environmental impact among the different countries. The United States and Australia exhibit higher carbon and ecological footprints, indicating greater resource consumption and emissions per capita. In contrast, Sweden demonstrates lower environmental impact, attributed to its sustainable practices and renewable energy usage. Also the data underscores the importance of renewable energy transition in mitigating environmental impact. Sweden leads in renewable energy usage, reflecting a commitment to clean energy policies. Other countries, including China, also demonstrate significant progress in renewable energy adoption, indicating a shift towards more sustainable energy sources.
3. Higher GDP per capita does not necessarily correlate with lower environmental impact. While the United States and Australia exhibit higher economic output, they also demonstrate higher environmental footprints. Conversely, countries like Sweden and the Netherlands achieve relatively lower environmental impact despite slightly lower GDP per capita, suggesting a decoupling of economic growth from resource consumption. Countries with higher levels of human development, as measured by the Human Development Index (HDI), tend to exhibit lower environmental impact and greater sustainability efforts. Sweden and the Netherlands, with high HDI values, lead in environmental sustainability, emphasizing the importance of integrating social, economic, and environmental policies for holistic development.
4. The analysis highlights the need for coordinated efforts at the national and international levels to address environmental challenges while promoting sustainable development. It emphasizes the importance of adopting cleaner technologies, reducing resource consumption, and fostering inclusive growth to ensure a more sustainable and resilient future for all.

5. Since 1970, the world has experienced a net global deficit. It is worth mentioning that since 1990, global CO₂ emissions have increased by more than 60%. Global carbon dioxide emissions from fossil fuels and industry amounted to 37,15 billion metric tons in 2022. The average resident of North America had the largest ecological footprint – more than eight hectares per capita according to 2017 data. By comparison, the average person living in Africa had an ecological footprint of only 1,36 hectares. Oceania and Latin America are the only regions of the world where the estimated biocapacity has exceeded the ecological footprint. Experts believe that emissions will increase by an average of 1,1% in the future. China is the largest contributor to global greenhouse gas emissions, followed by the United States. Since 1990, CO₂ emissions in China have more than quadrupled. The spread of COVID-19 caused global CO₂ emissions to decrease by approximately 5.5% in 2020.
6. The volume of CO₂ emissions in Ukraine was analysed on the basis of official statistics. Emissions decreased by 15% compared to 2008. This is due to the consequences of the global economic crisis of 2008. During this time, the production of cement, ammonia and metal decreased significantly. In 2010-2013, the growth of CO₂ emissions was characterized by a general recovery of the economy. In 2014-2015, a sharp reduction in emissions was observed, caused by the decline of the economy due to the occupation of the Autonomous Republic of Crimea and the city of Sevastopol, as well as the beginning of hostilities in the Donetsk and Luhansk regions. In 2016-2019, fluctuations in CO₂ emissions were observed at the level of 337-362 million tons of CO₂-equivalent. This period is characterized by the beginning of the active implementation of the energy efficiency policy and the gradual bringing of tariffs for electricity, hot water and heat to market values. However, in 2020, emissions fell by 11% compared to 2019 levels, because of COVID-19 pandemic and measures taken to combat the virus. In 2021, the recovery of the country's economy led to an increase in greenhouse gas emissions by 7,5% compared to 2020.
7. The degradation of the environment represents one of the most pressing challenges of the 21st century, with far-reaching consequences for ecological integrity, human well-being, and socio-economic stability. Addressing this multifaceted issue requires a holistic approach that considers the interconnectedness of ecological footprint and greenhouse gas emissions. By adopting sustainable practices, reducing carbon emissions, conserving natural resources, promoting renewable energy, and fostering international cooperation, we can mitigate environmental degradation and pave the way towards a more resilient and sustainable future for our planet.

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EXPENDITURES ON INNOVATION ACTIVITIES OF FIRMS IN POLAND AT THE NUTS-2 LEVEL (COVID AND POST-COVID PERSPECTIVES)

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Purpose: This research aims to identify how expenditures on firms' innovation activities in Poland differ at the NUTS-2 level (with a focus on the covid and post-covid perspectives).

Design/methodology/approach: This study adopts the following methods: comparative analysis, zero unitarization method and multivariate analysis. The research draws on data from Local Bank Data, Statistics Poland, related to expenditures on firms' innovation activities in the period 2018–2022.

Findings: The results reveal that, despite of the occurrence of conditions of high constraints caused by the covid pandemic, the highest diversity in expenditures on innovation is observed between almost the very same Polish NUTS-2 regions in 2018-2022. The results also indicate that the covid pandemic noticeably encourages Polish firms, especially from the service sector, to increase expenditures on innovation processes.

Research limitations/implications: This study has some limitations. As the focus of the research is on total firms' innovation expenditures and firms' own resources for innovation, it would be useful to see whether the results are similar for other variables describing expenditures on firms' innovation activities. It would also be worth investigating the reasons for maintaining the highest diversity between Polish NUTS 2 regions in terms of expenditure on firms' innovation processes, which can be observed almost between the same regions despite the conditions of severe constraints due to the covid pandemic.

