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FOREWORD

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

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about information management, human resource management, copyright, production management, supply chain management, logistics, risk management, artificial intelligence in management, Smart Cities, economics, sustainable management, organizational agility, design thinking, small business, tourism management, marketing, international management, quality management, innovativeness and public management.

Radosław Wolniak

BEHAVIORAL BIASES OF INVESTORS ON THE WARSAW STOCK EXCHANGE – AN ANALYSIS OF THE IMPACT OF DEMOGRAPHICS AND INVESTMENT EXPERIENCE

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Purpose: The aim of the study was to identify the most common behavioral errors made by investors on the Warsaw Stock Exchange and to understand how demographic factors and investment experience influence the occurrence of these errors. This could contribute to better tailoring of investment strategies and financial education for investors.

Design/methodology/approach: The theoretical part of the study draws on a critical literature review, whereas the empirical one employs a diagnostic survey based on a questionnaire as a research tool. To analyse the data, descriptive statistics were obtained and a correlation study was performed.

Findings: The study found that confirmation bias (58%) is the most common behavioral error, followed by a tendency to quickly close profitable investments (50%) and a strong aversion to losses (48%). Men are more likely to exhibit biases like confirmation and outcome bias, while women tend to show hindsight bias and the illusion of knowledge. Younger investors (18-40 years) are more prone to overconfidence and outcome bias, while those with higher education are more likely to commit confirmation and outcome biases. Experienced investors are less prone to these errors, suggesting that experience helps manage emotions and improve decision-making.

Research limitations/implications: The study's limitations include potential response bias and its focus on the Warsaw Stock Exchange, which limits generalizability. Future research could explore broader groups and use qualitative methods for deeper insights into investor motivations.

Practical implications: The findings suggest that financial institutions should develop educational programs to help investors avoid behavioral errors, ultimately improving investment outcomes and market stability.

Originality/value: The originality of the study lies in its behavioral approach, emphasizing emotions, cognitive biases, and investment experience, offering valuable insights for investors, advisors, analysts, and researchers in behavioral economics.

Keywords: behavioral finance, investors, behavioral biases, investments, stock exchange.

Category of the paper: Research paper.

1. Introduction

Behavioral errors of investors on the stock market represent one of the key issues in the analysis of contemporary financial markets, forming an important intersection of psychology, economics, and financial theory. While classical economic theory, based on the assumption of investor rationality, plays a foundational role in modeling market processes, actual market participants' behaviors often deviate from this idealized concept. Investors make decisions not only based on the analysis of rational, objective data but also under the influence of various cognitive biases, emotions, and heuristics, which introduce a significant degree of uncertainty into investment processes. Frequent tendencies towards overconfidence, excessive reactions to information, or disproportionate attachment to losses (the so-called loss aversion effect) lead to errors that can have a long-lasting impact on investors' financial outcomes. The analysis of behavioral errors made by investors on the Warsaw Stock Exchange (WSE) thus represents a particular area of interest, enabling not only an understanding of why participants in this market make irrational decisions but also identifying the mechanisms that determine these decisions in a local context. The Warsaw Stock Exchange, as one of the key capital markets in Central and Eastern Europe, has its specificity arising from unique economic, political, and cultural conditions that shape the behaviors of its participants. Factors such as the historical volatility of the market, relationships with financial institutions, and local investment preferences have a significant impact on the decisions made by investors on this market, which requires particular consideration in research on behavioral errors. In this context, it is crucial to account for the impact of two key factors: investor demographics and investment experience. Demographic variables such as age and education level can significantly affect how risk is perceived, investment strategies are formed, and the propensity for making risky decisions. On the other hand, investment experience, understood as the length of market participation and prior experiences with successes or failures, also shapes decision-making processes, influencing investors' sensitivity to market changes and their ability to manage emotions related to risk. This article aims to analyze these two key factors in the context of behavioral errors on the WSE. It will present the mechanisms underlying investment decisions and discuss specific examples of typical mistakes made by investors in this market. The article will also present research findings on the correlation between demographic characteristics, investment experience, and tendencies to make behavioral errors. Understanding these mechanisms constitutes not only a significant element of financial market theory but also a practical tool for investors who can use this knowledge to consciously manage their investment portfolios, minimizing the risk of making mistakes and maximizing potential returns. The presented analysis may also contribute valuable insights to the development of regulatory policy and investment education on the WSE, enabling more effective and informed participation in the capital market.

The originality of this work lies in the application of a behavioral approach to the analysis of investor behavior, with particular emphasis on the influence of emotions, cognitive biases, and investment experience on decision-making in the financial market.

2. Literature review

2.1. Behavioral Biases in Investment Decisions and Their Types

Investment decisions on stock exchanges are influenced by many factors, among which psychological conditions play a significant role. These factors are the subject of study within the field of behavioral finance. Behavioral finance is defined as a scientific discipline that, based on the analysis of individual and social cognitive and emotional biases, explains the economic decisions of investors (Opolski, Potocki, Świst, 2010, p. 78). Proponents of this field argue that the human mind sometimes misinterprets reality and incoming data, which leads investors to fail to properly value securities (Szyszka, 2009, p. 34). Behavioral finance draws from the achievements of economics, psychology, and sociology, and in many respects, challenges the assumptions of traditional financial theory.

One of the fundamentals of classical finance theory is the idea of rational choices made by economic agents. A rational investor seeks to maximize their profits, remains unaffected by emotions or external pressures, and bases their decisions solely on sound financial analysis (Zaleśkiewicz, 2003, pp. 9-10). The decisions of a rational investor should minimize risk for a given expected rate of return, or maximize the expected rate of return for a given level of risk. Assumptions regarding ideal rationality have been the subject of numerous debates in the literature. The critique of this approach began with Simon (Simon, 1955, pp. 99-118), who pointed out the time and technological constraints as key obstacles preventing the achievement of perfect rationality (Ostaszewska, 2013, p. 64). The theory of bounded rationality was developed by Tversky and Kahneman (Tversky, Kahneman, 1979, pp. 1124-1131), who stated that bounded rationality arises from time pressure and the complexity of information. Investors often deviate from rational methods by employing heuristics, which are simplified processes for data analysis. Heuristics can be useful as a tool to facilitate the analysis of complex information, but they can also lead to serious and systematic reasoning errors. The validity of the expected utility theory was ultimately undermined by prospect theory, formulated by Tversky and Kahneman, which describes the decision-making process under risk and the behavior of investors in the face of potential gains and losses (Tversky, Kahneman, 1979, pp. 1124-1131).

It is suggested that under conditions of risk and uncertainty, investors make systematic errors arising from both their beliefs and preferences. The phenomenology of behavioral errors investigates the deeper psychological and cognitive mechanisms that shape decision-making (Kahneman, 2013). A behavioral error, also known as a psychological error, refers to the tendency to formulate certain thoughts or experience specific emotions that can lead to a systematic deviation from the criteria of rationality and sound judgment (Barberis, Thaler, 2003, pp. 1053-1128). The human mind, in order to avoid the need to process vast amounts of information, performs significant selection of the data it receives, choosing what it considers relevant. To do this, it employs mental shortcuts called heuristics, which expedite the process of generating solutions. Although these are not always optimal, they are generally satisfactory, which reduces the cognitive effort involved in decision-making. In an attempt to cope with a lack of information, the human mind relies on stereotypes, generalizations, past experiences, and known facts (Baker, Filbeck, Nofsinger, 2021, p. 42). While these mechanisms may speed up decision-making, they do not always lead to optimal choices, illustrating the need to understand and manage behavioral errors for better personal and professional life management.

There is ongoing debate regarding the classification of behavioral errors, but one proposed framework divides them into cognitive, emotional, and socio-cultural errors. This classification arises from the recognition that behavioral errors can be associated with the influence of internal or external factors. Internal factors are responsible for cognitive and emotional errors, while socio-cultural errors result from the impact of external factors (Baker, Filbeck, Nofsinger, 2021, p. 42). Each of these categories refers to different psychological mechanisms and affects the decision-making process in distinct ways.

Cognitive errors arise from the limitations of the human mind in processing information. Investors often employ simplified decision-making strategies, known as heuristics, which can lead to systematic errors. Cognitive errors can be divided into two main types: belief persistence errors and information processing errors.

Cognitive errors related to belief persistence involve individuals holding onto their existing beliefs even after encountering information that contradicts them. Once someone has decided to believe in something, they are likely to stick to that belief, even in the face of opposing arguments. As a result, people tend to uncritically accept conclusions that align with their belief system and reject those that do not, regardless of the rationality or validity of the presented claims. This category includes various cognitive errors, particularly conservatism bias, confirmation bias, attributional egoism, hindsight bias, and the illusion of control. The persistence of beliefs is linked to the desire to avoid confronting one's beliefs with reality. Such a confrontation causes psychological discomfort, which people try to avoid in the simplest way possible. The psychological stress resulting from the coexistence of two or more conflicting beliefs or values is referred to as cognitive dissonance. Consequently, individuals often ignore, dismiss, or downplay information that does not align with their existing beliefs (Baker, Filbeck, Nofsinger, 2021, p. 42).

Information processing errors are related to the incorrect processing of data on which decisions are based. People strive to achieve certain goals and realize their beliefs through their decisions, and therefore need to gather and process information. A significant portion of the information acquired is irrelevant to the issue at hand, but some pieces are crucial for the efficient flow of the decision-making process. The challenge lies in incorporating relevant information while filtering out unnecessary data. People often make decisions based on their previous experiences and incidental current events. As a result, they are prone to cognitive errors arising from improper information processing, which can lead to suboptimal decisions, particularly in financial matters. Information processing errors include: the familiarity bias, framing effect, limited attention bias, mental accounting bias, outcome effect, and temporal proximity effect (Baker, Filbeck, Nofsinger, 2021, p. 42).

Emotional errors, on the other hand, arise from the influence of emotions on the decision-making process. Emotions can lead to irrational investment decisions, particularly in situations of stress or euphoria. Understanding the role of emotions in the investment process helps to better comprehend the course of decisions that seem rational on the surface. People who typically rely on common sense may sometimes succumb to emotions and make irrational financial decisions. Warren Buffett observes that "rational behavior requires, on the one hand, clarity of mind, and on the other hand, emotional discipline" (Cunningham, 1997, p. 86). Emotions directly affect investment behaviors. There is even a field called emotional finance, which studies the role of emotions in financial activities and describes the impact of subconscious processes on money-related decisions. These processes influence not only the behavior of individual investors but can also affect the entire market. Positive emotions can amplify optimism, leading to a greater willingness to take risks. Conversely, negative emotions can intensify pessimism, discouraging investors from taking risky actions. In investment decisions, an emotionally-driven increase in risk tolerance can lead to overly reckless choices. On the other hand, positive emotions may encourage heightened activity. Negative emotions, especially those related to adverse experiences, can cause paralysis and discourage investors from taking any action, particularly if they are risk-averse. People use many subconscious defense mechanisms to protect themselves from emotional pain when an investment they considered exceptional fails to meet their expectations. In a broader context, emotions can also explain the formation of price bubbles, market crashes, and other market phenomena. Common emotional errors include: overconfidence bias, loss aversion, endowment effect, self-control bias, status quo bias, and regret aversion (Baker, Filbeck, Nofsinger, 2021, pp. 66-67).

Social and cultural errors in the context of investments refer to the influence of social norms, cultural values, and societal expectations on individuals' investment decisions. These often lead to irrational financial decisions that are not the result of pure economic analysis or individual preferences, but are shaped by a broader social and cultural context. Social norms can impose certain expectations regarding how to invest or save money. For instance, there are cultural beliefs about financial security that may encourage investors to choose less risky but also less

profitable investment options, even in the presence of better alternatives. Cultural values, such as respect for tradition or a tendency toward collectivism, can also influence investment decisions, favoring certain types of assets or investment strategies. Additionally, socio-cultural errors may manifest in the investment behaviors of individuals shaped by historical experiences or family patterns. For example, certain social groups may be more inclined to invest in specific industrial sectors due to family traditions or the perception of certain industries as more prestigious.

These aspects are crucial for behavioral finance, which studies how psychological, social, and cultural factors influence financial decisions. They indicate that making investment decisions is not merely a rational and logical process but is also strongly conditioned by the individual's social and cultural environment. Therefore, understanding socio-cultural errors is essential for effective portfolio management and reducing the risk of making decisions based on irrational social patterns.

2.2. Analysis of Selected Cognitive, Emotional, and Socio-Cultural Errors

In the investment decision-making process, cognitive, emotional, and socio-cultural biases play a crucial role, as they can lead to a distorted assessment of the market situation and the making of irrational decisions. These psychological distortions pose a significant threat to the stability and effectiveness of an investment portfolio, and understanding their nature is critical for improving the quality of decision-making. Analyzing selected cognitive biases, such as conservatism bias, confirmation bias, attribution egotism, hindsight bias, and the illusion of control, enables a better understanding of the mechanisms behind irrational investment decisions.

One of the fundamental cognitive biases in the investment context is conservatism bias. This bias refers to the tendency to maintain existing beliefs and ignore new information, especially when it contradicts previously held knowledge. This cognitive mechanism can lead to inadequate responses to changing market conditions and, consequently, to misguided investment decisions (Baker, Filbeck, Nofsinger, 2021, p. 45). Individuals prone to conservatism bias actively seek out information and opinions that confirm their preexisting beliefs. As a result, when confronted with new data, they struggle to objectively revise their position.

A similar mechanism is evident in the phenomenon known as confirmation bias, which is characterized by the tendency to selectively accept information that aligns with initial assumptions while ignoring information that contradicts them. This bias, part of the group of belief perseverance errors, can be seen as a manifestation of wishful thinking and a closed mindset. It also serves as a way to alleviate a certain type of discomfort. Jason Zweig, a columnist for The Wall Street Journal, describes this as follows: "In short, the mind acts as a fervent yes-man, constantly repeating what we want to hear" (Zweig, 2007, p. 76). Confirmation bias occurs when individuals dismiss important facts and opinions that do not

align with their preexisting assumptions or conclusions. People susceptible to this bias selectively gather information that supports their beliefs or interpret available data in a manner consistent with what they already consider to be true. Once they receive satisfactory confirmation of their beliefs, they often stop seeking new information, which can lead to negative consequences (Heshmat, 2015).

Closely related to confirmation bias is another cognitive error from the "belief perseverance" category—*attribution egotism*. This bias involves attributing positive events or outcomes to one's own merits while blaming others or external factors for failures. When things do not go as planned, people instinctively seek out individuals or circumstances to blame—essentially looking for a scapegoat. For instance, when an investment yields profits, individuals are quick to credit their own knowledge and skills for the success. However, when outcomes are unfavorable, they often shift the blame onto others (e.g., a financial advisor) or external factors e.g., a newspaper article promoting the investment (Baker, Filbeck, Nofsinger, 2021, p. 48).

The *hindsight bias* is another significant phenomenon that leads to the erroneous perception of past events as being more predictable than they actually were. In the context of investment decisions, hindsight bias can result in misjudging risk and prior decisions. Investors may believe they "always knew" that a particular investment would be either good or bad, which can cause them to overestimate their ability to predict future outcomes. This overconfidence can lead to excessive self-assurance and hasty decision-making, based more on past experiences than on an objective analysis of the current situation (Chery, 2017).

Particular attention should be given to the *illusion of control*, which is defined as the false belief that one has an increased influence over the course of observed events as personal involvement grows. Ellen Langer identifies five key characteristics that amplify this illusion, including the sequence of outcomes and familiarity with the problem. When investment decisions yield a series of positive results, investors tend to feel that they are in control of the situation, regardless of whether the outcomes are due to chance or not. This confirmation of predictions reinforces the illusion of control. Another factor that strengthens this illusion is familiarity with the problem. The more an investor feels familiar with a particular subject, the more likely they are to experience the illusion of control. During an ongoing financial market boom, investment-related language becomes ubiquitous, further reinforcing the belief in one's ability to make sound investment decisions, irrespective of actual market knowledge (Swacha-Lech, 2010, pp. 158-159).

In classical economics, the principle "money has no label" prevails, meaning that the origin of money does not affect how it is spent. However, this assertion was challenged by Richard Thaler, a prominent figure in behavioral economics, who introduced the concept of *mental accounting*. According to Thaler, mental accounting refers to a set of cognitive operations performed by individuals and households to organize, evaluate, and analyze financial transactions (Thaler, 1999, pp. 183-206). Experimental studies by Thaler demonstrated that

people tend to treat money differently depending on its source or the purpose for which they intend to use it. In the context of investors, mental accounting has a significant impact on financial decision-making. Investors may mentally categorize their assets into different groups, such as "safe" and "risky" investments. While the overall performance of the entire investment portfolio should be the primary focus, investors often treat, for example, gains from one category separately from losses in another. Mental accounting influences the subjective treatment of money and investments, which can lead to decisions that are inconsistent with rational financial management principles.

The outcome bias refers to the tendency to evaluate decisions based on their final outcomes, regardless of whether the result was due to intentional actions or pure chance. After a decision is made, people typically stop analyzing the circumstances under which it was made and instead assess the experience through the lens of the final result. If the outcome is favorable, the entire experience is perceived as positive. However, when the outcome is unfavorable, people often unjustly criticize the entire process that led to it. In theory, both the process and the result should be evaluated separately, but in practice, this rarely happens (McNulty, 2015).

The recency effect refers to the tendency to attribute greater significance to more recent information. Investors often assess the state of their portfolio based on the latest results or their beliefs about those results. Vivid memories from the recent past can significantly influence these evaluations. This error in information processing often occurs because people find it easier to recall events that happened recently than those from a slightly earlier period. As a result, new, fresh information seems more important to them than older data (Baker, Filbeck, Nofsinger, 2021, p. 60).

Understanding the above cognitive biases and their impact on the investment decision-making process is essential for investors to consciously avoid traps that lead to irrational actions. In practice, this means developing critical thinking skills and the ability to objectively analyze available information, which can improve the quality of investment decisions and reduce the risk of making mistakes.

In the world of investments, many decisions made by investors are not based on logical analysis or hard data, but on emotional reactions and psychological conditioning. One of the most widespread and destructive emotional biases, leading to an underestimation of risk, overestimation of one's own abilities, and neglect of key market information, is overconfidence. This occurs when investors are overly confident in their ability to predict the financial market or the value of assets. This can result in making overly risky investment decisions or ignoring significant risk factors (Shefrin, 2007, p. 6).

Overconfidence in investors can manifest in four main ways (Gajdka, 2013, p. 38):

- Illusion of Superiority – Investors often attribute themselves with above-average skills, knowledge, and capabilities, building a belief in their exceptional ability to assess situations accurately.