Practical implications: The results suggest a further strengthening of the pro-innovation attitude of Polish industrial and service firms. The research also highlights the need for policy makers to further strengthen the conditions for fostering innovation processes of firms.

Originality/value: This research contributes to the ongoing discussion on the drivers and sources of firms' innovation activities through the identification of the differences between the NUTS-2 regions in Poland in terms of expenditures on innovation activities in the covid and post-covid perspectives. The study also reveals more about the innovation processes of Polish firms under severe conditions.

Keywords: expenditures on firms' innovation activities, innovation activities of firms, the covid perspective, the post-covid perspective.

Category of the paper: research paper.

1. Introduction

As firms' innovation activities is valued for its contribution to firms' competitiveness (Fitsch et al., 2020), the increasing body of research addresses the drivers and sources of innovation (Isaksen, Jakobsen, 2017; Lehnert et al., 2020; Zygmunt, 2020; Gritlsch, 2021; Zygmunt, 2022b; Brodny, Tutak, 2022). The growing interest in this area stems from the crucial role of firms' innovation performance not only for firms' competitiveness but also for the competitiveness of regions and countries (Fitsch et al., 2020). This relationship is of concern in endogenous growth and knowledge spillover theories, which emphasise networks between firms and, *inter alia*, the research system and government institutions (Gritlsch, 2021). Over the decades, scholars have highlighted, among others, the role of knowledge cooperation in firms' innovation activities (Isaksen, Jakobsen, 2017). Other studies focus specifically on the relationship between human resources and the improvement of firms' innovativeness (Zygmunt, 2022b). Research and development (R&D) processes have also attracted interest as a driver of firms' innovation performance (Lehnert et al., 2020). Research attention has also been paid to expenditures on firms' innovation activities. Such expenditures are believed to be a key element in increasing firms' innovativeness (Decyk, 2023). This study focuses on the above driver of firms' innovation activities to provide further considerations in this area. Previous studies provide evidence that the issues related to expenditures on firms' innovation activities have been previously considered for Poland. In this context, the main areas of research have been placed mostly on firms' R&D expenditures as a stimulator of firms' innovativeness (Zygmunt, 2020a; Lubacha, 2021; Wyrwa, 2022; Brodny, Tutak, 2022; Decyk, 2023). The previous research also has considered the innovation processes of Polish firms under severe conditions, such as the covid pandemic (Koziół-Nadolna, 2022; Dominiak, Rachwał, 2022; Wojnicka-Sycz et al., 2022). However, there is still a relatively small amount of research on expenditures on innovation performance of Polish firms in the context of the covid and post-covid perspectives. This, together with the growing need to understand the attitude of Polish firms towards innovation under conditions of high constraints, motivated this research. Therefore, this study aims to assess how expenditures on firms' innovation activities in Poland differs at the NUTS-2 level (with a focus on the covid and post-covid perspectives). The hypothesis was tested using the following methods: comparative analysis, zero unitarization method and multivariate analysis. The data for this study comes from Local Bank Data, Statistics Poland. The 2018-2022 period is covered in this study.

This study provides contribution to the ongoing discussion on innovation drivers and sources by identifying of how NUTS-2 regions in Poland differ in terms of expenditures on firms' innovation activities in the covid and post-covid perspectives. This research also sheds more light on the innovation processes of Polish firms under severe conditions.

The paper proceeds as follows: the first section builds the theoretical background and hypothesis development. The next section presents the methodology used to explore how expenditures on firms' innovation activities in Poland differ at the NUTS-2 level (with a focus on the covid and post-covid perspectives). The results of the study are then presented. Conclusions, implications, limitations and suggestions for further research are presented in the last section.

2. Literature review

The growing interest in expenditures on firms' innovation activities stems from the need to understand the drivers and sources of firms' innovation processes. This is because firms' innovativeness can shift firms' competitive advantages, which can contribute to the competitiveness of regions and countries (Fitsch et al., 2020). In this context, expenditures on firms' innovation activities is considered to be essential for stimulating firms' innovation attitudes (Zygmunt, 2020a; Decyk, 2023). For this reason, research in this area is of great importance and has been the subject of a number of studies (Brodny, Tutak, 2022; Wyrwa, 2022). In this respect, various aspects of expenditure on innovation activities of firms are the focus of the research considered for Poland. In particular, a lot of attention has been paid to firms' R&D expenditures as a booster of the innovation capacity of firms. In this vein, Zygmunt (2020a) applies R&D expenditures of firms to assess the differentiation between Polish NUTS-2 regions in terms of intramural R&D expenditures incurred by firms, universities and regional policy actors. Wyrwa (2022) uses R&D expenditures of firms as an important indicator of firms' innovation activities and innovation development of the European Union countries. On the other hand, Brodny and Tutak (2022) apply R&D expenditures of firms as a one of the indicators to assess the innovation capacity of Polish NUTS-2 regions. Firms' R&D expenditures are also used as a one of the measures of innovation activities of firms in the study of regional innovativeness in Poland provided by Lubacha (2021). Another study, by Decyk (2023), emphasises not only firms' R&D expenditures but also other expenditures on innovation activities of firms (such as, among others, investment expenditures) in order to evaluate the level of innovation activities between the Member States of the European Union. Special attention is paid here to the innovation capacity of the service sector. Thus, the above studies suggest that the issues related to expenditures on firms' innovation activities in Poland are a relevant area of research, that can be approached from different perspectives.