- Calibration Effect – Investors tend to be overly confident in the accuracy of their predictions, even when they lack solid foundations for those predictions. For example, when asked to provide forecasts within a specific confidence interval, they often overestimate the precision of their knowledge.
- Illusion of Control – This refers to the belief that one can influence random events through their actions, even though such control is, in reality, impossible.
- Unrealistic Optimism – This is the tendency to have excessive faith in positive outcomes or successes, despite lacking sufficient evidence to support such beliefs. It often manifests as "wishful thinking," where individuals interpret reality in an overly positive light, disregarding facts or data that suggest otherwise.

Another important factor influencing investment decisions is overconfidence, which can lead to unpredictable consequences, such as larger investment losses, a lack of flexibility in adapting to changing market conditions, and limiting the growth potential of an investment portfolio. Therefore, a moderate approach and awareness of one's limitations are crucial for effective portfolio management.

Many investors are reluctant to sell assets at a lower price than what they paid for them. They hope that, if they wait longer, their value will increase, at least to the original level. At the same time, many are tempted to quickly realize gains to avoid losing them. Such phenomena reflect an aversion to loss, stemming from the belief that losing a certain amount is more painful than the joy of a comparable gain. Loss aversion is linked to the disposition effect, which causes investors to hold onto losing stocks for too long while selling gaining stocks too quickly. Individuals prone to loss aversion perceive reality in terms of gains and losses rather than risk and expected returns (Baker, Filbeck, Nofsinger, 2021, p. 68).

The endowment effect can occur, for instance, in an investor who inherits assets—such as stocks—and refuses to sell them, even though they do not align with their investment strategy due to the level of risk or the current portfolio composition. The endowment effect manifests when an investor holds onto certain assets or unjustifiably considers them "special" simply because they already own them. An individual prone to this effect assigns a value to their assets that others may view as overestimated. In other words, people tend to want to sell what they own for more than they would be willing to pay for similar items. For example, research shows that owners of tickets for a prestigious match demand prices 14 times higher than what they would be willing to pay themselves (Carmon, Ariely, 2000, pp. 165-190).

The self-control bias is a phenomenon that affects investment decisions and involves difficulty in maintaining discipline and self-control when pursuing long-term goals, in favor of immediate gratification. In practice, this means that many individuals, despite good intentions, quickly abandon resolutions and goals they set for themselves because, in the moment, they prefer to satisfy their short-term desires. This bias leads to making inefficient investment decisions, where long-term objectives are sidelined in favor of immediate pleasures. An example of this is abandoning retirement savings because current needs seem more urgent.

People affected by this phenomenon are often referred to as satisficers, individuals who, instead of striving for larger, long-term achievements, settle for smaller, quicker rewards (Thaler, Sunstein, 2008, pp. 165-190).

In the context of investments, another important phenomenon is the status quo bias, which refers to people's tendency to prefer the current state of affairs and avoid changes, even when those changes could bring benefits. In investment decisions, this effect manifests in individuals sticking to previously made investment choices regardless of changing circumstances. Those prone to the status quo bias feel comfortable with their past decisions and often avoid making changes, even when it may be detrimental. An example of this is holding an excessively large proportion of stocks in one's employer's company, which can increase investment risk (Baker, Filbeck, Nofsinger, 2021, p. 71). This phenomenon is difficult to overcome because many people believe there is no need to change something that "isn't broken". Therefore, investors should be educated on the relationship between risk and expected returns, as well as the importance of adjusting their portfolio in response to changing market conditions and investment goals. Awareness that an investment portfolio should evolve over time is crucial for making more effective financial decisions.

Regret aversion is another common phenomenon that influences decisions made in various areas of life, particularly in the context of investments. Regret aversion involves refraining from action due to the fear of potential negative consequences resulting from a decision. In investment decisions, people often experience regret, either from actions taken or from inaction, which can affect their choices (Thaler, 2016, p. 65). Regret from action occurs when an investor makes a decision that leads to an unfavorable outcome, such as selling stocks just before their value increases. In this case, the investor experiences discomfort and regret due to the loss of potential gains (Baker, Filbeck, Nofsinger, 2021, p. 72). On the other hand, regret from inaction occurs when an investor refrains from taking an action that could have benefited them, such as not selling stocks that are decreasing in value, and later regrets not realizing the profit at the right time. People prone to regret tend to avoid situations that could lead to this negative emotion. In practice, this means that when in doubt, they prefer to hold back rather than risk the regret of making a wrong decision. This tendency to avoid regret can lead to excessive caution and the avoidance of making risky investment decisions (Baker, Filbeck, Nofsinger, 2021, p. 73). Over the long term, regret aversion can lower investment effectiveness because investors may miss opportunities to increase the value of their portfolios. This can result in a more conservative approach and the abandonment of potentially higher-return assets, ultimately jeopardizing the achievement of long-term investment goals.

Emotional mistakes, such as overconfidence, reluctance to accept losses, the endowment effect, self-control bias, attachment to the status quo, and regret avoidance, have a significant impact on investment decisions. Awareness of these phenomena is crucial for investors who want to effectively manage their portfolios. A balanced approach and education on risk and expected returns can significantly increase the chances of success in the financial markets.

It is important to strive for an understanding of one's own limitations and to adjust investment strategies in response to changing market conditions.

3. Research method

The aim of the study was to identify the most common behavioral errors made by investors on the Warsaw Stock Exchange and to understand how demographic factors and investment experience influence the occurrence of these errors. The research problem was formulated as the following question: To what extent do various demographic and investment characteristics of investors influence their tendency to make specific behavioral errors?

In the quantitative research, a diagnostic survey method employing a questionnaire technique was used. The research instrument was a survey questionnaire, which included questions regarding both demographic characteristics and the investment experience of the participants. The questionnaire used in the study was carefully designed to effectively identify the most common behavioral errors made by investors on the Warsaw Stock Exchange (GPW). Each question was tailored to the specific nature of the error to enable precise identification of typical investment behaviors that may indicate the presence of particular cognitive biases. For example, the question regarding the confirmation bias was phrased as follows: "Do you mainly seek information that confirms your current investment beliefs, or do you actively look for information that might challenge your investment decisions?" Such questions were aimed at capturing behaviors associated with specific errors, such as excessive adherence to one opinion or ignoring opposing information.

The preliminary testing of the questionnaire aimed to ensure that the questions were clear, understandable, and effective in diagnosing behavioral errors. This testing involved conducting a pilot study with a small group of investors who participated in the survey before the actual data collection. The goal of this stage was also to verify whether the questions were appropriately formulated in terms of both content and structure, ensuring they were easy to understand and allowed for the accurate identification of specific behavioral errors. The testing also aimed to identify any difficulties in interpreting the questions and to check whether the length of the survey was not too burdensome for the respondents. After the preliminary test, minor adjustments were made to the questionnaire, focusing on the precision of the questions and the way response options were presented. The testing also allowed for an evaluation of the consistency of the questions and their relevance in the context of studying behavioral errors among investors on the GPW. This ensured that the questionnaire would serve as an appropriate diagnostic tool, tailored to the target group, and ready to be used in the main phase of the study.

The study was conducted from February to September 2024, and the research sample consisted of 550 investors selected using the snowball sampling method. This sampling approach allowed for reaching investors at various levels of expertise in the capital market, including both novice and experienced investors.

The empirical data obtained from the study were subjected to statistical analysis using SPSS (Statistical Package for the Social Sciences) version 25 and Microsoft Excel 2022 spreadsheet software. The significance level for statistical tests was set at the conventional threshold of $\alpha = 0.05$. Test results with a probability statistic ranging from $0.05 < p < 0.1$ were interpreted as significant at the level of statistical trends.

The numerical characteristics of the distribution of individual features of the studied investors were assessed using statistical measures such as the arithmetic mean and standard deviation, which enabled a detailed analysis of the distribution of demographic and investment characteristics within the sample.

The research was conducted on the Warsaw Stock Exchange (GPW) for several key reasons. First, GPW is the main financial market in Poland, where individual investors and institutions carry out transactions and make investment decisions. Analyzing behavioral errors in this specific market helps to better understand the factors that influence investment decisions in the local context. Second, a study focused on GPW enables the analysis of specific market conditions, regulations, and investment trends in Poland. This is important in the context of financial education and investment strategies, as it allows for an approach tailored to local realities and the specific demographic characteristics and investment experience of Polish investors. Additionally, conducting the research on GPW allows for gathering data directly from local investors, which increases the accuracy of the results and their practical application. As a result, educational programs and recommendations for investors can be better tailored, contributing to improved decision-making and financial market stability in Poland.

4. Results and discussion

4.1. Characteristics of the studied investors

The research showed that the majority of the investors on the Warsaw Stock Exchange are men (65%), while women represent 35% of the studied group (see Fig. 1). The dominance of men among the respondents may suggest that men are more likely to engage in stock market investing. This may be attributed to a greater propensity for risk-taking, which is more commonly observed among men than women.

Women, who make up the minority of the studied investors, may make more cautious investment decisions, which could result in a lower tendency to take risky decisions and better portfolio management. This might also indicate that women are less susceptible to behavioral errors such as overconfidence or herd behavior.

The low percentage of women among investors highlights the need for educational and promotional activities that could encourage more women to get involved in investing. This could include educational programs specifically targeted at women, which would help them better understand the capital market and increase their confidence in making investment decisions.

The dominance of men among investors on the Warsaw Stock Exchange may have a significant impact on market dynamics and the typical behavioral errors made by investors. At the same time, the low representation of women indicates an opportunity to increase market diversity and stability through educational and promotional activities aimed at potential female investors.

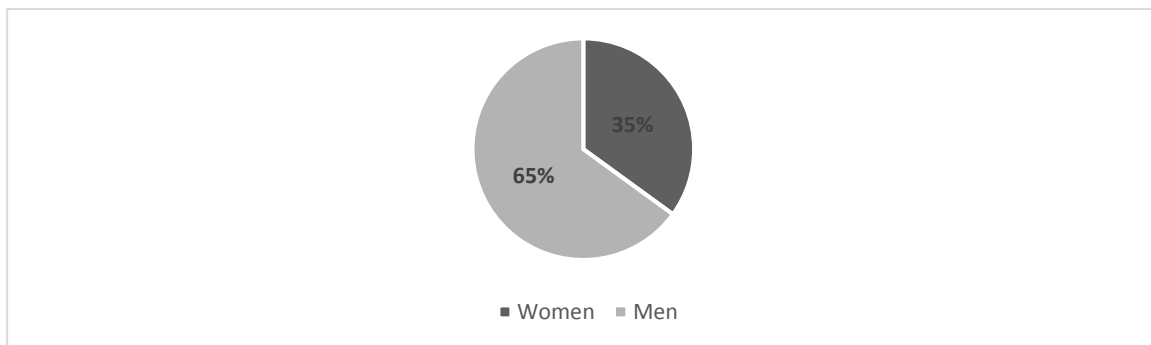


Figure 1. Gender Structure of the surveyed investors.

Source: Own compilation based on conducted research.

The age distribution among the studied investors on the Warsaw Stock Exchange shows that the majority of investors are between the ages of 31 and 50, accounting for 55% of the studied population (see Fig. 2).

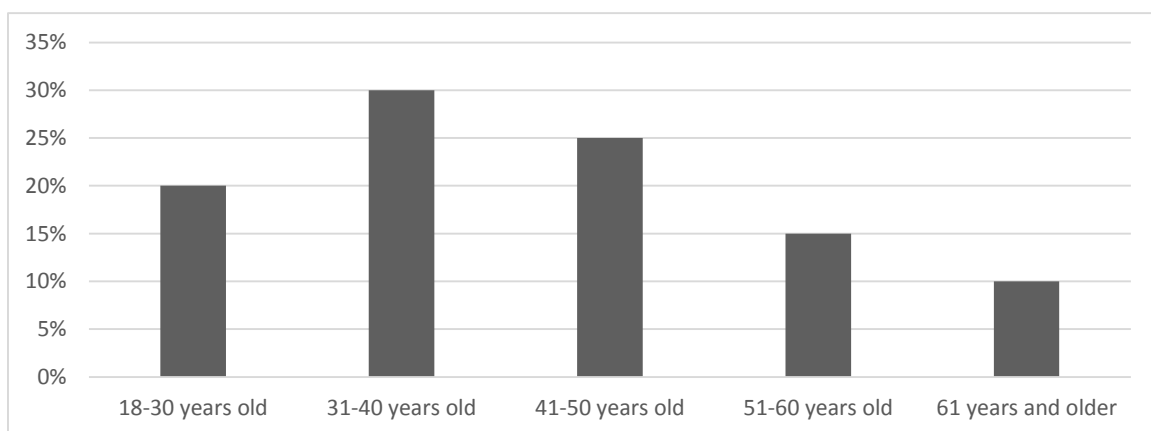


Figure 2. Age Structure of the surveyed investors

Source: Own compilation based on conducted research.

Younger investors (18-30 years old) make up 20% of the respondents, suggesting that the younger generation is interested in investing in the stock market. They may be more inclined to take risks and explore new technologies and investment tools, such as mobile apps. At the same time, they may be more prone to behavioral mistakes due to lack of experience, such as overreacting to short-term market fluctuations or following the herd mentality.

The largest group, accounting for 30% of the respondents, consists of investors aged 31 to 40. Investors in this age group often achieve career and financial stability, enabling them to allocate more funds to investments. They already have some experience, which can reduce their tendency to make basic behavioral mistakes, but they may still exhibit overconfidence in making investment decisions.

Investors aged 41-50 make up 25% of the respondents. This age group is often characterized by greater financial stability and professional and investment experience. Investors in this group may have a more balanced approach to risk and better skills in assessing long-term market trends, reducing the likelihood of behavioral mistakes such as overconfidence or the disposition effect.

Investors aged 51-60, who make up 15% of the respondents, are approaching retirement and exhibit more caution, focusing on capital preservation. They are less prone to mistakes stemming from overconfidence, but their conservative approach may limit potential gains. On the other hand, investors over the age of 60, accounting for 10% of the respondents, are the most cautious, concentrating on protecting their capital. While they avoid errors related to overconfidence, their risk aversion can significantly limit returns.

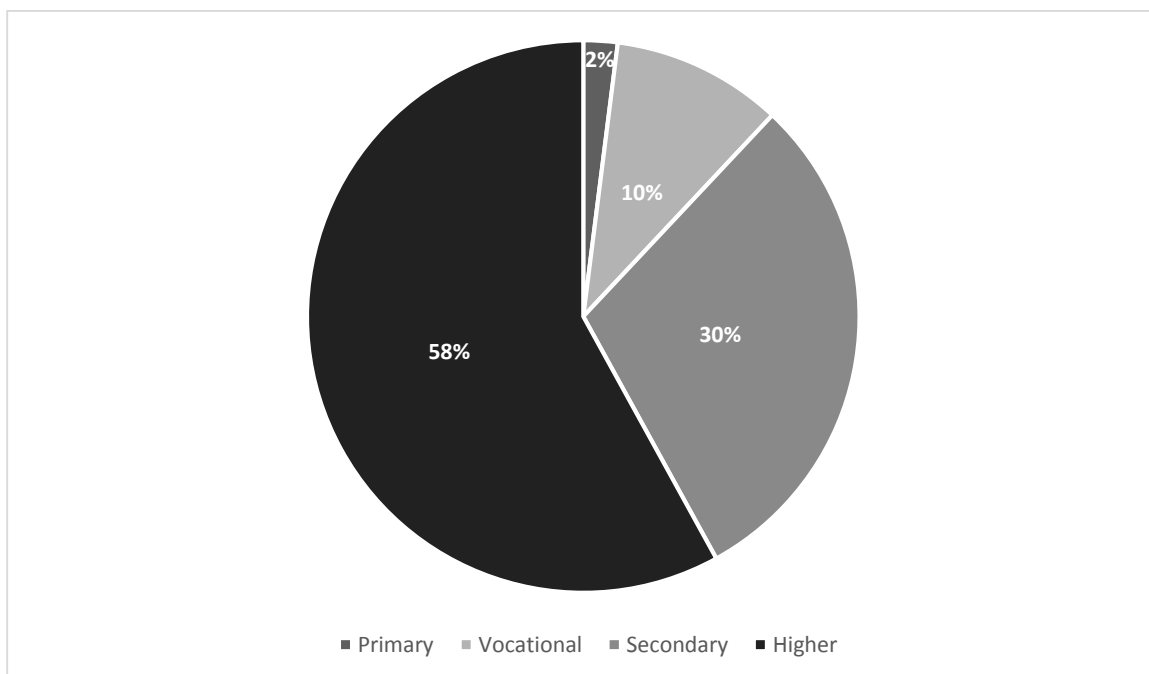


Figure 3. The education structure of the surveyed investors.

Source: Own compilation based on conducted research.

Research has shown a varied level of education among the surveyed investors on the Warsaw Stock Exchange (see Figure 3). The smallest group of investors had primary education (2%). The small number of investors with primary education may indicate limited access to investment knowledge and lower involvement in the capital market. This group may be more prone to behavioral errors resulting from a lack of knowledge, such as herd behavior or availability heuristics. Investors with vocational education made up 10% of the respondents; they possess practical skills that may be useful in investments but may also encounter barriers to accessing advanced tools and market analysis. They may be inclined to more conservative investment strategies. The group of investors with secondary education constitutes a significant portion of the respondents (30%) and has solid educational foundations that can support their ability to understand and analyze financial markets. Investors with secondary education may be moderately susceptible to behavioral errors but open to further investment education. The majority of investors on the Warsaw Stock Exchange have higher education (58%), which may contribute to better preparation for making investment decisions and a lower susceptibility to behavioral errors.

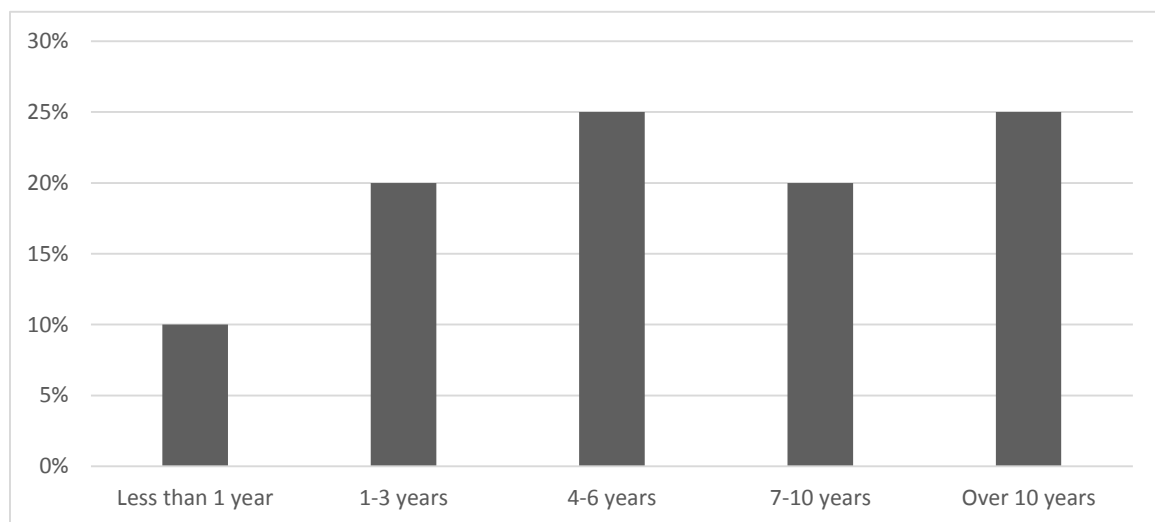


Figure 4. The investment experience of the surveyed investors.