With regard to expenditures on innovation activities by firms, it seems crucial to also consider the attitude of Polish firms towards innovation under conditions of high constraints. This is related to the argument that firms through the crisis may characterise the innovation capacity to adapt to changes and be more resilient (Heinonen, Strandvik, 2020; Hossain, 2020;

Schilling, 2020; Sheng et al., 2020; Netz et al., 2022). Consistent with this argument are the majority of the results on the attitudes of Polish firms under conditions of severe constraints induced by the covid pandemic. Among them, Wojnicka-Sycz et al. (2022) provide evidence that the majority of Polish firms from Subcarpathian Voivodship and Lower Silesian Voivodship distinguish an increase in innovation processes as an effect of the need to face to new requirements of the environment. Similarly, Kozioł-Nadolna (2022) finds that during the covid pandemic firms from West Pomeranian Voivodship do not indicate a significant reduction in their innovation activities. Another study, by Dominiak and Rachwał (2022), pays special attention to the attitude of the industrial and service sectors in the context of the high constraints of the covid pandemic. In this regard, Dominiak and Rachwał (2022) indicate that the covid pandemic has a short-term impact on the industrial and service sectors in Poland. Dominiak and Rachwał (2022) also provide evidence that the industrial and service sectors during the covid pandemic show better resilience to conditions of high constraints than during the 2009 global crisis. This is consistent with the argument of Heinonen, Strandvik (2020), Hossain (2020), Schilling (2020), Sheng et al. (2020), and Netz et al. (2022) that firms through the crisis may characterise the attitude to adapt to changes and be more resilient. In this vein, Gajewski and Kutan (2023), considering among others the attitude of Polish firms under severe conditions, find that Polish NUTS-4 that were better adapted to the 2009 global crisis were also better adapted to the changes caused by the covid pandemic.

The above studies highlight the growing interest in understanding the attitude of Polish firms towards innovation under conditions of high constraints. While there is a dearth of research on how expenditures on firms' innovation activities in Poland differs at the NUTS-2 level in the covid and post-covid perspectives this study aims to fill this gap. Thus, the hypothesis to be tested is as the following:

H: Innovation activities in Poland differ at the NUTS-2 level (in the covid and post-covid perspectives).

3. Methodology

The data for this research was gathered from Local Bank Data, Statistics Poland, as a dataset which makes it possible to analyse how expenditures on firms' innovation activities in Poland differ at the NUTS-2 level in the covid and post-covid perspectives. A special focus has been placed on data related to total expenditures on innovation activities in order to illustrate in total all the sources through which firms in Poland improve their innovation processes under conditions of high constraints. These include domestic funds from public institutions, own funds, foreign funds and credits, loans and other financial liabilities from banks and financial institutions. To understand how Polish firms were willing to finance innovation

activities from their own resources under conditions of severe constraints, the data on firms' own funds for innovation activities were have been included separately for the study. To illustrate the differences between sectors, the data on expenditures on innovation activities were collected for industrial and service firms. In order to show the changes in expenditures on innovation activities in Poland at the NUTS-2 level in the covid and post-covid perspectives, the study covers the period 2018-2022. Table 1 presents descriptive statistics of the variables.

Table 1.
Descriptive statistics

Variable	Description	Mean	St. Dev.	Min.	Max.
industrial firms with expenditures on innovation activities (X_1)	industrial firms with expenditures on innovation activities (%)	16.70	2.95	8.80	26.20
service firms with expenditures on innovation activities (X_2)	service firms with expenditures on innovation activities (%)	9.58	3.92	1.70	28.80
total expenditures on innovation activities by industrial firms (X_3)	total expenditures on innovation activities by industrial firms (PLN) per inhabitant	504.11	243.57	184.22	1424.21
total expenditures on innovation activities by service firms (X_4)	total expenditures on innovation activities by service firms (PLN) per inhabitant	346.38	486.78	1.79	3104.62
own funds for innovation activities of industrial firms (X_5)	own funds for innovation activities of industrial firms (PLN) per inhabitant	375.43	191.13	88.89	842.17
own funds for innovation activities of service firms (X_6)	own funds for innovation activities of service firms (PLN) per inhabitant	297.75	464.85	1.79	2855.51

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.

In order to examine how expenditures on innovation activities differs in Poland at the NUTS-2 level in the covid and post-covid perspective, the following methods were used: comparative analysis, zero unitarization method and multivariate analysis. The first one allows for a comparative analysis of the variables used in the study between Polish NUTS-2 regions. The zero unitarization method and multivariate analysis on the other hand allow for an understanding of how NUTS-2 regions in Poland differ in terms of expenditures on innovation activities in the covid and post-covid perspective. The following methods are commonly used to make variables comparable (Kiselakova et al., 2020). First, a constant reference point was employed to normalize the variables (Kukuła, Bogocz, 2014):

$$R(X_{jt}) = \max_{it} x_{ijt} - \min_{it} x_{ijt} \quad (1)$$

As the variables used in the study are stimulants, they were standardised according to the formula (Kukuła, Bogocz, 2014):

$$z_{ijt} = \frac{x_{ijt} - \min_{it} x_{ijt}}{\max_{it} x_{ijt} - \min_{it} x_{ijt}} \quad (2)$$

where $z_{ijt} \in [0,1]$; ($i = 1,2, \dots, n$); ($j = 1,2, \dots, m$); ($t = 1,2, \dots, l$).