Source: Own compilation based on conducted research.

Among the respondents who answered the question about their investment experience, there is noticeable variation in the length and type of their investment involvement (see Figure 4). The smallest group consists of individuals who have been investing for less than a year (10%), suggesting that they are mostly beginner investors just starting to explore financial markets and the stock exchange. A larger portion of respondents, 20%, have investment experience ranging from 1 to 3 years. This group has already become familiar with the basic mechanisms of investing and has encountered various market situations, which may have influenced their approach to risk and investment strategies. Those with 4 to 6 years of investment experience make up 25% of the respondents. These are investors who have gained solid knowledge and experience, tested different investment strategies, and had the opportunity to manage their

portfolios under various market conditions. The group with 7 to 10 years of experience, also representing 20%, consists of individuals with a long-term investment perspective. They possess significant experience that allows them to make more complex investment decisions and be more aware of risks. The most experienced group, consisting of investors with over 10 years of experience (also 25% of the respondents), indicates a deep understanding of financial markets, the ability to cope with long-term trends, and the skill to manage portfolios across different economic cycles.

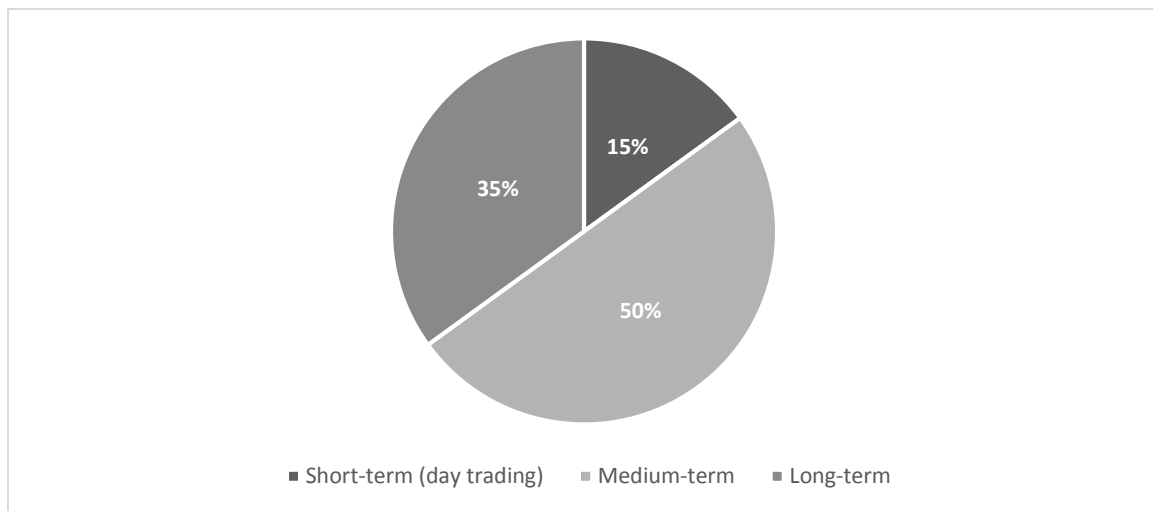


Figure 5. The investment styles of the surveyed investors.

Source: Own compilation based on conducted research.

Based on the data presented in Figure 5, there is a noticeable variation in investment styles among the surveyed investors. The group of investors who prefer a short-term investment style, specifically day trading, represents 15% of the respondents. These individuals engage in intensive trading activity, often making quick investment decisions within a single day. Their strategies rely on dynamic price movements and quick reactions to current market events. The largest group, comprising 50% of the respondents, prefers a medium-term investment style. These investors typically make investment decisions over periods ranging from several months to a few years, focusing on both fundamental and technical analysis. Their goal is to achieve medium-term profits by managing their portfolios in response to changing market conditions. Long-term investors, making up 35% of the respondents, emphasize a long-term perspective. They prefer buy-and-hold strategies, maintaining assets for extended periods, believing that their value will increase in the future. These investors often exhibit lower trading activity, focusing on company fundamentals and long-term macroeconomic trends.

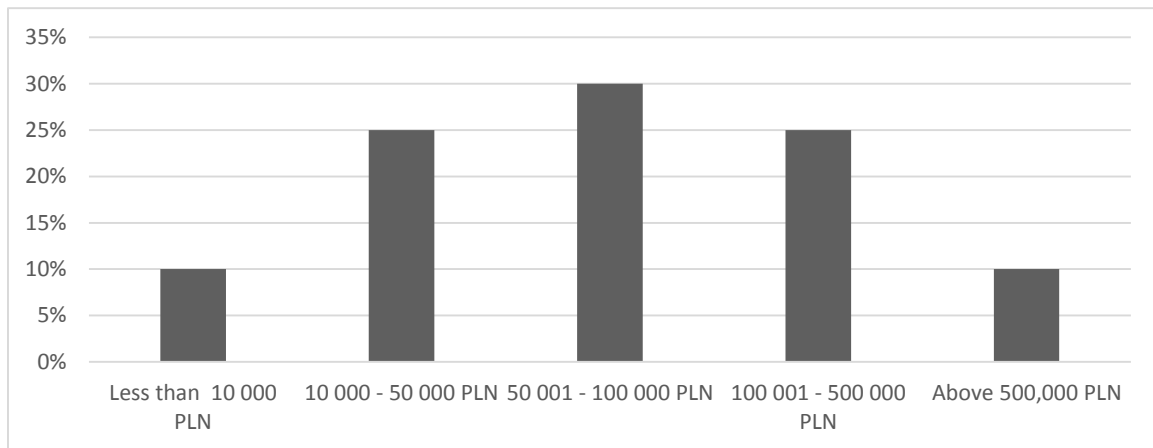


Figure 6. The average value of the investment portfolios of the surveyed investors.

Source: Own compilation based on conducted research.

The analysis of the average value of investment portfolios among the surveyed investors shows that the group is diverse in terms of the size of financial assets and approaches to investing, ranging from small portfolios of beginner investors to substantial portfolios of advanced investors (see Figure 6). The smallest group, representing 10% of the respondents, has portfolios valued at less than 10,000 PLN, suggesting that these are mostly beginner investors or those who are just starting their investment journey. Another 25% of respondents have portfolios valued between 10,000 and 50,000 PLN, indicating an increasing level of engagement and capital building. The group of investors with portfolios worth between 50,001 and 100,000 PLN, accounting for 30% of the respondents, reflects the presence of investors who may already be pursuing more advanced investment strategies. Next, 25% of the respondents have investment portfolios valued between 100,001 and 500,000 PLN, which indicates a significant number of investors with substantial funds. The smallest group, 10% of the respondents, has portfolios valued above 500,000 PLN, suggesting that these are investors with large capital who may be managing their assets with advanced capital management strategies and investing for the long term.

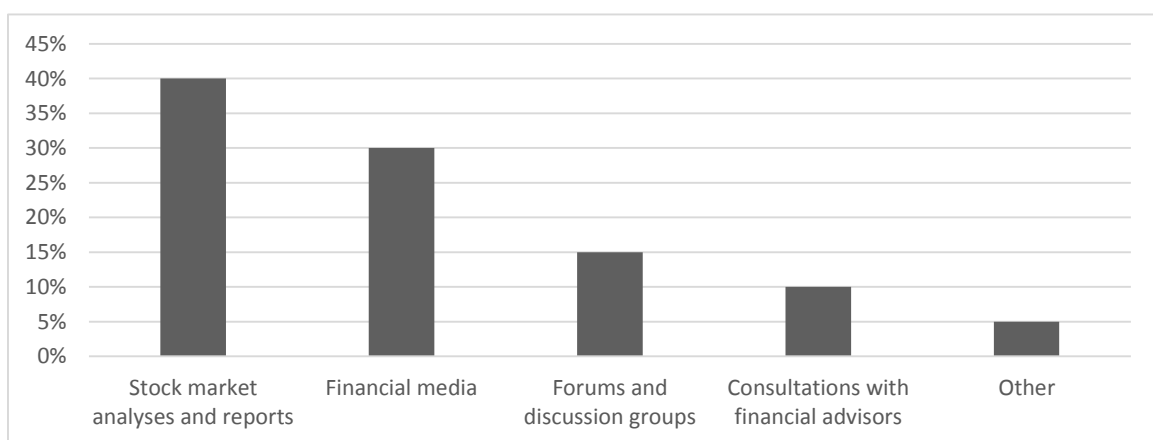


Figure 7. The main sources of investment information for the surveyed investors.

Source: Own compilation based on conducted research.

The diversity of investment information sources used by investors shows that they rely on a variety of tools and platforms to obtain the data and analyses they need to make informed investment decisions (see Figure 7). The largest group, 40% of respondents, consists of individuals who primarily use stock market analyses and reports. This source provides them with detailed data and analyses about financial markets, helping them make well-informed investment decisions. Financial media, such as newspapers, television, and the internet, are the main source of information for 30% of the respondents. These platforms offer broad access to current economic and market news, as well as expert analyses, enabling investors to track trends and respond to market changes. Forums and discussion groups serve as an information source for 15% of respondents. In these places, investors exchange opinions, experiences, and investment ideas, which can be helpful in making investment decisions. Consultations with financial advisors are chosen by 10% of respondents. These investors prefer direct, professional advice and support from experts, which can help in developing personalized investment strategies. Other, less popular sources of information (5% of respondents) include various methods such as investment education, reading industry books, or using specialized investment apps.

In summary, the study results show that most investors on the Warsaw Stock Exchange are men aged 31-50, with higher education, who invest in a medium-term manner. Investors have diverse investment experience, and their investment portfolios vary in value. The primary sources of investment information are stock market analyses and financial media.

4.2. Behavioral biases exhibited by investors on the Warsaw Stock Exchange

In order to identify the most common behavioral errors made by investors on the Warsaw Stock Exchange (GPW), a questionnaire was developed that included questions related to various behavioral biases known from the literature on behavioral economics, behavioral finance, and financial psychology. The questions were designed to identify typical investment behaviors and tendencies that might indicate the presence of specific behavioral errors. These errors were identified as indicators of behavioral bias, which were calculated as the ratio of the number of respondents who indicated a given error to the total number of respondents involved in the study. This result was presented as a percentage (see Table 1).

The study on overconfidence among investors on the GPW was based on questions such as: "Do you often feel that you can predict stock market movements with high confidence?" and "How often do you make investment decisions with confidence, despite the potential risk of losses?" To study the conservatism bias, investors were asked: "Do you stick to your current investments even when new information suggests better investment opportunities?" and "How often do you change your investments based on new information?" In the case of confirmation bias, respondents were asked: "Do you mainly seek information that confirms your current investment beliefs, or do you actively search for information that might challenge your investment decisions?" To assess attribution egotism, participants answered questions

like: "How often do you attribute the success of your investments to your own intelligence and skills?" and "Is it easier for you to explain investment losses by external factors?" For the hindsight bias, the study investigated: "After market results are announced, do you feel that you could have predicted those results with more confidence than was possible beforehand?" Questions regarding the illusion of control included: "Do you believe that your actions can significantly affect the outcomes of your investments?" and "How often do you make investment decisions assuming you have full control over their results?" To investigate the familiarity bias, the respondents were asked: "Do you prefer investments in industries or companies with which you have personal or emotional ties?" and "Do these connections influence your investment decisions?" For framing bias, respondents answered questions such as: "Does the way investment information is presented affect your investment decisions?" and "Is it easier for you to make decisions when information is presented in a specific way?" To assess the limited attention bias, participants were asked: "Do you often focus on one aspect of an investment, ignoring other important factors?" and "How important are different aspects of investments when making decisions?" In the case of mental accounting, they were asked: "How often do you make investment decisions based on your biases about correlations between different events in the market?" and "Do these biases affect your decisions?" For the disposition effect, the study explored: "How often do you tend to quickly close profitable investments but delay the sale of losing investments?" and "What factors influence your investment sale decisions?" Questions about the proximity effect in time asked: "Do you often make investment decisions based on short-term stock price movements, rather than analyzing the long-term fundamentals of the investment?" To study loss aversion, respondents answered questions like: "Do you avoid selling investments that are incurring losses, even if the fundamentals of the investment have deteriorated?" and "What emotions or beliefs influence your decisions in such situations?"

The questions were tailored to each behavioral bias in order to allow precise identification of investment tendencies and behaviors that may indicate the occurrence of a specific behavioral error among investors on the Warsaw Stock Exchange. This approach enabled a systematic analysis and interpretation of the study results, aimed at understanding the impact of these errors on the investment decision-making process.

Table 1.

The list of most common behavioral mistakes made by investors on the Warsaw Stock Exchange

Behavioral bias	Occurrence Rate*
Confirmation bias	58%
Outcome bias	50%
Loss aversion	48%
Hindsight bias	45%
Overconfidence bias	42%
Attentional bias	40%
Recency bias	38%
Attributional Egoism	37%

Cont. table 1.

Framing Effect	33%
Conservatism bias	30%
Illusion of Control	28%
Familiarity bias	25%
Mental accounting bias	22%

* The incidence rate of behavioral errors was calculated as the ratio of the number of respondents who identified a particular error to the total number of respondents participating in the study. This result was presented as a percentage.

Source: own analysis based on the conducted research.

The most common behavioral error is the confirmation bias (58%). This means that investors often seek and give more weight to information that confirms their current investment beliefs. This decision-making approach can lead to ignoring or undervaluing information that could challenge their decisions. Half of the respondents show a tendency to quickly close profitable investments and delay selling losing ones. This behavior may result in suboptimal portfolio management and a decrease in overall portfolio profitability. A high frequency of loss aversion (48%) indicates that investors often avoid selling investments that are losing money, even when fundamental factors suggest the need to adjust their investment strategy. This can lead to holding onto investments instead of reacting promptly to changing market conditions. A significant number of respondents experience hindsight bias (45%), which means that after market results are announced, they feel they could have predicted the outcomes with more certainty than was actually possible earlier. This phenomenon can lead to unjustified overconfidence in the investment decision-making process. Over 40% of investors exhibit overconfidence bias when forecasting stock market movements and making investment decisions. This can result in increased investment risk and decision-making errors. A notable proportion of respondents exhibit attentional bias (40%), meaning they focus on one aspect of an investment while overlooking other important factors. This can lead to incomplete risk analysis and an incomplete understanding of potential benefits from an investment. Nearly one-third of investors make investment decisions based on short-term stock price movements, instead of analyzing the long-term fundamentals of investments. As a result, this behavior can lead to decisions based on fleeting trends rather than solid foundations of fundamental analysis. A high frequency of attribution egotism (38%) indicates that investors tend to attribute their successes to their own skills and intelligence, while attributing failures to external factors or blaming others, such as financial advisors. This phenomenon can lead to unwarranted overconfidence and errors in evaluating one's own investment competence. Thirty-three percent of respondents experience framing bias, meaning they make investment decisions based on how information is presented. This leads to subjective judgments and decisions based on incomplete or misleading reference frames. Thirty percent of investors exhibit conservatism bias, which involves holding onto current investments despite new information suggesting better investment opportunities. This behavior can result in missed investment opportunities and reduced potential profits. More than a quarter of respondents experience the illusion of control, which is the belief that their actions can significantly influence the outcome of their

investments. This phenomenon can lead to excessive trust in one's own abilities and risky investment decisions. Some respondents show familiarity bias (25%), meaning they prefer to invest in industries or companies with which they have personal or emotional connections. This can lead to subjective assessments of investment value and decisions based on emotional rather than rational grounds. About one-fifth of respondents experience mental accounting, meaning they make investment decisions based on biases regarding correlations between different market events. This behavior can lead to misinterpretations of data and decisions based on false assumptions.

4.3. Analysis of the impact of demographic and investment characteristics on behavioral errors made by investors on the Warsaw Stock Exchange

Investing in financial markets is not only based on fundamental or technical analysis but also on the psychological and behavioral aspects of investors' decision-making.

The study takes into account demographic characteristics such as gender, age, and education, which can have a significant impact on risk-taking and investment preferences. Additionally, investment characteristics such as investment styles, experience, and the average value of the investment portfolio will be analyzed. Understanding how these factors shape investment decisions and which behavioral errors may arise depending on an investor's demographic and investment profile will allow for a better understanding of the dynamics of the capital market in Poland. This analysis may also provide insights for financial institutions and regulators on how to better tailor communication and educational strategies to different investor segments in order to minimize the risk of behavioral errors and increase the effectiveness of investment decisions on the Warsaw Stock Exchange.

To examine the differences in the frequency of behavioral errors made by men and women on the Warsaw Stock Exchange, a chi-square test was conducted. The chi-square test results for each behavioral error are presented in Table 2.

Table 2.

Differences in the Frequency of Behavioral Errors Committed by Men and Women on the Warsaw Stock Exchange

Behavioral bias	Men	Women	Test Statistic (χ^2)	p-Value
Confirmation bias	208	111	7.21	0.007
Outcome bias	179	96	5.12	0.024
Loss aversion	172	92	4.67	0.031
Hindsight bias	161	86	3.98	0.046
Overconfidence bias	150	81	3.45	0.063
Limited attention bias	143	77	2.21	0.137
Recency effect	136	73	1.98	0.159
Attributional egotism	136	67	1.75	0.186
Framing effect	119	63	1.48	0.223
Conservatism bias	108	57	1.12	0.290
Illusion of control	100	54	0.98	0.322
Familiarity bias	90	48	0.75	0.387
Mental accounting	79	42	0.52	0.471

Source: own analysis based on the conducted research.

A statistical analysis revealed significant differences in the frequency of selected behavioral errors committed by men and women on the Warsaw Stock Exchange. Men were more likely than women to exhibit errors such as confirmation bias ($\chi^2 = 7.21$, $p = 0.007$), outcome bias ($\chi^2 = 5.12$, $p = 0.024$), loss aversion ($\chi^2 = 4.67$, $p = 0.031$), and overconfidence ($\chi^2 = 3.45$, $p = 0.063$). In contrast, women were more likely than men to exhibit hindsight bias ($\chi^2 = 3.98$, $p = 0.046$) and familiarity bias ($\chi^2 = 0.75$, $p = 0.387$). No significant gender differences were found in the frequency of other behavioral errors (all $p > 0.05$).

To examine differences in the frequency of behavioral errors across age groups, a chi-square test was also conducted. The results indicate significant differences in the occurrence of most behavioral errors among the analyzed age groups. Detailed statistical results are presented in Table 3.

Table 3.

Differences in the Frequency of Behavioral Biases Among Different Age Groups of Investors

Behavioral bias	18-30 years old	31-40 years old	41-50 years old	51-60 years old	61 years old and above	Test Statistic (χ^2)	p-Value
Confirmation bias	64	59	57	53	86	25.21	0.001
Outcome bias	52	48	45	42	88	20.33	0.007
Loss aversion	46	44	42	40	92	15.18	0.032
Hindsight bias	43	41	39	37	88	11.45	0.071
Overconfidence bias	40	38	36	34	83	7.61	0.200
Limited attention bias	39	36	34	32	79	5.12	0.278
Recency effect	37	34	32	30	76	3.56	0.469
Attributional egotism	35	32	30	28	78	2.24	0.643
Framing effect	31	28	26	24	73	1.34	0.841
Conservatism bias	29	26	24	22	64	0.78	0.978
Illusion of control	27	24	22	20	61	0.42	0.976
Familiarity bias	24	21	19	17	57	0.21	0.992
Mental accounting	21	18	16	14	52	0.12	0.996

Source: own analysis based on the conducted research.

Younger age groups (18-30 years and 31-40 years) exhibited a higher frequency of biases such as confirmation bias, outcome bias, and loss aversion compared to older age groups (41-50 years, 51-60 years, and 61 years and above). These effects were statistically significant (all $p < 0.05$). Additionally, significant differences were observed across age groups in levels of overconfidence, limited attention bias, and the temporal proximity effect (all $p < 0.05$), with younger groups demonstrating higher susceptibility to these biases. However, no significant differences were found between age groups in the frequency of framing bias, conservatism bias, illusion of control, good knowledge bias, or mental accounting (all $p > 0.05$).

Table. 4.

Differences in the Frequency of Behavioral Biases Depending on the Education Level of Investors

Behavioral bias	Primary	Vocational	Secondary	Higher	Test Statistic (χ^2)	p-Value
Confirmation bias	2	12	49	256	28.47	< 0.001
Outcome bias	1	11	44	219	24.18	< 0.001
Loss aversion	3	16	48	197	20.92	< 0.001
Hindsight bias	2	15	45	186	17.63	< 0.001
Overconfidence bias	1	14	42	174	14.72	0.002
Limited attention bias	2	13	40	165	12.85	0.005
Recency effect	0	12	38	159	10.91	0.012
Attributional egotism	2	11	37	153	9.23	0.027
Framing effect	1	10	33	138	7.48	0.058
Conservatism bias	1	9	30	125	5.97	0.114
Illusion of control	0	9	28	117	4.52	0.210
Familiarity bias	1	8	25	104	3.17	0.367
Mental accounting	1	7	22	91	2.09	0.555

Source: own analysis based on the conducted research.

Analyzing the differences in the frequency of behavioral biases depending on the education level, a chi-square test was conducted (Table 4). Individuals with higher education (secondary and higher) exhibited less frequent tendencies to commit errors such as confirmation bias, outcome bias, loss aversion, hindsight bias, overconfidence, limited attention bias, and the temporal proximity effect compared to individuals with lower education (primary and vocational). All of these differences were statistically significant (all $p < 0.05$), suggesting that the level of education may influence investment decision-making and susceptibility to specific behavioral biases.

No significant differences were found between education groups in the frequency of framing bias, conservatism bias, illusion of control, good knowledge bias, and mental accounting (all $p > 0.05$). This indicates that these biases may occur to a similar extent regardless of the respondents' formal education level.

Subsequently, an analysis was conducted to examine the relationship between investment experience and the occurrence of behavioral biases.

Table. 5.

Investment Experience and Behavioral Biases Committed by the Surveyed Investors

Behavioral bias	Less than 1 year	1-3 years	4-6 years	7-10 years	More than 10 years	Test Statistic (χ^2)	p-Value
Confirmation bias	32	64	80	64	79	0.64	0.96
Outcome bias	33	55	62	44	81	12.58	0.002
Loss aversion	29	53	61	44	77	10.22	0.037
Hindsight bias	25	52	62	47	62	4.12	0.389
Overconfidence bias	26	50	55	39	61	14.02	0.007
Limited attention bias	22	44	55	44	55	0.60	0.96
Recency effect	21	42	52	42	52	0.51	0.97
Attributional egotism	20	41	51	41	50	0.43	0.98
Framing effect	18	36	46	36	46	0.34	0.99

Cont. table 5.

Conservatism bias	17	33	41	33	41	0.28	1.0
Illusion of control	15	31	39	31	36	0.23	1.00
Familiarity bias	14	28	35	28	35	0.20	1.00
Mental accounting	12	24	30	24	30	0.17	1.00

Source: own analysis based on the conducted research.

The statistical analysis conducted using the chi-square test revealed significant differences in the occurrence of certain behavioral biases depending on investment experience (Table 5). The most significant results concerned outcome bias ($\chi^2 = 12.58$, $p = 0.002$), loss aversion ($\chi^2 = 10.22$, $p = 0.037$), and overconfidence ($\chi^2 = 14.02$, $p = 0.007$). These results indicate that investors with varying levels of investment experience significantly differ in their susceptibility to these behavioral biases.

The greater the investment experience, the higher the likelihood of outcome bias occurring. The largest differences were observed between the group with less than 1 year of experience and the group with over 10 years of experience.

Investors with different levels of investment experience also exhibited differences in their approach to loss aversion. In groups with less investment experience, such as less than 1 year (29 cases) and 1-3 years (53 cases), fewer instances of loss aversion were observed compared to groups with more experience, such as 4-6 years (61 cases), 7-10 years (44 cases), and over 10 years (77 cases). These results suggest that investors with more experience may be more inclined to make investment decisions that minimize the risk of loss.

Moreover, investors with varying levels of investment experience showed differences in the degree of overconfidence. In groups with less experience, fewer instances of overconfidence were observed compared to groups with greater experience. These results suggest that more experienced investors may display higher levels of overconfidence when making investment decisions.

The other behavioral biases examined (confirmation bias, hindsight bias, limited attention bias, temporal proximity effect, attributional egotism, framing effect, conservatism bias, illusion of control, good knowledge bias, and mental accounting) did not show significant differences in occurrence depending on investment experience (all $p > 0.05$).

Next, the analysis checked whether there were differences in the occurrence of behavioral biases between different investment styles.

Table 6.

Investment Styles and Behavioral Biases Committed by the Surveyed Investors

Behavioral bias	Short-term	Medium-term	Long-term	Test Statistic (χ^2)	p-Value
Confirmation bias	47	160	112	3.12	0.21
Outcome bias	40	138	97	4.56	0.10
Loss aversion	40	132	93	0.24	0.24
Hindsight bias	37	124	87	5.47	0.065
Overconfidence bias	35	115	81	3.78	0.15
Limited attention bias	33	110	77	4.21	0.12
Recency effect	32	104	73	2.56	0.28

Cont. table 6.

Attributional egotism	31	101	71	3.01	0.22
Framing effect	27	91	64	4.34	0.11
Conservatism bias	24	83	58	5.12	0.077
Illusion of control	23	77	54	3.89	0.144
Familiarity bias	21	69	48	4.72	0.093
Mental accounting	18	61	42	2.78	0.25

Source: own analysis based on the conducted research.

Based on the conducted analysis, it can be concluded that the investment style is not a major factor influencing the occurrence of most behavioral biases (Table 6). In most cases, the p-value is greater than the typical significance level of 0.05, which means there are no significant differences in the occurrence of most behavioral biases between different investment styles (short-term, medium-term, and long-term). However, in the case of a few biases (e.g., hindsight bias, conservatism bias), the p-values are close to 0.05, suggesting that there may be some differences that would warrant further investigation.

Table. 7.

Average Value of the Investment Portfolio and Behavioral Biases Committed by the Surveyed Investors

Behavioral bias	Less than 10 000 PLN	10 000- 50 000 PLN	50 001- 100 000 pln	100 001- 500 000 PLN	Above 500 000 PLN	Test Statistic (χ^2)	p-Value
Confirmation bias	32	80	96	80	32	2.34	0.67
Outcome bias	28	69	83	67	28	3.12	0.54
Loss aversion	27	65	79	66	27	1.98	0.74
Hindsight bias	25	62	74	62	25	4.45	0.35
Overconfidence bias	23	58	69	58	23	2.89	0.58
Limited attention bias	22	55	66	55	22	3.21	0.52
Recency effect	21	51	63	53	21	2.77	0.60
Attributional egotism	20	51	61	51	20	3.05	0.55
Framing effect	18	46	54	46	18	4.12	0.39
Conservatism bias	17	41	49	41	17	4.89	0.29
Illusion of control	15	39	46	39	15	2.56	0.63
Familiarity bias	14	35	41	34	14	3.78	0.44
Mental accounting	12	31	36	30	12	1.89	0.76

Source: own analysis based on the conducted research.

To examine whether there is a statistically significant relationship between the average value of the investment portfolio and the behavioral biases committed by the surveyed investors, the chi-square test was also used (Table 7). The analysis indicates that there are no statistically significant differences in the occurrence of behavioral biases depending on the value of the investment portfolio. All p-values are significantly greater than 0.05, which means that the average value of the investment portfolio does not have a significant impact on the frequency of different behavioral biases committed by the surveyed investors.

Finally, it is worth comparing the results of this study with other similar studies. Right from the start, both similarities and differences can be observed. Similar to the research by Barberis, Shleifer, and Vishny (1998), which highlights the dominance of the confirmation bias among

investors, the study on the GPW also observed that the confirmation bias was the most frequently made error. In contrast, the research by De Bondt and Thaler (1995) indicates that experienced investors are less prone to making behavioral errors, which is also reflected in the analyzed results, where investors with more experience were less susceptible to errors such as overconfidence or the outcome bias. However, differences appear in the demographic context, where in the GPW study, younger groups of investors exhibited a greater tendency to make mistakes, while studies in other markets, such as the U.S. market, suggest that younger generations may display a more balanced approach to investing. Additionally, the study in Poland includes a detailed analysis of the impact of education on the occurrence of behavioral errors, which is less common in international studies that primarily focus on investment experience. The methodological approach, based on questionnaires among actual investors, is in line with many studies in this field but differs from more controlled laboratory experiments, such as those conducted by Thaler and Sunstein (2008). Despite these differences, the study's results, which emphasize the need for financial and psychological education as well as the use of personalized investment strategies, align with the recommendations of other researchers, such as Lusardi and Mitchell (2014), who highlight the importance of financial education in minimizing behavioral errors.

5. Conclusion

The study of behavioral biases committed by investors on the Warsaw Stock Exchange allowed for the identification of the most common tendencies and behaviors that lead to suboptimal investment decisions. The study showed that different behavioral biases can significantly impact investors' decision-making on the WSE. Confirmation bias is the most frequent behavioral bias among the surveyed investors. Investors tend to seek information that confirms their pre-existing beliefs, which can lead to ignoring important but conflicting information. Additionally, respondents often exhibit a tendency to quickly close profitable investments while delaying the sale of loss-making ones (outcome bias). This behavior can result in suboptimal portfolio management. Investors often avoid selling loss-making investments, even when the fundamentals indicate the need to change strategy, which leads to holding onto unfavorable positions. Demographic analysis revealed that gender, age, education level, and investment experience have a significant impact on the tendency to commit specific biases. Men are more likely to make errors related to overconfidence ($p = 0.063$) and confirmation bias ($p = 0.007$), which suggests that they may overestimate their investment abilities and be reluctant to accept new information that challenges their decisions. Younger investors are more likely to exhibit errors such as confirmation bias, outcome bias, and loss aversion (all $p < 0.05$). This may be due to their less experience and a tendency to make

emotional decisions. Investors with more experience are more likely to make the outcome bias error ($p = 0.002$) and display higher levels of confidence ($p = 0.007$). The lack of significant differences in behavioral errors based on the value of the investment portfolio (all $p > 0.05$) suggests that cognitive biases occur regardless of the investor's wealth level. Investment style (short-term, medium-term, long-term) does not significantly impact the behavioral errors made ($p > 0.05$), meaning that regardless of the investment strategy, investors are susceptible to similar errors.

To effectively minimize the impact of behavioral errors on investment decisions on the Warsaw Stock Exchange (GPW), a series of specific actions should be implemented at the levels of education, technology, advisory services, and regulation. First and foremost, it is worth introducing wide-ranging educational programs at various levels – from high schools to adult investors – focusing on behavioral economics, behavioral finance, and investment psychology. An example could be the implementation of courses that teach how to identify and avoid common investment errors, such as the confirmation bias or outcome bias. Similar to programs like "Finance in Schools" in other countries or "Financial Lessons" in Poland, online training or webinars accessible to a wider group of investors should also be organized. Awareness campaigns explaining phenomena such as overconfidence, loss aversion, or framing effects can help raise investor awareness and improve their ability to recognize these errors in practice. The next step is to implement modern analytical tools and applications that support investment decision-making. Applications such as robo-advisors, which automatically analyze market data and help investors build diversified portfolios, can minimize the risk of making decisions based on emotions. It is also worth promoting platforms with prediction functions that help investors assess the risks associated with specific investments, such as apps that analyze market performance and offer recommendations based on artificial intelligence algorithms. In terms of advisory services, the development of a market for professional investment advisors and financial psychologists is recommended, offering comprehensive support in managing emotions and recognizing tendencies to make behavioral errors. It is also worth creating educational and coaching platforms that allow investors to continuously work on their mistakes and emotions, using tools like e-learning or online sessions with financial psychologists to help control emotions related to investing. From a regulatory perspective, it is necessary to introduce requirements for the transparency of risks associated with various investment products. An example could be the implementation of regulations similar to the MiFID II directive in the European Union, which obligates financial institutions to provide full information on the risks associated with investments. These regulations could also include the requirement to use tools for assessing psychological risks, such as behavioral tests, to better tailor investment offerings to individual investor needs. Strengthening anti-manipulation regulations, increasing control over financial markets, and ensuring transparency of transactions will be crucial in preventing decisions based on incomplete or manipulated information. Moreover, financial institutions should introduce personalized investment strategies based on an investor's behavioral profile,

which would be based on psychometric tests assessing the willingness to take risks and susceptibility to behavioral errors. This approach could be modeled on best international practices, such as in the USA, where financial institutions offer individual advisory services based on detailed psychological analyses of clients. Regular monitoring of investment performance and analyses of the effects of educational and advisory programs will allow for strategy adjustments, which over time will improve the quality of investment decisions and contribute to increasing market stability. It is also important to invest in research on the effectiveness of implemented programs and tools in order to continuously optimize actions.

The results of the study are of great significance for the development of behavioral finance, highlighting common cognitive errors that can influence investment decisions and financial outcomes. The discovery of diversity in the errors made based on demographics and investment experience may help better tailor educational and advisory strategies for both financial institutions and individual investors. The findings can be used to create educational programs that help investors avoid typical behavioral errors. Additionally, this study may serve as a starting point for further analyses in the context of other financial markets, which will contribute to expanding knowledge on the impact of emotions and psychology on investment decisions.

Finally, it is worth addressing certain limitations of the study, which, although providing valuable insights, may influence the interpretation of the results. First, there is a risk of bias in the responses provided by the respondents, which may stem from their personal beliefs, experiences, or the desire to present themselves in the best possible light. Second, the limitation of the research sample to investors active on the Warsaw Stock Exchange (GPW) may impact the representativeness of the results, as it does not take into account other markets, which may differ in terms of investor behavior, regulations, or sector characteristics. In order to obtain more universal and comprehensive results, future research should include broader groups of investors from various financial markets, both domestic and international. This would allow for a wider understanding of behavioral phenomena in a global context and enable more accurate conclusions regarding differences in investment approaches. Additionally, it is recommended to incorporate qualitative research, such as in-depth interviews or case study analysis. This approach could provide valuable insights into investors' motivations, decisions, and the emotions accompanying the investment process. Qualitative research would allow for a more detailed picture that is difficult to capture using only quantitative tools.

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MEASUREMENT OF MUSIC STREAMERS' PREFERENCES USING BEST-WORST SCALING AND CONJOINT ANALYSIS METHODS

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Purpose: The main aim of the research was to measure the music streamers' preferences using Best-Worst Scaling and conjoint analysis methods. The additional purpose is to compare the results obtained from both used methods, which should get similar conclusions. Finally, the cooperation of the `support.BWS3` and `conjoint` R packages as the one common tool for measurement of stated preferences was also examined.

Design/methodology/approach: Multi-profile Best-Worst Scaling method uses a modeling approach based on the conditional logit model, whereas traditional conjoint analysis method applies a linear regression model. Therefore, comparing the results of both methods was even more interesting.

Findings: In the paper, the results of measurement and analysis of music streamers' preferences were presented, calculations from different preference models were confronted and the correct use of R packages in the form of completed scripts was demonstrated.

Research limitations/implications: The limitations of one used method were compensated by the second one. The cooperation of both methods and used R packages was not only confirmed but also led to complete the research results.

Practical implications: The research results, as well as the combined use of some R packages may interest practitioners, researchers and students in the fields of marketing research, in the area of measurement of consumers' preferences. Streaming companies, manufacturers of playback equipment, artist and record labels as well as marketers should be interested in the research results.

Social implications: One of the used packages – authoring `conjoint` R package implements the traditional conjoint analysis method similarly to the module Conjoint IBM SPSS program. The statistics (over a half million of downloads) indicate that the non-commercial `conjoint` package is popular among R users.

Originality/value: In addition to the benefits in form of conclusions drawn from the research, the paper presents one more example confirming results of both used methods. There are no similar studies confirming the results of multi-profile Best-Worst Scaling (Case 3 BWS) and traditional conjoint analysis methods based on measurement of music streamers' preferences.

Keywords: stated consumers' preferences, Best-Worst Scaling, conjoint analysis, R program.

Category of the paper: research paper.

JEL Classification: C6, C8, D1.

1. Introduction

Streaming music began to gain importance in the early 2000s, but its real expansion started from 2010 and continued in the next years, when platforms such as Spotify, Apple Music, YouTube Music, Tidal and Deezer began to gain huge popularity. Today, streaming services have become the dominant way people listen to music, while traditional sources such as radio, records, and even MP3 downloads have become a thing of the past.

According to many studies, we live in the golden age of streaming. The global streaming industry market was worth about \$21 billion in 2019, and according to report of the Recording Industry Association of America, as much as 80% of music industry revenues came from streaming in 2022. Forecasts suggest that the market will continue to grow at an average annual rate of 17,8% through 2027, almost eliminating music piracy.