The synthetic index was then calculated as follows (Kiselakova et al., 2020):

$$SM_{it} = \frac{1}{m} \sum_{j=1}^m z_{ijt} \quad (3)$$

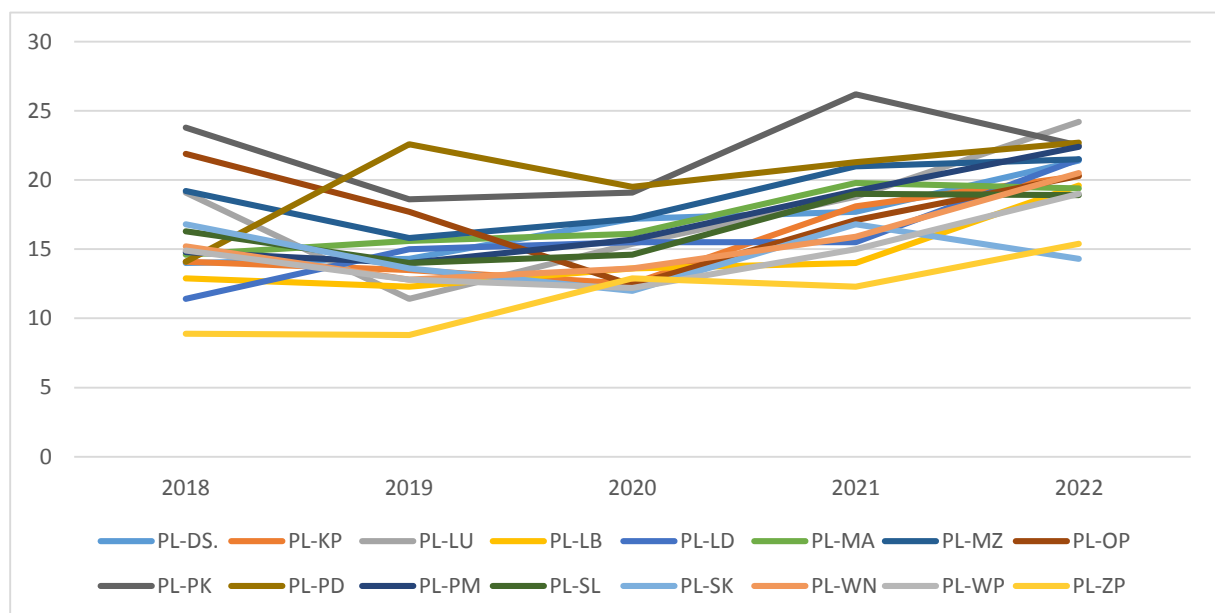
where $z_{ijt} \in [0,1]$; $SM_{it} \in [0,1]$; $(i = 1,2, \dots, n)$; $(j = 1,2, \dots, m)$; $(t = 1,2, \dots, l)$.

This approach allows to analyse differences in innovation expenditure in Poland at the NUTS-2 level in the covid and post-covid perspectives.

4. Results and discussion

4.1. The comparative analysis

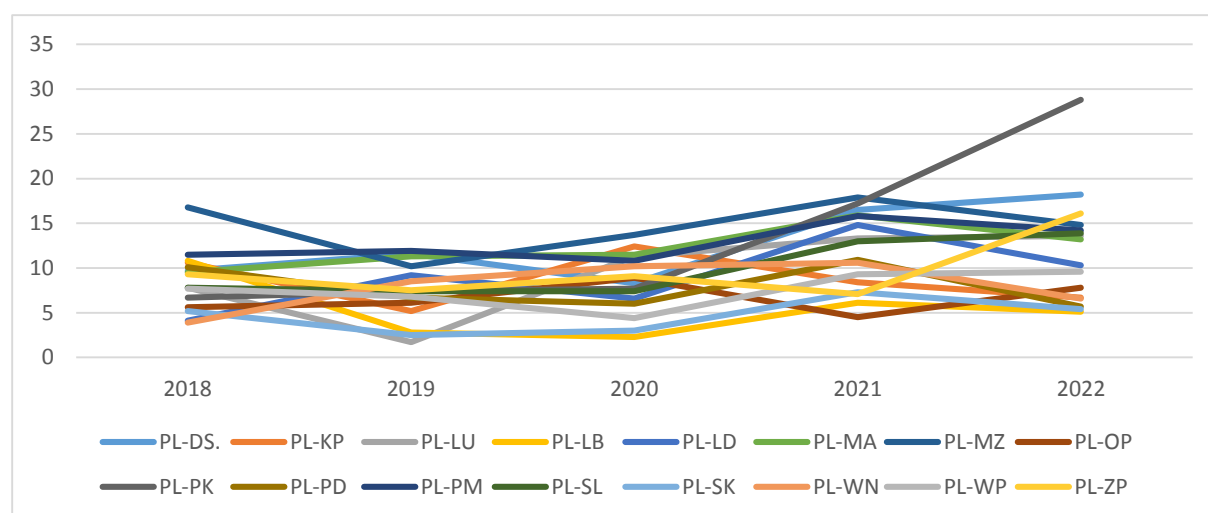
The results of the comparative analysis of the variables considered in the study reveal interesting features for 2018-2022 (Figures 1-6). Regarding the sector of analysis, the results show a higher percentage of industrial firms spending on innovation activities than service firms (Figures 1-2). This can be observed not only in the covid perspective but also in the post-covid perspective in the majority of NUTS-2 regions in Poland. Apart from this, similar trends can be seen in the industrial and service sectors.