The rise of streaming music has brought significant changes to the entire music industry. Previously, the main sources of income were record sales and concerts, whereas today revenue comes primarily from music streaming services. The change in the music industry's business model means changes in the model of listening and creating music. Users can listen to song or playlist at any time, and the fee is not paid for songs on a physical medium but for a subscription, i.e. access to libraries. Creators earn mainly through streaming plays, which directly influences how music is produced and promoted.

Due to the features of streaming, it should be noted that music streaming is not only a way to listen to music, but it is also a tool for measurement all kinds of data including user activities and preferences. All users choices are monitored by algorithms, which then can recommend songs based on the diagnosed preferences.

The paper presents the results of measurement and analysis of stated preferences of music users, who are listening to music streaming from popular internet services and platforms. All calculations and visualizations of the obtained results were carried out using the R program and appropriate packages, in particular, the `support.BWS3` (Aizaki, 2024) package for the multi-profile Best-Worst Scaling and the `conjoint` (Bąk, Bartłomowicz, 2018a) package for the traditional conjoint analysis.

In the research, multi-profile Best-Worst Scaling (Case 3 BWS) method was applied first. Using a modeling approach based on discrete choice model (conditional logit model), the best and the worst attributes as well as attribute levels were identified. Then, conjoint analysis method was used. Using traditional conjoint model (linear regression model) next results of measurement of music streamers' preferences including attributes' importance were obtained. Additionally, having the results from both methods, a comparison of multi-profile Best-Worst Scaling and traditional conjoint analysis methods was made. Finally, the cooperation of the `support.BWS3` and `conjoint` R packages as the one common tool for measurement and analysis of stated preferences was also examined.

2. Literature review

The applications of Best-Worst Scaling as well as conjoint analysis methods, include the measurement of stated preferences in many areas. In food marketing research, examples of applications contain: chocolate (Thomson et al., 2010), wine (Cohen, 2009), coffee (Cohen, Neira, 2004), breakfast bars (Hein et al., 2008), restaurants (Chrzan, Golovashkina, 2006). In medical and healthcare the applications are as follows: healthcare system reform (Louviere, Flynn, 2010), residency programs (Wang et al., 2011), treatment decisions in rheumatoid arthritis, side effects of smoking (Marti, 2012). In values, research examples include: food safety issues (Finn, Louviere, 1992), food values (Luss, Briggeman, 2009), brand equity (Menictas et al., 2012), ethical beliefs (Auger et al., 2007) and energy-saving (Poortinga, 2003). There are also many examples in transportation, environmental, public policy and other research.

In the field of measurement and analysis of stated preferences of music users, who are listening to music streaming from popular internet services and platforms some research also were made.

Jones (2020) investigated users' loyalty to streaming platforms, focusing on the asset specificity of features and estimating users' willingness to pay (WTP) for each feature. A structural equation model based on survey data revealed that feature satisfaction positively influences both asset specificity and overall satisfaction with streaming platforms, thereby strengthening user loyalty. Using the conjoint analysis method Jones estimated that users are willing to pay at least \$14,40 per month for platforms that offer recommendations, playlist and social features, and the ability to download music. Kim, Nam, & Ryu (2017) estimated and compared U.S. and Korean consumers' marginal willingness to pay (MWTP) for streaming services using the conjoint analysis method. The study examined attributes such as advertisements, streaming mode, exclusive content and offline usage. The results indicated that U.S. and Korean consumers have different preferences and MWTP for these product attributes. Based on the findings, the research suggests implications for both streaming services and the broader streaming industry.

Shin & Kim (2025) examined adolescent users, a highly influential demographic that rapidly adapts to new technology trends, to analyze the competitive dynamics among major music streaming services. The study selected 4 platforms (YouTube Music, Melon, Flo, Genie Music) and surveyed adolescent users aged 14 to 18. Grounded in niche theory, the research identified 5 gratification factors: price value, music diversity, ease of use, optional services and recommendation services. The competitiveness of each service was analyzed based on these factors. Through this analysis, the study offers strategic implications for Korean music streaming services to achieve sustainable success amid global competition.

Maftai, Gerogiannis & Papageorgiou (2016) identified the critical success factors of online music streaming services and examined the relationships between them. In the research they found that the core of online music streaming include free music streaming, the ability to purchase music in both digital and physical formats, the absence of advertisements and the satisfaction of supporting one's favorite artists.

Lopes & Coelho (2021) conducted a study that included interviews to gain a deeper understanding of the profile, behaviors, and motivations of the new music consumer. Their findings confirmed that habit, performance expectancy and price value play the most significant roles in influencing the intention to use a paid music streaming service. At the same time, new dimensions such as personalization, attitude toward piracy and perceived freemium-premium fit emerged as additional factors influencing the adoption of this type of service. The research provides valuable insights into consumer behavior in music streaming services, offering several theoretical and practical implications for music streaming service providers.

Allan & Leijonhufvud (2022) conducted a test to examine preferences of music streaming users, perceived sound quality and how the musical content affected them. Among the results, education and experience were found to influence preferences in some cases.

More research results covering streamers' music preferences using Best-Worst Scaling or conjoint analysis methods can be found in subject literature (Bamert et al., 2005; Breidert, Hahsler, 2007; Shin, Kim, 2014; Baek, 2023).

In the field of comparing the results of Best-Worst Scaling and conjoint analysis methods, research has been conducted such as the study by Cheng, Zhang, Lambert & Feuz (2023). This study compared consumer willingness to pay (WTP) derived from conjoint analysis and Best-Worst Scaling (Case 3 BWS) survey formats. Data on consumer preferences for single-use eating-ware products made from biobased materials were collected. The results suggest that for the most preferred attribute levels, WTP estimates are similar in magnitude and consistent in sign across both methods. However, for the least preferred attributes, WTP estimates from the conjoint analysis method are higher than those obtained from the multi-profile Best-Worst Scaling.

Hollin, Peay & Bridges (2015) compared Best-Worst Scaling (Case 2 BWS) and conjoint analysis methods, within a study measuring patients' muscular dystrophy treatment. Both methods were applied to 18 potential treatments, incorporating 6 attributes at 3 levels. The results showed that profile Best-Worst Scaling and conjoint analysis methods produced similar parameter estimates, conditional attribute importance and policy simulations. The highest concordance was observed for benefit and risk parameters, while differences emerged for nausea and knowledge about the drug, where a lack of monotonicity was noted in the conjoint analysis. Given the simplicity of combining Case 2 BWS and conjoint analysis for single profiles, the researchers suggested that a combined approach could be easily adopted. Potoglou, Burge, Flynn, Netten, Malley & Forder (2011) also compared Best-Worst Scaling (Case 2 BWS) and conjoint analysis methods using an in-person survey. Respondents were

asked to answer both conjoint and Case 2 BWS questions. They found no significant difference between the methods regarding stated preferences.

More research results comparing the results of conjoint analysis and Best-Worst Scaling (or discrete choice) methods can be found in subject literature (van Dijk et al., 2016; Xie et al., 2013; Severin et al., 2013; Cheng et al., 2021; Himmeler et al., 2021).

According to the presented sources, there are no similar studies in the literature measuring and confirming the results of multi-profile Best-Worst Scaling and traditional conjoint analysis methods based on measurement of music streamers' preferences.

3. Research methodology

Both methods used in the research are widely known, have a long history and hold a well-established position among methods of measurement and analysis of stated preferences. Historically, the older method is the traditional conjoint analysis, moreover the Best-Worst Scaling can be seen as a tool to eliminate some shortcomings of the conjoint analysis. Due to these all, although the multi-profile Best-Worst Scaling is used in the research as the basic method, in the next section the traditional conjoint analysis is discussed first.

3.1. Conjoint analysis

The first publication presenting conjoint measurement in psychometrics appeared in 1964 (Luce, Tukey, 1964), followed by additional works in the 1970s (Green, Rao, 1971; Green, Wind, 1973; Green, Srinivasan, 1978). Since then, numerous studies have discussed the methodological challenges and applications of conjoint analysis in marketing research. Nowadays, conjoint analysis is a group methods widely used for studying consumers' stated preferences for products and services, as well as political opinions and religious attitudes. A comprehensive review of the existing achievements and future development perspectives in conjoint analysis is provided in (Green et al., 2004; Gustafsson et al., 2007; Rao, 2014).

In the paper, the traditional conjoint analysis (TCA) was used. Two most important steps of TCA procedure are the measurement of consumers' preferences and the parameters estimation of conjoint analysis model.

The research material used in the traditional conjoint analysis method consists of marketing data on preferences declared by respondents obtained through survey research. Respondents evaluate product or service profiles¹ (real or hypothetical) described by a set of features

¹ Attributes and their levels generate different variants (profiles) of goods or services. The number of all possible profiles to be generated depends on the number of attributes and the number of levels (it is the product of level numbers of all attributes). In practice, only a subset of variants meeting the relevant conditions (e.g. of the system orthogonality) is ranked by respondents in the form of the so-called fractional factorial design.

(attributes), thus expressing their (empirical) preferences. Based on the collected data, the total preferences are decomposed using statistical methods by calculating the share of each attribute in the estimated total utility value of the profile. Part-worth utilities are estimated for each respondent individually and as average value for the studied sample (Green, Wind, 1975; Walesiak, Bąk, 2000; Bąk, 2004).

In the traditional conjoint analysis the linear regression model is used, the parameters of which (part-worth utilities of the attribute levels) are estimated using the Ordinary Least Squares (OLS) method. The model for the selected respondent can be presented in the following form (Hair et al., 1995):

$$\hat{Y}_s = b_{0s} + b_{1s}X_{1s} + \dots + b_{ms}X_{ms} = b_{0s} + \sum_{j=1}^m b_{js}X_j \quad (1)$$

where:

$s = 1, \dots, S$ – respondent's number;

S – number of respondents.

The knowledge of part-worths utilities allows conducting the analysis covering:

- the total utilities of the profiles in the cross-section of respondents,
- the analyzed sample and the identified groups (segments) of respondents,
- the relative importance ranking of individual attributes in the cross-section of respondents in the analyzed sample,
- the simulation market shares of the selected profiles,
- the segmentation of respondents.

The total utility of i profile for s respondent (U_i^s) is calculated based on the following formula (Hair et al., 1995; Walesiak, 1996):

$$U_i^s = b_{0s} + \sum_{j=1}^m U_{l_j^i}^s \quad (2)$$

where:

b_{0s} – the intercept for s respondent;

$U_{l_j^i}^s$ – part-worths utility of l level of j attribute of i profile for s respondent;

l_j^i – level number of j attribute in i profile.

The average total utility (at an aggregated level, i.e., for the whole sample covering S respondents) of i profile (U_i) is calculated based on the following formula (Hair et al., 1995; Walesiak, 1996):

$$U_i = \frac{1}{S} \sum_{s=1}^S \left(b_{0s} + \sum_{j=1}^m U_{l_j^i}^s \right) \quad (3)$$

The results in the form of estimated partial utilities obtained in the conjoint analysis procedure can be used in simulation models of market events, the so-called choice simulators, which enable the analysis of what-if scenarios. Making some simulation analysis of market shares it is also possible to estimate the total utility of additional profiles, which were not ranked by the respondents in the survey. The anticipated market share of the selected profiles is estimated based on the maximum utility model, probabilistic BTL (Bradley-Terry-Luce) model and logit model (Hair et al., 1995; Walesiak, 1996; Walesiak, Bąk, 2000; Bąk, 2013).

The parameters values of the estimated conjoint analysis model (estimated part-worth and total utilities) can additionally constitute the basis for consumers' segmentation, as they reflect the respondents' preferences presented in the research regarding the specific profiles of products or services.

The knowledge of part-worth utilities also allows estimating the importance for every attribute in the assessment of profiles, which are the subject of research. The relative importance of j attribute for s respondent (W_j^s) is calculated using the formula (6) (Hair et al., 1995):

$$W_j^s = \frac{\max\{U_{lj}^s\} - \min\{U_{lj}^s\}}{\sum_{j=1}^m (\max\{U_{lj}^s\} - \min\{U_{lj}^s\})} \times 100\% \quad (4)$$

The average importance of the attributes in the cross-section of the whole sample covering S respondents (W_j) is calculated based on the formula:

$$W_j = \frac{1}{S} \sum_{s=1}^S W_j^s \quad (5)$$

where W_j^s – defined by a formula (4).

The traditional conjoint analysis method is a useful tool for studying consumer preferences, but it has certain limitations. First, it assumes that consumers make decisions in a fully rational and hierarchical manner, which does not always reflect real market behavior. Second, the number of attributes and their levels must be carefully selected because too many can lead to cognitive overload for respondents. Additionally, interpreting the results requires advanced statistical methods, which can be a challenge for companies lacking analytical resources. Finally, studies using this method can be costly and time consuming, especially when they require large respondent samples and complex experimental designs.

More information about traditional conjoint analysis method and conjoint group of methods and their applications in practice can be found in subject literature (Hair et al., 1995; Coombs et al., 1977; Gustafsson et al., 2007; Green, Rao, 1971; Green, Srinivasan, 1990; Green, Wind, 1975; Wilkinson, 1998; Vriens, Wittink, 1994; Zwerina, 1997; Rao, 2014; Lu, Zhang, 2020; Walesiak, 1996; Walesiak, Bąk, 2000; Bąk, 2004; Bąk, Bartłomowicz, 2012, 2018b; Bartłomowicz, Bąk, 2021).

3.2. Best-Worst Scaling

The first publication discussing Best-Worst Scaling (BWS) presenting its theory, method and application was introduced in the 1990s (Louviere, 1988). More detailed descriptions of the method were provided in subsequent publications in 1991 and next years (Louviere, 1991), (Finn, Louviere, 1992). Since then, numerous studies were published on Best-Worst Scaling, showcasing various models for analyzing data based on stated preferences.

There are Case 1, Case 2 and Case 3 of Best-Worst Scaling method (Louviere et al., 2015), which differ in terms of the complexity of the items (options) under consideration. However, in each version of the method respondents are asked to choose the best (most important, most attractive) and the worst (least important, least attractive) items (objects, levels or profiles) comparing a finite and different set of alternatives.

In the object Best-Worst Scaling (Case 1 BWS) method, researchers examine the relative values assigned to each item in a given list of objects, considering only the items themselves without decomposing them into factors. A necessary number of distinct subsets of items is generated using an experimental design. Each subset is then presented to respondents as a choice set, and the process is repeated until all subsets have been evaluated (Finn, Louviere, 1992).

In the profile Best-Worst Scaling (Case 2 BWS) method, attributes levels replace objects. Respondents make their best-worst choices by comparing different levels of different attributes, what can be more difficult than comparing objects. It means that the alternatives in a Case 2 BWS question correspond to attribute levels presented within a choice set (Himmler et al., 2021; Flynn, 2010),

In the multi-profile Best-Worst Scaling (Case 3 BWS) method, each question corresponds to full profiles presented within a choice set. Respondents evaluate a sequence of choice sets based on the entire scenario rather than individual factor levels as in Case 2 BWS, or isolated factors as in Case 1 BWS (Louviere et al., 2000).

The most similar to traditional conjoint analysis method is multi-profile Best-Worst Scaling method because respondents are asked to select full profiles among a set of profiles. Case 3 BWS sometimes is also called conjoint BWS. However, unlike traditional conjoint analysis wherein respondents are asked to rank or rate profiles, the Case 3 Best-Worst Scaling tasks respondents with selecting best and worst profiles.

Regardless of the BWS method type, collecting two responses (best-worst choices) provides more specific data about respondents' preferences for items than can be obtained through conjoint analysis. The key assumption is that the best-worst choice captures the greatest difference in perceived importance among items on an underlying ranking of importance. Comparisons have shown (Cheng et al., 2023) that BWS methods offer advantages over other approaches, such as superior discriminatory power without increasing respondent burden and higher predictive validity, supporting empirical research using these methods.

Analyzing of responses in BWS methods can be made with 2 approaches – a counting approach and a modeling approach. The counting approach calculates several types of scores based on number of times (frequency) that item i is selected as the best (B_{in}) or the worst (W_{in}) in all the questions for respondent n (Finn, Louviere, 1992; Lee et al., 2007; Cohen 2009; Mueller et al., 2009). The scores are divided into two categories – disaggregated (individual level) and aggregated (total level) scores.

The disaggregated BW (best-worst) scores and its standardized scores are calculated based on the following formulas (Finn, Louviere, 1992; Lee et al., 2007; Louviere, Flynn, 2010):

$$BW_{in} = B_{in} - W_{in}, \quad std.BW_{in} = \frac{BW_{in}}{r} \quad (6)$$

where r – the frequency with which item i appears across all questions.

The aggregated version of BW score and its standardized score as well the square root of the ratio and its standardized score are calculated based on the following formulas:

$$BW_i = B_i - W_i, \quad std.BW_i = \frac{BW_i}{Nr} \quad (7)$$

$$sqrt.BW_i = \sqrt{\frac{B_i}{W_i}}, \quad std.sqrt.BW_i = \frac{sqrt.BW_i}{max.sqrt.BW_i} \quad (8)$$

The modeling approach uses discrete choice models to analyze respondents' responses. The probability of selecting item i as the best and item j as the worst is expressed as a conditional logit model (CLM) and calculated as maxdiff (9), marginal (10) or marginal sequential (11) models using formulas:

$$Pr(i, j) = \frac{\exp(v_i - v_j)}{\sum_{p,q; p \neq q} \exp(v_p - v_q)} \quad (9)$$

$$Pr(i, j) = \frac{\exp(v_i)}{\sum_p \exp(v_p)} \cdot \frac{\exp(-v_j)}{\sum_p \exp(-v_p)} \quad (10)$$

$$Pr(i, j) = \frac{\exp(v_i)}{\sum_p \exp(v_p)} \cdot \frac{\exp(-v_j)}{\sum_q \exp(-v_q)} \quad (11)$$

In the paper multi-profile Best-Worst Scaling (Case 3 BWS) method using maxdiff² model was used.

² Maxdiff (Maximum Difference Scaling) model assumes that respondents make selections because the difference in utility between i and j represents the greatest utility difference among $m \times (m - 1)$ possible utility differences, where $m \times (m - 1)$ is the number of possible pairs in which profile i is selected as the best profile and profile j is selected as the worst profile from m profiles.

Best-Worst Scaling has some limitations that should be considered. First, as the number of attributes per task increases (especially beyond 5-6), the decision-making process becomes more demanding, potentially leading to errors or random responses due to cognitive overload. Second, BWS method assumes that attributes are evaluated independently, while in reality, their importance may change depending on context and the interaction with other product features. Lastly, advanced statistical analysis is required to transform raw data into meaningful insights, making the interpretation of results more complex.

More information about multi-profile Best-Worst Scaling method and other BWS methods and their practical applications, can be found in subject literature (Lee et al., 2007; Louviere, 1991; Louviere, Flynn, 2010; Marley, Louviere, 2005; Flynn et al., 2007; Flynn, 2010; Fogarty, Aizaki, 2018; Aizaki et al., 2015; Marley, 2010; Cohen, 2023).