Legend: PL-DS – Lower Silesian Voivodship; PL-KP – Kuyavian-Pomeranian Voivodship; PL-LU – Lublin Voivodship; PL-LB – Lubusz Voivodship; PL-LD – Łódź Voivodship; PL-MA – Lesser Poland Voivodship; PL-MZ – Masovian Voivodship; PL-OP – Opole Voivodship; PL-PK – Subcarpathian Voivodship; PL-PD – Podlaskie Voivodship; PL-PM – Pomeranian Voivodship; PL-SL – Silesian Voivodship; PL-SK – Świętokrzyskie Voivodship; PL-WN – Warmian-Masurian Voivodship; PL-WP – Greater Poland Voivodship; PL-ZP – West Pomeranian Voivodship.

Figure 1. Percentage of industrial firms with expenditures on innovation activities in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.



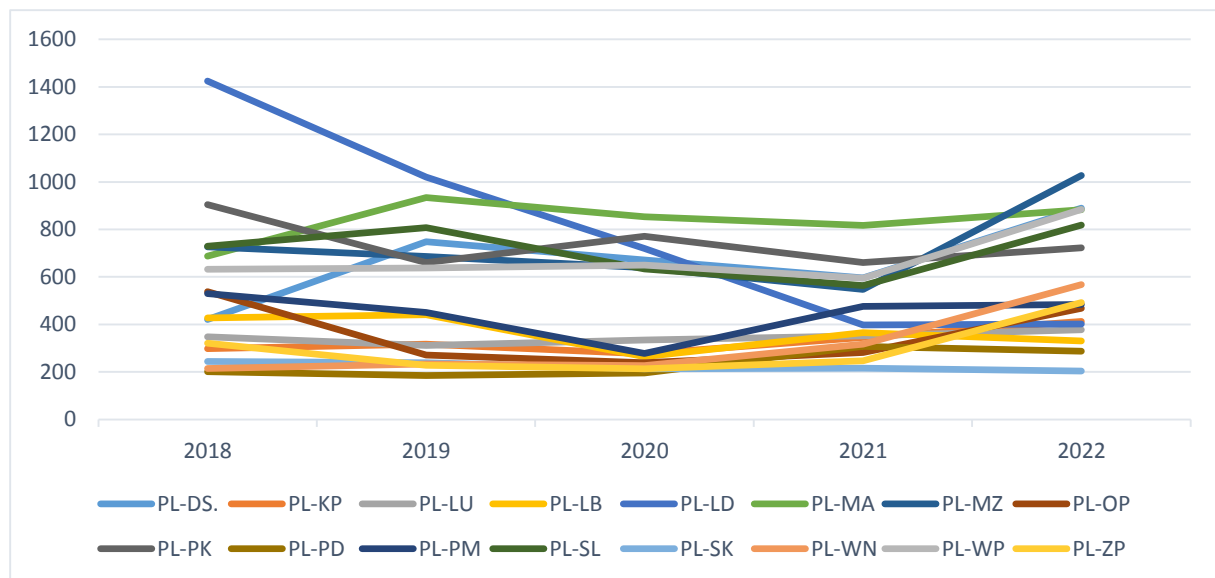
Legend: like in Figure 1.

Figure 2. Percentage of service firms with expenditures on innovation activities in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.

The findings indicate that, with the exception of 2019, the percentage of industrial and service firms with expenditures on innovation processes is increasing in the majority of Polish NUTS-2 regions. This is also evident in the conditions of severe constraints experienced by firms in the covid perspective (especially in 2020). This may be related to the need to invest in innovative solutions in order to adapt to extraordinary demands of the market environment. This is in line with the results of the study by Heinonen and Strandvik (2020), which suggest that conditions of severe constraints can shift firms' innovation processes. The results show above-average percentage of service firms involved in innovation activities. This is especially seen for the year 2021 in the majority of Polish NUTS-2 regions. This may be due to the need to implement the solutions imposed on the service sector. The increase in the percentage of industrial and service firms with expenditures on innovation activities is also observed in the majority of NUTS-2 regions in Poland in the post-covid perspective. This may indicate the need for Polish firms to further increase their competitive advantage.