4. Results

In the measurement and analysis of stated preferences of users streaming the music from popular internet services and platforms (Spotify, Apple Music, YouTube Music, Tidal, Deezer, etc.) multi-profile Best-Worst Scaling (Case 3 BWS) method was used first. After collecting and then preparing data on respondents' preferences using modeling approach based on discrete choice model (conditional logit model), the best and the worst attributes as well as attribute levels were identified.

All calculations were carried out using the R program with `support.CEs` (Aizaki, 2023), `support.BWS` (Aizaki, 2023), `support.BWS3` (Aizaki, 2024) and `survival` (Therneau et al., 2024) packages for Best-Worst Scaling and the `conjoint` (Bąk, Bartłomowicz, 2018a) package for conjoint analysis. In the construction of experimental designs the `crossdes` (Sailer, 2022) and `DoE.base` (Groemping, 2023) packages were used. For the purpose of visualization of the results, the `broom` (Robinson et al., 2024), `fpc` (Hennig, 2024) and `ggplot2` (Wickham, 2016; Wickham et al., 2024) packages were applied:

```
> library(broom),
> library(conjoint),
> library(crossdes),
> library(DoE.base),
> library(fpc),
> library(ggplot2),
> library(support.BWS),
> library(support.BWS3),
> library(support.CEs),
> library(survival).
```

The following features (with the respective levels) were listed in the set of variables describing the examined product: quality of music (standard, high, lossless)³, offline mode (disabled, playlists, full)⁴, number of titles (under 10000, between 10000-40000, over than 40000) and subscription (student, multi, family)⁵:

```
> stream.bws3.ffd<-list(
+ quality=c("standard","high","lossless"),
+ offline=c("disabled","playlists","full"),
+ titles=c("under_10k","b10_40k","over_40k"),
+ subscription=c("student","multi","family"))
```

Similar to discrete choice experiments, in Case 3 BWS method, question consists at least 3 (or more) profiles. Each profile has 2 (or more) attributes with each attribute having 2 (or more) levels. Consequently, the profile is expressed as a combination of attribute-levels. Respondents were asked to choose the best and worst profiles from a question.

The number of variables (4) combined with the number of their levels (3) enables the construction of 81 (full factorial design) different profiles of streaming music. Due to the respondents' limited capacity to evaluate a large number of profiles, a final set of 9 profiles using `oa.design` function from `DoE.base` R package was selected:

```
> stream.oa.des<-oa.design(
+ nl=c(3,3,3,3),
+ randomize=FALSE)
> stream.oa.des
  A B C D
1 1 1 1 1
2 1 2 3 2
3 1 3 2 3
4 2 1 3 3
5 2 2 2 1
6 2 3 1 2
7 3 1 2 2
8 3 2 1 3
9 3 3 3 1
class=design, type= oa
```

The design in a form of fractional factorial design meets the criterion of orthogonality:

```
> ca<-as.numeric(unlist(stream.oa.des))
> stream.ca.des<-as.data.frame(matrix(ca,nrow=9,ncol=4))
> colnames(stream.ca.des)<-names(stream.bws3.ffd)
> names(stream.ca.des)<-names(stream.bws3.ffd)
> round(cor(stream.ca.des),5)
```

	quality	offline	titles	subscription
quality	1	0	0	0
offline	0	1	0	0
titles	0	0	1	0
subscription	0	0	0	1

³ Quality of music depends on bitrate. Standard quality means low bitrate (no more than 192 kbps). High bitrate is between 256 kbps - 320 kbps. Lossless music means the best bitrate (over 700 kbps) or quite lossless music (e.g. FLAC, ALAC).

⁴ It is more comfortable to stream the music with full access to the libraries. Disabled mode means you can't download the music, playlists – only playlist are available to download, full – access to download all libraries.

⁵ The student subscription means access for 1 device and lower fee, multi – max 3 devices and medium fee, family – access for max 4 persons and highest fee.

```
> det(cor(stream.ca.des))
[1] 1
```

The resultant design is a matrix with 9 rows and 4 columns. The columns correspond to attributes, while the rows correspond to profiles (cf. tab. 1). For example, profile 3 consists the following attribute levels: standard quality of music (1), full access mode (3), between 10k and 40k titles (2) and family type of subscription (3).

Next, balanced incomplete block design (BIBD) is needed. The `find.BIB` function from `crossdes` package assigns profiles from fractional factorial design and creates BIBD design. All 9 profiles ($trt = 9$) have to be used, at least 3 in each question ($k = 3$), and such a number of questions ($b = 12$) that this design also meets the criterion of orthogonality:

```
> stream.bibd.des<-find.BIB(trt=9,b=12,k=3)
> stream.bibd.des
      [,1] [,2] [,3]
[1,]     5     6     7
[2,]     1     2     6
[3,]     4     7     8
[4,]     3     4     6
[5,]     1     5     8
[6,]     2     7     9
[7,]     3     5     9
[8,]     2     4     5
[9,]     1     4     9
[10,]    2     3     8
[11,]    1     3     7
[12,]    6     8     9
> isGYD(stream.bibd.des)
```

```
[1] The design is a balanced incomplete block design w.r.t. rows.
```

Table 1.
Fractional factorial design

Number of profile	Attributes of food service			
	Quality of music	Offline mode	Number of titles	Type of subscription
1	standard	disabled	under 10k	student
2	standard	only playlists	over 40k	multi
3	standard	full access	between 10k and 40k	family
4	high	disabled	over 40k	family
5	high	only playlists	between 10k and 40k	student
6	high	full access	under 10k	multi
7	lossless	disabled	between 10k and 40k	multi
8	lossless	only playlists	under 10k	family
9	lossless	full access	over 40k	student

Source: author's compilation using `DoE.base` R package.

In the BIBD design each row corresponds to question, while each column corresponds to profiles. For example, row 6 means a set of 3 profiles: 2, 7 and 9 (cf. Table 1). The result of executing the function `isGYD` (also from `crossdes` R package) indicates that the resultant design is a balanced incomplete block design.

The fractional factorial design of profiles (stream.oa.des) and balanced incomplete block design of questions (stream.bibd.des) allows using the `bws3.design` function to generate a questionnaire design (stream.bws3.des) for respondents in accordance with the assumptions of the Case 3 BWS method:

```
> stream.bws3.des<-bws3.design(
+   bibd=stream.bibd.des,
+   ffd=stream.oa.des,
+   attribute.levels=stream.bws3.fd)
> questionnaire(stream.bws3.des)
```

Block 1

Question 1

	alt.1	alt.2	alt.3
quality	"high"	"high"	"lossless"
offline	"playlists"	"full"	"disabled"
titles	"b10_40k"	"under_10k"	"b10_40k"
subscription	"student"	"multi"	"multi"

Question 2

	alt.1	alt.2	alt.3
quality	"standard"	"standard"	"high"
offline	"disabled"	"playlists"	"full"
titles	"under_10k"	"over_40k"	"under_10k"
subscription	"student"	"multi"	"multi"

Question 3

	alt.1	alt.2	alt.3
quality	"high"	"lossless"	"lossless"
offline	"disabled"	"disabled"	"playlists"
titles	"over_40k"	"b10_40k"	"under_10k"
subscription	"family"	"multi"	"family"

Question 4

	alt.1	alt.2	alt.3
quality	"standard"	"high"	"high"
offline	"full"	"disabled"	"full"
titles	"b10_40k"	"over_40k"	"under_10k"
subscription	"family"	"family"	"multi"

Question 5

	alt.1	alt.2	alt.3
quality	"standard"	"high"	"lossless"
offline	"disabled"	"playlists"	"playlists"
titles	"under_10k"	"b10_40k"	"under_10k"
subscription	"student"	"student"	"family"

Question 6

	alt.1	alt.2	alt.3
quality	"standard"	"lossless"	"lossless"
offline	"playlists"	"disabled"	"full"
titles	"over_40k"	"b10_40k"	"over_40k"
subscription	"multi"	"multi"	"student"

Question 7

	alt.1	alt.2	alt.3
quality	"standard"	"high"	"lossless"
offline	"full"	"playlists"	"full"
titles	"b10_40k"	"b10_40k"	"over_40k"

```
subscription "family"      "student"      "student"
```

```
...
```

```
Question 12
```

```
alt.1      alt.2      alt.3
quality    "high"      "lossless"  "lossless"
offline    "full"      "playlists" "full"
titles     "under_10k" "under_10k" "over_40k"
subscription "multi"    "family"     "student"
```

In the research the respondents' responses from a survey conducted in 2024-2025 were used. The survey questionnaire included questions for Best-Worst Scaling method, questions for conjoint analysis method and questions about basic respondents' characteristics. The survey was prepared using Microsoft Forms and distributed using Microsoft Teams programs. The data were collected using employing the convenience sampling method, which involved selecting respondents based on their availability and willingness to participate in the study. In the research, 108 correctly completed questionnaires were used as a source of statistical data for both methods. The data containing respondents' preferences (stream.bws3.pref) for the Case 3 BWS method are as follows:

```
> stream.bws3.pref<-read.csv2("bws3.csv",header=TRUE)
> stream.bws3.pref<-stream.bws3.pref[,1:28]
> head(stream.bws3.pref);tail(stream.bws3.pref)
> stream.bws3.pref<-stream.bws3.pref[,1:26]
  id BLOCK B1 W1 B2 W2 B3 W3 B4 W4 B5 W5 B6 W6 B7 W7 B8 W8 B9 W9 B10 W10 B11 W11
1  1      1 3  2 2  1 2  3 2 3  3 2  2 1 3  1 3  2 3  1  2  1  1  2
2  2      1 2  1 3  1 2  1 2  1 2  3 3  2  1 3  2  1  2  1  3  1  3  1
3  3      1 3  1 3  1 2  1 3  1 3  1 3  1  3  1  3  1  3  1  2  1  3  1
4  4      1 2  1 2  1 3  1 3  1 3  1 2  3  1 3  3  2  3  1  2  1  2  3
5  5      1 3  1 2  1 1  3 2  3 1  2 2  3  1 2  2  1  2  1  2  1  3  1
6  6      1 3  2 1  3 2  1 1  2 3  2 2  3  3  1  3  2  3  2  2  3  3  2
  B12 W12 sex age
1    3    2  0  20
2    2    3  0  21
3    3    1  0  20
4    3    1  1  20
5    1    2  0  20
6    3    2  1  20
  id BLOCK B1 W1 B2 W2 B3 W3 B4 W4 B5 W5 B6 W6 B7 W7 B8 W8 B9 W9 B10 W10 B11
103 103    1 3  2 3  1 1  3 2  1 3  2 2  3  1 3  3  2  3  1  2  1  2
104 104    1 2  1 2  1 2  1 2  1 2  1 2  1  2  1  2  3  2  1  2  1  2
105 105    1 2  1 2  1 3  1 3  1 3  1 2  1  2  3  3  2  3  1  3  1  2
106 106    1 3  1 1  3 3  1 1  3 3  2 2  1  2  1  3  2  3  2  2  1  3
107 107    1 1  2 3  1 1  3 3  1 1  2 2  3  3  2  1  3  3  1  2  3  3
108 108    1 3  1 2  1 3  1 3  1 3  1 2  3  1  3  3  2  3  1  3  1  2
  W11 B12 W12 sex age
103  3    3    2  0  20
104  1    2    1  1  20
105  3    3    1  1  22
106  1    3    1  1  20
107  2    1    2  0  20
108  3    3    1  0  21
```

The multi-profile Best-Worst Scaling method employs a model approach requiring the definition of conditional logit model formula, whose parameters are then estimated. All necessary elements, presented in the form of an appropriate dataset, are provided by the `bws3.dataset` function:


```

> stream.bws3.dat<-bws3.dataset(
+   data=stream.bws3.pref,
+   response=colnames(stream.bws3.pref)[3:26],
+   choice.sets=stream.bws3.des,
+   categorical.attributes=names(stream.bws3.ffd),
+   optout=FALSE,
+   asc=c(0,0,0),
+   model="maxdiff")
> head(stream.bws3.dat);tail(stream.bws3.dat)
  id BLOCK QES PAIR BEST WORST RES.B RES.W RES ASC1 ASC2 ASC3 standard high
1  1      1   1   1   1   2      3      2   0   0   0   0   0   0   0
2  1      1   1   2   1   3      3      2   0   0   0   0   0   0   1
3  1      1   1   3   2   1      3      2   0   0   0   0   0   0   0
4  1      1   1   4   2   3      3      2   0   0   0   0   0   0   1
5  1      1   1   5   3   1      3      2   0   0   0   0   0   0  -1
6  1      1   1   6   3   2      3      2   1   0   0   0   0   0  -1
  lossless disabled playlists full under_10k b10_40k over_40k student multi
1         0         0         1   -1         -1         1         0         1   -1
2        -1        -1         1    0         0         0         0         1   -1
3         0         0        -1    1         1        -1         0        -1    1
4        -1        -1         0    1         1        -1         0         0    0
5         1         1        -1    0         0         0         0        -1    1
6         1         1         0   -1        -1         1         0         0    0
  family STR
1      0 1010
2      0 1010
3      0 1010
4      0 1010
5      0 1010
6      0 1010
  id BLOCK QES PAIR BEST WORST RES.B RES.W RES ASC1 ASC2 ASC3 standard high
7771 108    1  12    1    1    2     3     1    0    0    0    0    0    0    1
7772 108    1  12    2    1    3     3     1    0    0    0    0    0    0    1
7773 108    1  12    3    2    1     3     1    0    0    0    0    0    0  -1
7774 108    1  12    4    2    3     3     1    0    0    0    0    0    0    0
7775 108    1  12    5    3    1     3     1    1    0    0    0    0    0  -1
7776 108    1  12    6    3    2     3     1    0    0    0    0    0    0    0
  lossless disabled playlists full under_10k b10_40k over_40k student multi
7771        -1         0        -1    1         0         0         0         0    1
7772        -1         0         0    0         1         0        -1        -1    1
7773         1         0         1   -1         0         0         0         0  -1
7774         0         0         1   -1         1         0        -1        -1    0
7775         1         0         0    0        -1         0         1         1  -1
7776         0         0        -1    1        -1         0         1         1    0
  family STR
7771     -1 108120
7772      0 108120
7773      1 108120
7774      1 108120
7775      0 108120
7776     -1 108120

```

In the formula, for each attribute one attribute level should be omitted. In the research, the last attribute levels (lossless, full, over_40k, family) were assumed as reference levels for the corresponding attributes (BWS model 1). The structure of the conditional logit model is similar to that of a linear regression function:

$$\text{RES} \sim \text{standard} + \text{high} + \text{disabled} + \text{playlists} + \text{under_10k} + \text{b_10_40k} + \text{student} + \text{multi} + \text{strata}(\text{STR})$$

```

> stream.bws3.model<-RES ~ standard + high + disabled + playlists +
under_10k + b10_40k + student + multi + strata(STR)
> stream.bws3.clm<-clogit(
+   formula=stream.bws3.model,
+   data=stream.bws3.dat)

```

```
> stream.bws3.clm
> gofm(stream.bws3.clm)
```

Call:

```
clogit(formula = stream.bws3.model, data = stream.bws3.dat)
```

	coef	exp(coef)	se(coef)	z	p
standard	-0.54137	0.58195	0.04940	-10.959	< 2e-16
high	-0.27899	0.75655	0.04716	-5.915	3.31e-09
disabled	-0.34768	0.70632	0.04864	-7.147	8.84e-13
playlists	-0.18235	0.83331	0.04688	-3.890	0.000100
under_10k	-0.18413	0.83183	0.04813	-3.826	0.000130
b10_40k	0.16107	1.17477	0.04696	3.430	0.000604
student	-0.30042	0.74050	0.04834	-6.215	5.13e-10
multi	-0.03358	0.96698	0.04685	-0.717	0.473552

Likelihood ratio test=262.4 on 8 df, p=< 2.2e-16
n= 7776, number of events= 1296

Rho-squared = 0.05649267
Adjusted rho-squared = 0.05304754
Akaike information criterion (AIC) = 4397.875
Bayesian information criterion (BIC) = 4439.211
Number of coefficients = 8
Log likelihood at start = -2322.12
Log likelihood at convergence = -2190.938

The coefficients of omitted variables are normalized to 0. Therefore, other coefficients indicate how each variable affects the probability of selection (utility) compared to the reference category. The strata(STR) denotes that variable STR is used to identify each combination of respondent and Case 3 BWS question.

According to the obtained results, standard (-0,54) quality of streaming music significantly decreases the probability of selection, indicating that users prefer better quality – at least high (-0,28) or rather lossless (0) quality of music (cf. Figure 1). Downloading restrictions negatively impact the respondents' choices. Users significantly dislike the disabled (-0,35) offline mode (no music downloads available). Limiting downloads to only playlists (-0,18) reduces the dislike but it is still strong. The best (most preferred) offline mode is full (0) access to libraries.

Music libraries' size also influences streamers' preferences. The worst (least preferred) level is under 10k (-0,18) titles. The results show that number between 10k and 40k (0,16) titles is enough and even more preferred than over 40k (0) titles. For subscription type, the student (-0,31) plan restricted to only single device is the worst rated. This group may need additional incentives, such as discounted lossless streaming or expanded download options. The multi device (-0,03) plan is also not a key factor, meaning users may not strongly consider the number of devices allowed when choosing a subscription. Instead, family type of subscription (0) and factors like music quality and access to downloads play a more significant role.

Using traditional conjoint analysis method the results of multi-profile Best-Worst Scaling were confronted and next results were determined. Respondents evaluated the same 9 profiles⁶

⁶ The profiles from the stream.oa.des design.

on an interval scale [0-10] considering the relative attractiveness of the profiles and assigning a higher value to the profile that was more attractive than the others. It means that the data was collected as a form of rating:

```
> stream.ca.pref<-read.csv2("conjoint.csv",header=TRUE)
> head(stream.ca.pref);tail(stream.ca.pref)
```

	profil1	profil2	profil3	profil4	profil5	profil6	profil7	profil8	profil9
1	4	6	5	6	8	6	4	5	7
2	0	4	6	6	2	7	6	6	3
3	2	4	5	2	6	9	2	7	10
4	2	4	5	5	5	4	4	5	5
5	2	4	5	6	7	7	0	0	2
6	4	3	2	2	7	4	3	2	9

	profil1	profil2	profil3	profil4	profil5	profil6	profil7	profil8	profil9
103	1	3	5	2	4	6	3	4	6
104	3	4	8	8	8	8	8	7	7
105	2	4	3	6	4	4	6	4	5
106	4	4	6	6	9	7	7	7	10
107	1	8	10	3	9	8	2	5	6
108	3	5	5	6	7	4	6	4	5

In the conjoint R package, the main function `Conjoint` needs 3 arguments. Apart from the data set on empirical respondents' preferences, the fractional factorial design and attribute levels' names are necessary:

```
> stream.ca.des
  quality offline titles subscription
1      1      1      1             1
2      1      2      3             2
3      1      3      2             3
4      2      1      3             3
5      2      2      2             1
6      2      3      1             2
7      3      1      2             2
8      3      2      1             3
9      3      3      3             1
```

```
> levn<-cbind(
+   stream.bws3.ffd$quality,
+   stream.bws3.ffd$offline,
+   stream.bws3.ffd$titles,
+   stream.bws3.ffd$subscription)
> stream.levn<-c(unlist(levn))
> stream.ca.levn<-stream.levn
> stream.ca.levn
 [1] "standard" "high"      "lossless" "disabled" "playlists" "full"
 [7] "under_10k" "b10_40k"  "over_40k" "student"  "multi"     "family"
```

The availability of data on empirical preferences (`stream.ca.pref`), the coded research design (`stream.ca.des`) and the names of attribute levels (`stream.ca.levn`) allow summarizing (in the cross-section of respondents) the most important results of measurement of preferences using the `Conjoint` function (TCA model):

```
> Conjoint(stream.ca.pref,stream.ca.des,stream.ca.levn)
```

Call:

```
lm(formula = frml)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-4,926 -1,407 -0,037  1,296  4,741
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	4,971193	0,064358	77,243	< 2e-16 ***
factor(x\$quality)1	-0,773663	0,091016	-8,500	< 2e-16 ***
factor(x\$quality)2	0,534979	0,091016	5,878	5,72e-09 ***
factor(x\$offline)1	-0,971193	0,091016	-10,671	< 2e-16 ***
factor(x\$offline)2	0,251029	0,091016	2,758	0,00592 **
factor(x\$titles)1	-0,823045	0,091016	-9,043	< 2e-16 ***
factor(x\$titles)2	0,572016	0,091016	6,285	4,97e-10 ***
factor(x\$subscription)1	-0,144033	0,091016	-1,582	0,11386
factor(x\$subscription)2	0,004115	0,091016	0,045	0,96395

Signif. codes: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' 1

Residual standard error: 2,006 on 963 degrees of freedom

Multiple R-squared: 0,23, Adjusted R-squared: 0,2236

F-statistic: 35,96 on 8 and 963 DF, p-value: < 2,2e-16

```
[1] "Part worths (utilities) of levels (model parameters for whole sample):"
      levnms      utls
1  intercept  4,9712
2   standard -0,7737
3      high   0,535
4  lossless   0,2387
5  disabled -0,9712
6  playlists  0,251
7      full   0,7202
8 under_10k -0,823
9   b10_40k  0,572
10 over_40k  0,251
11  student -0,144
12     multi  0,0041
13   family  0,1399
[1] "Average importance of factors (attributes):"
[1] 28,34 29,92 22,76 18,99
[1] Sum of average importance: 100,01
[1] "Chart of average factors importance"
```

According to the obtained results from conjoint analysis method, standard (-0,77) quality of music, disables (-0,97) offline mode, under 10k (-0,82) titles and student (-0,14) type of subscription are also (like for BWS method) the least preferred levels of the used variables (cf. Figure 1). The most preferred levels of music quality are high (0,53) and lossless (0,24), which switch their rankings between both methods. Next most preferred attribute levels are the same: full (0,72) access to libraries, between 10k and 40k (0,57) titles and family (0,14) subscription. Similar to BWS method, also rest of unmentioned attribute levels: only playlists (0,25), over 40k (0,25) titles and multi device (0,004) subscription take second place:

```
> df<-data.frame(names=stream.levn,coef=0)
> coef<-stream.bws3.clm$coef
> df[1,2]=coef[1];df[2,2]=coef[2];
> df[4,2]=coef[3];df[5,2]=coef[4];
> df[7,2]=coef[5];df[8,2]=coef[6];
> df[10,2]=coef[7];df[11,2]=coef[8];
> df$type<-ifelse(df$coef>=0,"above","below")
> df$names<-factor(df$names,levels=rev(df$names))
> ggplot(df,aes(x=names,y=coef))+
+ xlab("Attributes' levels")+ylab("Probabilities")+
+ geom_bar(position='stack',stat='identity',width=.9,aes(fill=type))+
+ scale_fill_manual(values=c("above"="#9fc79a","below"="#C79a9a"))+
```

```

+ theme(legend.position='none',axis.title=element_text(size=12),
+ axis.text=element_text(size=12))+
+ geom_text(aes(label=round(coef,3),y=coef+.00),size=4)+
+ coord_flip()+geom_hline(yintercept=0)

> stream.ca.util<-caUtilities(stream.ca.pref,stream.ca.des, stream.ca.levn)
> util<-stream.ca.util[2:13]
> df<-data.frame(names=stream.ca.levn[1:12],util)
> df$type<-ifelse(df$util>0,"above","below")
> df$names<-factor(df$names,levels=rev(df$names))
> ggplot(df,aes(x=names,y=util))+
+ xlab("Attributes' levels")+ylab("Part-worth utilities")+
+ geom_bar(position='stack',stat='identity',width=.9,aes(fill=type))+
+ scale_fill_manual(values=c("above"="#9fc79a","below"="#C79a9a"))+
+ theme(legend.position='none',axis.title=element_text(size=12),
+ axis.text=element_text(size=12))+
+ geom_text(aes(label=round(util,3),y=util+.00),size=4)+
+ coord_flip()+geom_hline(yintercept=0)

```

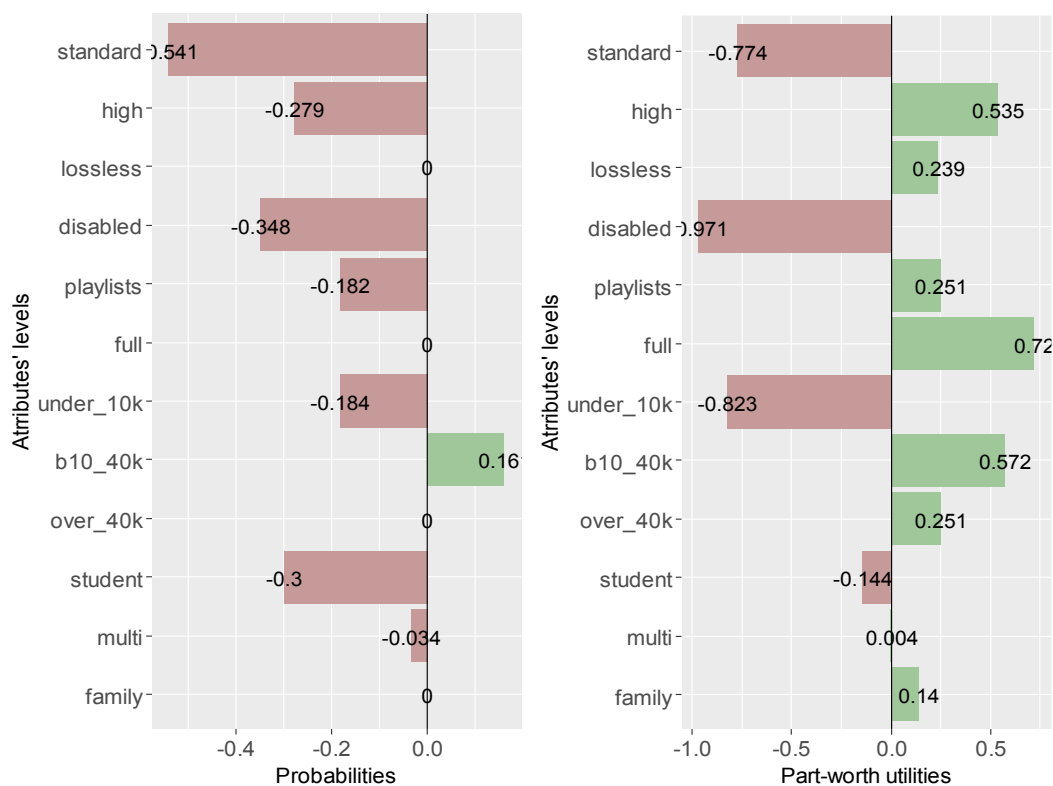


Figure 1. Probabilities (left) and part-worth utilities (right) of attribute levels.

Source: author's compilation using `support.BWS3` and `conjoint` R packages.

Since the results of Best-Worst Scaling method are based on probabilities while the conjoint analysis method uses utilities, a direct comparison of these results is inappropriate. In this case, the character of the preferences should be rather compared. Figure 2 shows the probabilities and part-worth utilities of attribute levels according to BWS model 1 and TCA with the reference levels being the last attribute levels. Figure 3 presents the same for BWS model 2, where the reference levels are the first attribute levels (BWS model 2):

```

> stream.bws3.model<-RES ~ high + lossless + playlists + full + b10_40k +
      over_40k + multi + family + strata(STR)
> stream.bws3.clm<-clogit(
+   formula=stream.bws3.model,
+   data=stream.bws3.dat)
> stream.bws3.clm
Call:
clogit(formula = stream.bws3.model, data = stream.bws3.dat)

```

	coef	exp(coef)	se(coef)	z	p
high	0.26238	1.30002	0.04823	5.440	5.33e-08
lossless	0.54137	1.71835	0.04940	10.959	< 2e-16
playlists	0.16533	1.17978	0.04824	3.427	0.00061
full	0.34768	1.41578	0.04864	7.147	8.84e-13
b10_40k	0.34520	1.41227	0.04845	7.124	1.05e-12
over_40k	0.18413	1.20217	0.04813	3.826	0.00013
multi	0.26685	1.30584	0.04841	5.512	3.55e-08
family	0.30042	1.35043	0.04834	6.215	5.13e-10

Likelihood ratio test=262.4 on 8 df, p=< 2.2e-16
n= 7776, number of events= 1296

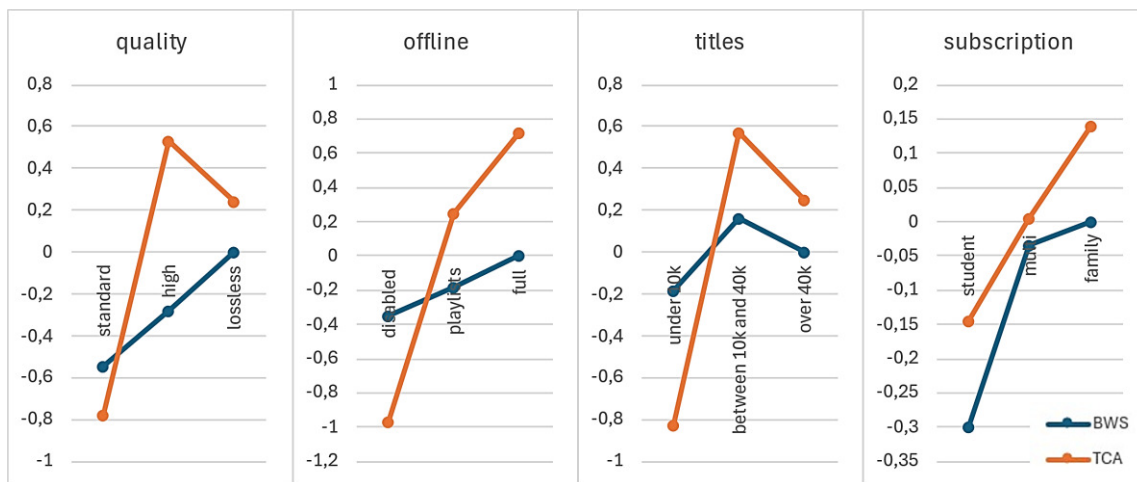


Figure 2. Probabilities and part-worth utilities of attribute levels – model 1.

Source: author's compilation using support.BWS3 and conjoint R packages.

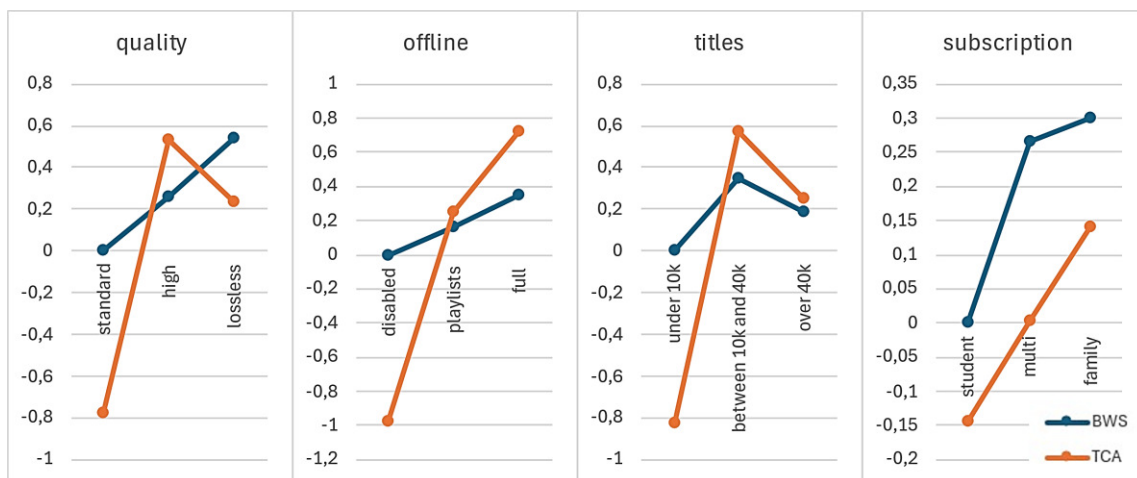


Figure 3. Probabilities and part-worth utilities of attribute levels – model 2.

Source: author's compilation using support.BWS3 and conjoint R packages.

The difference between Figures 2 and 3 lies in the vertical positioning of the BWS and TCA graphs, meaning that the shape of the graph is much more important than its location. As we can see, almost every pair of BWS and TCA preferences align closely, except for the previously noted switch between high and lossless levels of the music quality attribute.

What differs the most between the both methods is the importance of the attributes used in the study (cf. Figure 4). According to Best-Worst Scaling method, quality of music (40,42%) is the most important, the second place takes offline mode (26,11%). In contrast, traditional conjoint analysis identifies offline mode (29,92%) as the most important, with quality of music (28,34%) ranked on second place. The least important attribute in both methods is the type of subscription (16,46% in BWS / 18,99% in TCA):

```
> coef<-abs(stream.bws3.clm$coef)
> impo<-c(mean(coef[1:2]),mean(coef[3:4]),mean(coef[5:6]),mean(coef[7:8]))
> stream.bws3.impo=impo/sum(impo)*100
> stream.ca.impo=caImportance(stream.ca.pref,stream.ca.des)
> df=data.frame(names=names(stream.bws3.ffd),stream.bws3.impo)

> df$names<-factor(df$names,levels=c("quality","offline","titles","subscription"))
> ggplot(df,aes(x=names,y=stream.bws3.impo))+
+ xlab("Attributies")+ylab("Importance [%]")+
+ geom_bar(stat='identity',width=.9,fill="#9fc79a")+
+ theme(legend.position="none",axis.title=element_text(size=12),
+ axis.text=element_text(size=12))+
+ geom_text(aes(label=round(stream.bws3.impo,3),y=stream.bws3.impo+.00),size=4)+
+ geom_hline(yintercept=0)

> df=data.frame(names=colnames(stream.ca.des),stream.ca.impo)
> df$names<-factor(df$names,levels=c("quality","offline","titles","subscription"))
> ggplot(df,aes(x=names,y=stream.ca.impo))+
+ xlab("Attributies")+ylab("Importance [%]")+
+ geom_bar(stat='identity',width=.9,fill="#9fc79a")+
+ theme(legend.position="none",axis.title=element_text(size=12),
+ axis.text=element_text(size=12))+
+ geom_text(aes(label=round(stream.ca.impo,3),y=stream.ca.impo+.00),size=4)+
+ geom_hline(yintercept=0)
```

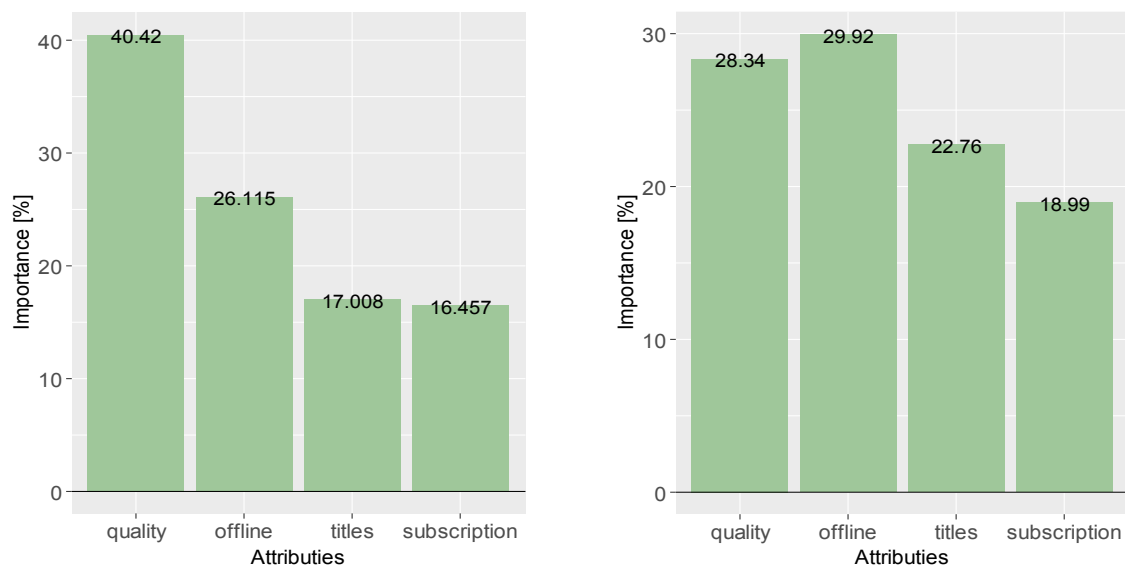


Figure 4. Importance of attributes according to BWS (left) and TCA (right).

Source: author's compilation using `support.BWS3` and `conjoint` R packages.

5. Discussion

Both conditional logit models show consistent trends, with streamers clearly preferring higher and lossless music quality, family subscription plan and access to full playlists. According to both models, a library between 10k and 40k titles is considered sufficient. The key distinction between the models is in how the results are presented. BWS model 1 emphasizes the negative aspects of less preferred options, while BWS model 2 highlights the positive aspects of more preferred choices.

The results indicate that both BWS and TCA models fit the data equally well, as confirmed by the identical likelihood ratio test (Likelihood ratio test = 262,4, p-value < 2,2e-16) and F-statistic test (F-statistic test = 35,96, p-value < 2,2e-16). It means that regardless of the chosen reference method, the analysis leads to similar conclusions regarding streamers' preferences.

A closer analysis of both models indicates that in BWS model 1, the multi device level of subscription type variable has a p-value of 0,47. It means that the effect is not statistically significant (p-value > 0,05). In TCA model both subscription factors – student (p-value of 0,12) and multi device (p-value of 0,96) are also not statistically significant.

A potential solution could be measurement of preferences after dividing respondents into homogeneous segments (Henig, 2024). The simple clustering music streamers using *k*-means method confirm 3 separately classes which can correspond with levels (student, multi, family) of subscription attribute (cf. Figure 5):