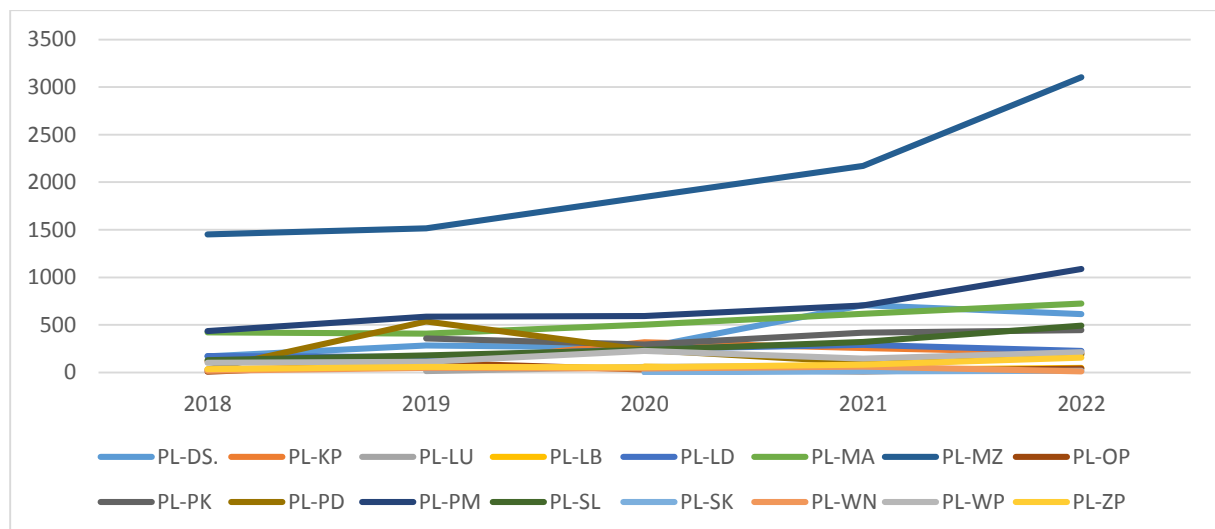
In terms of total expenditures on innovation activities, the results suggest that industrial firms in the majority of Polish NUTS-2 regions have more resources for innovation processes than service firms (Figures 3-4). This can be observed for the whole period 2018-2022.



Legend: like in Figure 1.

Figure 3. Total expenditures on innovation activities by industrial firms (PLN) per inhabitant in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.



Legend: like in Figure 1. Lack of data: 2018 – PL-LU, PL-PK, PL-SK; 2019 – PL-LB, PL-SK.

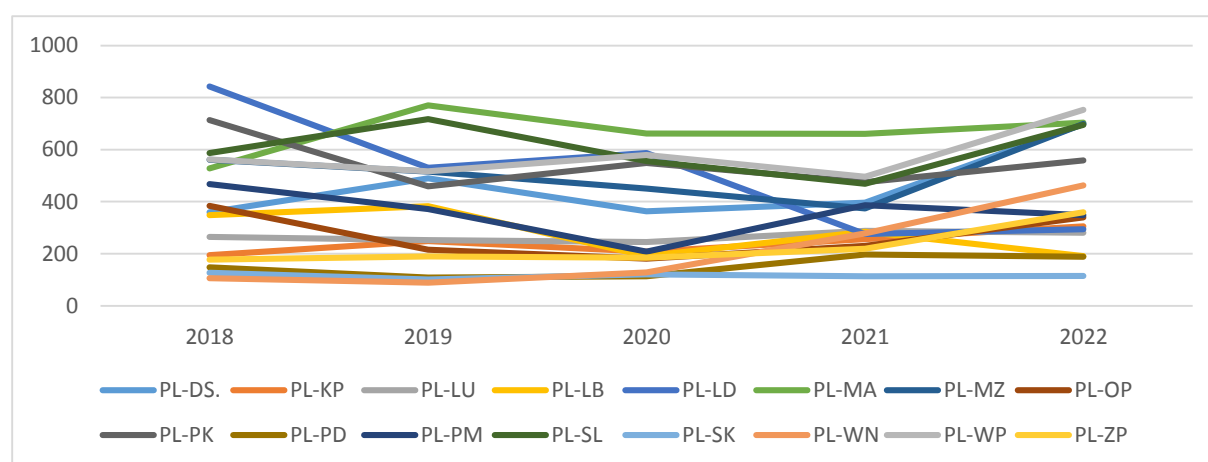
Figure 4. Total expenditures on innovation activities by service firms (PLN) per inhabitant in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.

Simultaneously, it should be emphasized that service firms in the majority of Polish NUTS-2 regions show significantly higher growth in total innovation expenditures compared to industrial firms. This is particularly observed in 2019 and 2020, which may be due to the need to increase the competitive advantage of this sector and its adaptation to the needs caused by the covid pandemic (2020). This is consistent with the results of the study by Dominiak and Rachwał (2022) on the short term-impact of the covid pandemic on industrial sector in Poland. This situation continues (albeit to a lesser extent) in 2021, where a stronger upward trend in total expenditures on innovation activities is observed for service firms than for industrial firms.

For both the industrial and the service firms, there is a noticeable increase in expenditures on innovation activities in the post-covid period in the majority of Polish NUTS-2 regions. This may indicate firms' focus on development rather than survival. It may lead to an improvement in their competitive advantage and, through the simultaneous effect, also impact on regional and national competitiveness. Such results are consistent with the studies provided by Hossain (2020), Schilling (2020), Sheng et al. (2020) and Netz et al. (2022) that firms through the crisis may characterise the innovation capacity to adapt to changes and be more resilient.

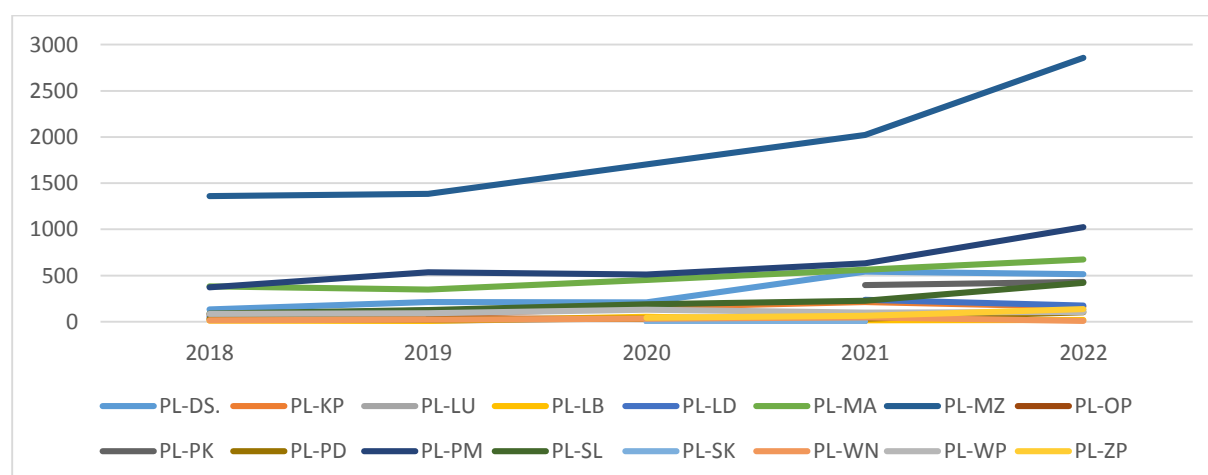
When considering the use of firms' own funds for innovation, the results indicate that both industrial and service firms in most Polish NUTS-2 regions predominantly financed innovation activities from their own resources in 2018-2022 (Figures 5-6).



Legend: like in Figure 1.

Figure 5. Own funds for innovation activities of industrial firms (PLN) per inhabitant in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.



Legend: like in Figure 1. Lack of data: 2018 – PL-OP, PL-PK, 2019 – PL-SK, PL-ZP, 2020 – PL-LD, PL-PK, 2022 – PL-OP, PL-SK.

Figure 6. Own funds for innovation activities of service firms (PLN) per inhabitant in Poland (2018-2022).

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.

According to the results, such a feature can also be observed for the covid perspective, when firms have to face conditions of high constraints. In this respect it is important to note that firms were willing to increase the level of own resources for innovation activities. This is consistent with the findings of Wojnicka-Sycz et al. (2022), who point to an increase in innovation processes as a result of the need to face new environmental requirements. This is especially seen for service firms from the majority of Polish NUTS-2 regions and may indicate the need to develop innovation processes in order to adapt to severe constraints. This is in line with the empirical evidence provided by Dominiak and Rachwał (2022), who indicate the changes in the service sector caused by the covid pandemic. With regard to industrial firms, the results show a decrease in the allocation of own resources to innovation activities in 2020 and 2021 (for the majority of Polish NUTS-2 regions). This may suggest that this sector tends to focus on survival rather than increasing competitive advantage in the covid perspective. The results for the post-covid perspective suggest an increased involvement of own resources in innovation activities for both sectors for most Polish NUTS-2 regions, which may imply to a turn towards strengthening innovation processes and thus contribute to strengthening the competitive advantage of regions and country.

4.2. The zero unitarization method and multivariate analysis

The outcomes of the zero unitarization method and multivariate analysis show a relatively high diversity between Polish NUTS-2 regions in terms of expenditures on innovation activities in the covid and post-covid perspectives (Table 2).

Table 2.

Expenditures on innovation activities of Polish firms at the NUTS-2 level in 2018-2022 (multivariate analysis)

2018			2019			2020			2021			2022		
No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM
1	PL-MZ	0.762	1	PL-MZ	0.806	1	PL-MZ	0.821	1	PL-MZ	0.757	1	PL-MZ	0.976
2	PL-LD	0.535	2	PL-MA	0.602	2	PL-MA	0.634	2	PL-MA	0.639	2	PL-MA	0.546
3	PL-MA	0.382	3	PL-SL	0.465	3	PL-WP	0.434	3	PL-DS.	0.434	3	PL-DS.	0.522
4	PL-PM	0.330	4	PL-LD	0.458	4	PL-SL	0.428	4	PL-PK	0.446	4	PL-SL	0.478
5	PL-SL	0.305	5	PL-DS.	0.398	5	PL-DS.	0.360	5	PL-PM	0.3910	5	PL-WP	0.476
6	PL-WP	0.272	6	PL-PK	0.387	6	PL-PM	0.229	6	PL-WP	0.360	6	PL-PK	0.383
7	PL-DS.	0.180	7	PL-PM	0.374	7	PL-KP	0.139	7	PL-SL	0.3703	7	PL-PM	0.313
8	PL-LB	0.128	8	PL-WP	0.324	8	PL-LU	0.126	8	PL-LD	0.211	8	PL-WN	0.216
9	PL-KP	0.080	9	PL-KP	0.121	9	PL-LB	0.077	9	PL-KP	0.173	9	PL-ZP	0.168
			10	PL-LU	0.098	10	PL-OP	0.056	10	PL-LU	0.148	10	PL-KP	0.123

Cont. table 2.

						11	PL-ZP	0.052	11	PL-LB	0.144	11	PL-LD	0.118
10	PL-ZP	0.056	11	PL-PD	0.097	12	PL-PD	0.036	12	PL-WN	0.128	12	PL-LU	0.096
									13	PL-PD	0.091			
11	PL-PD	0.021	12	PL-OP	0.092	13	PL-WN	0.028	14	PL-OP	0.081	13	PL-PD	0.023
									15	PL-ZP	0.077			
12	PL-WN	0.004	13	PL-WN	0.023	14	PL-SK	0.009	16	PL-SK	0.000	14	PL-LB	0.020

Legend: like in Figure 1. Lack of data: like in Figure 4, Figure 6.

Source: own study based on data from Local Data Bank, Statistics Poland, 2023.

This is in line with the stated hypothesis and indicates that in both the covid and post-covid perspectives there are similar characteristics related to the diversity between Polish NUTS-2 regions regarding expenditures on innovation processes. In this respect, for both perspectives, the observed differences in expenditures on innovation activities between Polish NUTS-2 regions indicate diversity in fostering innovation. While innovation activities is treated as an important driver of competitive advantage, such diversity may have consequences for the competitiveness of firms, regions and country. Simultaneously, the results of the study show that despite the occurrence of conditions of severe constraints related to covid, the highest diversity between Polish NUTS-2 regions in expenditures on innovation processes can be seen almost between the very same regions in 2018-2022. In this context, the highest diversity in this area is observed between Masovian Voivodship, Lesser Poland Voivodship and Warmian-Masurian Voivodship, Świętokrzyskie Voivodship, Lubusz Voivodship. This suggests that regardless of the covid perspective no significant changes have occurred in the distance between the regions with the highest and the lowest levels of expenditures on innovation activities. This is in line with the results of the study by Koziol-Nadolna (2022), which indicates that there was no significant reduction in firms' innovation activities during the covid pandemic. According to the results, Masovian Voivodship and Lesser Poland Voivodship emphasise the relatively highest level of expenditures on innovation processes compared to other Polish NUTS-2 regions, both in the covid and post-covid perspectives. This suggests that the Voivodships concerned possess a high potential to enhance innovativeness and competitiveness. On the contrary, compared to the other Polish NUTS-2 regions, the relatively lowest level of expenditures on innovation activities in characterises Warmian-Masurian Voivodship, Świętokrzyskie Voivodship, Lubusz Voivodship, Podlaskie Voivodship and Opole Voivodship in 2018-2022. This may lead to a reduction in the ability of firms, and consequently the regions, to innovate and improve their competitiveness.

5. Conclusions

This article adds to the discussion on the drivers and sources of firms' innovation activities by providing an insight into how expenditures on innovation processes differ across Polish NUTS-2 regions. A special focus is given to the covid and post-covid perspectives in order to understand the attitude of Polish firms towards innovation under conditions of high constraints. The results find that despite the occurrence of conditions of severe constraints caused by the covid pandemic, the highest diversity in terms of expenditures on innovation is observed between almost the very same Polish NUTS-2 regions in 2018-2022. Such an occurrence may be due to regional differences in the conditions for innovation activities of firms. Remarkably, the covid pandemic noticeably encourages Polish firms, especially in the service sector, to increase their expenditures on innovation processes. This may be connected with the need to increase the competitive advantage of this sector and to adapt it to the needs caused by the pandemic.

The findings of this study provide implications for policy makers and practitioners. Given that firms' innovation activities is seen as a key driver of competitiveness, not only of firms, but also of regions and countries, it is necessary to further strengthen the conditions for fostering innovation processes of firms. Public institutions should play an important role in this respect. The pro-innovation attitude of industrial and service firms is also crucial.

Some limitations can be identified, which may provide a basis for future research. This study concentrates on total innovation expenditures in order to capture all sources through which Polish firms improve their innovation processes under highly constrained conditions. It also focuses separately on firms' own resources for innovation in order to understand the extent to which Polish firms were willing to finance innovation activities from their own resources under severe conditions. It would be useful to see whether the results are similar for other variables describing expenditures on firms' innovation activities. It would also be worthwhile to examine the reasons for maintaining the highest diversity between Polish NUTS-2 regions in expenditures on innovation processes that can be seen almost between the very same regions despite the conditions of severe constraints caused by the covid pandemic.

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