```
> stream.ca.segm<-caSegmentation(stream.ca.pref,stream.ca.des,c=3)
> summary(stream.ca.segm)
      Length Class  Mode
segm     9      kmeans list
util 972      -none- numeric
sclu 108      -none- numeric
> plotcluster(stream.ca.segm$util,stream.ca.segm$sclu)
> stream.ca.dcf<-discrcoord(stream.ca.segm$util,stream.ca.segm$sclu)
> assignments<-augment(stream.ca.segm$segm,stream.ca.dcf$proj[,1:2])
> ggplot(assignments)+geom_point(aes(x=X1,y=X2,color= .cluster))+
+ labs(color="Class Assignment",title="Clustering Results")
```




Figure 5. Segmentation of music streamers.

Source: author's compilation using `conjoint` R package.

6. Conclusions

The paper explores the application of Best-Worst Scaling and conjoint analysis methods in the measurement and analysis of stated preferences. The objectives of the paper were to assess the music streamers' preferences, compare the results of both used methods and demonstrate the cooperation of `support.BWS3` and `conjoint` R packages as complementary analytical tool.

The research results showed that music streamers indicate different importance of streaming attributes and attribute levels. Although the importance of attributes differs in percentage terms, according to both methods, the most important for respondents are quality of music and offline mode, while the least important are the number of titles and type of subscription. In the case of attribute levels, the most attractive are full access to libraries of 10-40 thousand songs, family subscription type and high or lossless music quality. In the case of these two levels, the results switch their rankings between both methods. According to the results of all models, respondents indicate standard music quality, disabled offline mode, number of songs under 10k and student subscription type as the least attractive levels.

Using the R packages the probabilities and part-worth utilities of attribute levels according to both BWS and TCA models with different reference levels were calculated. The character of almost all pair of attribute levels are similar. It means that the confrontation of the results confirmed the compatibility of conclusions from both used methods.

The paper also demonstrates that combining used R packages allows for measurement and analysis of preferences, making it useful for practitioners, researchers and students in the fields of marketing research, in particular in the area of measurement of consumers' preferences. In particular, streaming companies, manufacturers of playback equipment, artist and record labels as well as marketers should be interested in the research results.

Streaming platforms can use the research results to adjust their subscription plans, focusing on higher music quality and comprehensive offline access. Offering lossless music as a standard or premium option could serve as a competitive advantage. Additionally, emphasizing family subscription plans over student or multi device options may increase customer retention.

Manufacturers can capitalize on the demand for high quality music by promoting devices that support lossless formats. Partnering with streaming services to offer promotional packages with access to high quality music can increase user adoption and brand loyalty.

Record labels should prioritize offering catalogs in lossless quality rather than simply expanding their song libraries. Investing in high quality recording and production can provide a more compelling listening experience, aligning with consumer demand for superior sound quality.

Marketing strategies should emphasize user convenience, premium music quality, and offline access as key selling points. Campaigns should target families rather than just individual users, highlighting cost savings and shared access benefits. Furthermore, leveraging social media influencers and music enthusiasts to demonstrate the advantages of high quality music can increase engagement and consumer trust.

The paper leaves room for further exploration. There are more methods of measurement of stated preferences and more R packages for them. The research suggests potential for future studies to explore more about the music streamers' preferences.

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STRENGTHS USE, DEFICIT CORRECTION, AND WORKLOAD IN ONSITE, HYBRID, AND REMOTE WORK

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Purpose: We applied the Strengths Use and Deficit Correction (SUDCO) model to compare employee developmental efforts and developmental opportunities in onsite, hybrid, and remote work models. The aim of this study was to investigate whether the SUDCO elements – such as strengths use, deficit correction, perceived organizational support (POS) for strengths use, perceived organizational support (POS) for deficit correction – and quantitative workload vary among onsite, hybrid, and remote employees. Moreover, the relationships between workload and the elements of the SUDCO model were tested in the total sample.

Design/methodology/approach: We examined 129 Polish employees working in distinct work models within an online cross-sectional study. The participants provided sociodemographic data, reported their current work model, and completed two self-report measures – the Quantitative Workload Inventory (QWI) and the Strengths Use and Deficit COrrrection (SUDCO) questionnaire.

Findings: Remote employees reported lower workload and higher deficit correction and POS for deficit correction than onsite employees. We found no significant correlations between workload and the four components of the SUDCO model.

Research limitations/implications: Our findings suggest better-perceived working conditions in terms of the lower amount of one's work, higher developmental opportunities, and more proactive behaviors aimed at reducing own incompetencies in remote work than onsite work. Workload emerged as not a crucial job demand that contributed to the employees' developmental efforts and perceived organizational support for them. As our study is based on a relatively small sample collected through the snowball sampling method during the COVID-19 pandemic, the results should be replicated in the future in post-pandemic conditions on a larger sample.

Practical implications: Our findings could support managers and HR practitioners in providing more effective employee development strategies and accurate assessment of employee potential. Moreover, the understanding that onsite, hybrid, and remote work arrangements offer distinct development opportunities might help the employees make more conscious vocational choices.

Originality/value: This study adds to our knowledge of differences in using individual's potential, developmental efforts, developmental opportunities, and workload among onsite, hybrid, and remote employees. The use of the integrative SUDCO model broadens the perspective of analyzing distinct work models thanks to involving both strengths- and deficit-based approaches.

Keywords: strengths use, deficit correction, workload, hybrid work, remote work.

Category of the paper: research paper.

1. Introduction

The fully remote and hybrid work models gained popularity in the workplace during the COVID-19 pandemic (Socolic, 2022). Since then, the organizational literature has mainly focused on the potential negative consequences of working remotely or hybrid and made recommendations regarding the most effective management practices or work designs in flexible work arrangements (Lamovšek et al., 2025; Wontorczyk, Rożnowski, 2022). In contrast, little emphasis has been placed on the differences in the employees' developmental perspectives and proactive organizational behaviors directed to ensure professional growth within distinct work models. Therefore, the current study aimed to shed new light on the competence development opportunities and developmental efforts in the onsite, hybrid, and remote work models. Based on the Strengths Use and Deficit Correction (SUDCO; van Woerkom et al., 2016) model arising from the positive organizational scholarship, we examined how onsite, hybrid, and remote work arrangements differ in strengths use, deficit correction, perceived organizational support (POS) for strengths use, and perceived organizational support (POS) for deficit correction.

In addition, we included in our study quantitative workload (i.e., the amount of one's work) due to the prevalence of this organizational stressor (especially within the remote and hybrid work models) and its potential detrimental role in employee's functioning at work (Bowling, Kirkendall, 2012; Grzegorzczak et al., 2021). Excessive quantitative workload involves so many job tasks that it might lead to partial goal blocking and neglecting some elements of the job and life (Spector, Jex, 1998). Thus, as a form of job demand, workload may hamper employees' developmental initiative, add to the perceptions of the workplace as unsupportive, and differ in onsite, hybrid, and remote workers. Therefore, we also tested whether the quantitative workload is related to the four elements of the SUDCO framework and differentiates those working within various work models.

This study focuses on the understudied aspects of working within distinct work models regarding the active organizational behaviors aimed at fulfilling one's potential at work and organizational support for employee developmental efforts. In particular, prior research has not tested the differences in the SUDCO elements among onsite, hybrid, and remote workers despite plausible disparities in employee developmental initiative and developmental opportunities in distinct work arrangements. Thus, this study fills the gap in the organizational science literature by testing whether onsite, hybrid, and remote employees vary in applying their strong points at work, reducing deficiencies, and perceived organizational support for such

proactive behaviors in the workplace. In addition, the present research proposes a new multidimensional approach, arising from positive organizational psychology, in analyzing the differences among onsite, hybrid, and remote work models. Applying the integrative SUDCO framework, including strengths and deficits at work, improves understanding of distinct aspects of using one's competencies, reducing incompetence, and receiving organizational support for developmental efforts in various work models.

The present study also broadens our knowledge about job demands – represented by workload – that might potentially diminish developmental efforts and opportunities among onsite, hybrid, and remote workers. Previous studies have not examined the relationships between quantitative workload and the SUDCO elements. However, this job demand might hinder employee developmental initiative and make the workplace unsupportive. Furthermore, differences in job characteristics among onsite, hybrid, and remote work might contribute to higher workload in some work models (Lamovšek et al., 2025; Wontorczyk, Rożnowski, 2022). Despite this, previous research has not directly focused on differences in workload among onsite, hybrid, and remote employees. Hence, this study tested whether the quantitative workload is related to diminished levels of the SUDCO components and varies among employees working within distinct work arrangements. The findings might increase awareness of potential organizational factors contributing to lower strengths use, deficit correction, POS for strengths use, and POS for deficit correction among organizational researchers and practitioners.

1.1. Onsite, hybrid, and remote work models

In recent years, the nature of work has dramatically changed due to digital transformation caused by the dissemination of information and communication technologies (ICT) in organizations. These new communication tools made it possible to perform job tasks outside the organization's physical location, leading to the popularization of novel forms of work, such as hybrid and remote work, constituting the alternative to traditional onsite work (Lamovšek et al., 2025). The COVID-19 pandemic, due to the sanitary restrictions, had provided an additional impulse for the shift in organizations from onsite work to hybrid and remote work practices (Ingusci et al., 2021; Sokolic, 2022). In the post-pandemic era, alternative work models have become widespread (Vartiainen, Vanharanta, 2024).

Both remote and hybrid work represent flexible work arrangements, as described in earlier publications, such as telework or working off-site (outside the organization premises), within which the employees can work from home and use some ICT. Fully remote work, which involves working only outside the company's location, appeared before the COVID-19 pandemic. It brings benefits (i.e., lack of commuting, higher autonomy, work-life balance, and productivity) as well as potential dangers (i.e., higher workload, longer working hours, and work-life interference) for employees and organizations (Grzegorzczak et al., 2021).

In turn, hybrid work mixes or blends onsite and remote work due to operating both in the physical space (i.e., outside the main workplace) and virtual space (i.e., using ICT). It shares with remote work virtuality due to the use of ICT. However, compared to remote work, hybrid work has additional characteristics, such as flexibility, adaptability, and autonomy in organizing physical and temporal spaces. Thus, hybridity enables an employee to make individualized, flexible work arrangements in time and space, taking into account the employer's goals and employee needs (Vartiainen, Vanharanta, 2024).

Both remote and hybrid work arrangements are contrasted with traditional onsite work, which lacks autonomy and flexibility due to performing work in the workspace, often within a fixed schedule. These differences in the job characteristics of work models might translate into disparities in organizational outcomes, including employee attitudes, behaviors, and perceptions of the workplace (Wontorczyk, Rożnowski, 2022). Consequently, we compared onsite, hybrid, and remote work models with regard to proactive behaviors (i.e., strengths use and deficit correction) and POS for such employee actions. As prior research has mainly focused on differences in task performance (Lamovšek et al., 2025), work engagement, and stress among those working within distinct models (Uru, Gozukara, Tezcan, 2022; Wontorczyk, Rożnowski, 2022), we applied the SUDCO model to provide an integrative view on developmental perspectives and efforts in onsite, hybrid, and remote work arrangements.

1.2. Strength-based and deficit-based approaches in the workplace

Strengths and deficits encompass the contrasting constructs, describing the positive and negative sides of human functioning (van Woerkom et al., 2016). In line with the salutogenic perspective, positive organizational psychology highlights strengths and their role in psychological well-being, health, and optimal functioning of an individual at work. In turn, the employee's weaknesses (or deficits) are emphasized in a traditional pathogenic approach, which focuses on preventing dysfunction and disease (Bakker, van Woerkom, 2018). As a result, standard positive prevention and interventions aim to use, develop, and enhance strengths rather than diminish or improve weaknesses (Seligman, 2002). This approach contrasts with the tendency in most organizations to create a deficit culture by taking employees' strengths for granted and focusing on improving their weaknesses. Accordingly, developing one's strengths in the organization rather than minimalizing his or her deficits is usually considered a way to excel instead of avoid failure at work in positive organizational psychology (Miglianico et al., 2020). In line with this view, strengths use is usually considered more important for employees' optimal functioning in the workplace than deficit correction due to its role in regulating motivation through need satisfaction (Gradito Dubort, Forest, 2023).

Nevertheless, some positive organizational scholars have recently suggested the equal importance of strengths-based and deficit-based approaches (Els Mostert, Brouwers, 2016; Mostert, van Woerkom, 2018). According to this newer approach, minimalizing weaknesses and applying strengths constitute complementary actions directed at employee growth and

development. Consequently, strengths use and deficit correction are postulated to be analyzed simultaneously within the same theoretical framework as positive, socially desirable organizational behavior, which helps to achieve organizational goals, limit organizational demands, and develop one's competencies (Stander, Mostert, 2013).

1.2.1. The Strengths Use and Deficit COrrrection Model

The Strengths Use and Deficit COrrrection (SUDCO) model advanced by Marianne van Woerkom et al. (2016) responds to this conceptual proposal. In particular, the SUDCO theoretical framework integrates or balances the salutogenic and pathogenic perspectives by referring to individual strengths and deficits. This model defines strengths as "specific individual characteristics, traits, and abilities that, when employed, are energizing and allow a person to perform at his or her personal best" (van Woerkom et al., 2016, p. 960). This broad definition includes different types of strengths (i.e., personal, psychological, and physical) and enables participants to give their meaning for strengths (Wood et al., 2011). In turn, deficits (deficiencies, weaknesses) are considered as "'ways of behaving, thinking, or feeling which do not come natural to an individual, which he or she does not enjoy doing, but in which he or she can achieve competent functioning if trained accordingly" (van Woerkom et al., 2016, p. 960). Both strengths and deficits are considered equally important for ensuring an employee's optimal functioning and positive organizational outcomes. Thus, they are simultaneously recognized within the SUDCO model, which combines the strengths-based and deficit-based approaches to human functioning (Els, Mostert, Brouwers, 2016; Mostert, van Woerkom, 2018).

1.2.2. Strengths use and deficit correction in the workplace

According to the SUDCO framework, an employee might undertake two types of proactive organizational behavior – strengths use and deficit correction. Strengths use is related to the personal initiative to use (or apply) one's strong points (strengths) in the workplace. For instance, it might manifest at work by actively choosing by the employees, who are aware of their competencies, the additional job tasks that allow them to use these competencies most effectively at work. In contrast, deficit correction entails the personal initiative of correcting (or improving) one's deficits at work (van Woerkom et al., 2016). In other words, deficit correction behaviors reflect employees' active efforts aimed at their personal development at work (Meyers et al., 2015). Accordingly, deficit correction includes gaining new skills, acquiring or increasing competencies, and decreasing own areas of incompetence. For instance, an employee might deliberately choose job tasks and organizational situations to practice his or her skills to reduce a competency gap (van Woerkom et al., 2016).

Strengths use and deficit correction encompass agentic work behaviors which contribute to the employees' thriving and optimal functioning in the workplace (Moore, Bakker, van Mierlo, 2022). In particular, strengths use has been widely examined in the positive organizational scholarship with regard to a wide range of favorable organizational and individual consequences. For instance, strengths use was related to increased work performance, job satisfaction, work engagement, psychological well-being, proactivity in the workplace,

sense of meaning at work, helping behaviors, and lower counterproductive behaviors, absenteeism, and stress (Bakker, van Woerkom, 2018; Miglianico et al., 2020). In addition, strengths interventions aimed at identifying and promoting strengths use and/or development were recognized as crucial for fostering socially desirable organizational outcomes at the individual-, group-, team-, and organizational levels (Ghielen, van Woerkom, Meyers, 2018). Accordingly, meta-analysis indicated their effectiveness in developing human potential at work thanks to increasing employees' personal resources, job performance, workplace, and general well-being (Virga et al., 2023).

In contrast, only single studies have focused on the consequences of deficit correction for employees and organizations. Their results indicated that – similarly to strengths use, but in some cases with lower strength – deficit correction positively predicted such favorable organizational outcomes as thriving (Rothmann, Mahomed, 2019), psychological well-being, task performance, and contextual performance (Gradito Dubort, Forest, 2023). Consequently, both strengths use and deficit correction were identified as essential for positive work outcomes. Therefore, promoting them simultaneously in the workplace using the combined approach was recommended as the most effective way of increasing employee's optimal functioning at work (Mostert, Els, van Woerkom, 2018). Following this suggestion, we analyzed both strengths use and deficit correction in our study.

1.2.3. Perceived organizational support (POS) for strengths use and deficit correction

Strengths use and deficit correction at work depend on the employee's efforts and organizational support (Els, Mostert, Brouwers, 2016). Thus, the SUDCO model distinguishes two additional aspects referring to the organizational context – perceived organizational support (POS) for strengths use and perceived organizational support (POS) for deficit correction. POS for strengths use is defined in terms of employees' subjective evaluations of the active organizational support to use strengths at work. In organizational practice, it might consist of assigning tasks to an employee that fit his or her strong points. Conversely, POS for deficit correction concerns the employees' subjective perceptions of the range of organizational support for improving their own deficiencies at work. For example, it might manifest itself in providing the employees with training, coaching, or other learning opportunities, which help them better perform tasks (van Woerkom et al., 2016).

POS for strengths use and POS for deficit correction constitute the job resources that might be crucial to successful personal development in the workplace and realizing the full potential of an employee (Stander, Mostert, 2013). Accordingly, previous findings indicate the decisive role of employees' belief that the organization supports their proactive organizational behaviors, such as strengths use and deficit correction. Within the SUDCO framework, POS for strengths use was reported to be a positive predictor of strengths use (Luan et al., 2023). Likewise, POS for deficit correction was strongly related to higher deficit correction (Lorenz et al., 2021; van Woerkom et al., 2016).

Through the broader lens of the organizational support theory, both forms of POS embody employees' attributions concerning their favorable or unfavorable treatment by the organization (Kurtessis et al., 2017) concerning personal growth opportunities (Moore, Bakker, van Mierlo, 2022). Consequently, in line with the social exchange theory and the norm of reciprocity, POS could lead to increased performance, loyalty, and job-related efforts, which the employees treat as a trade-off for job resources and benefits offered by the organization (Kurtessis et al., 2017). In line with this view, better investigated POS for strengths use positively predicted favorable work-related outcomes, including higher work engagement (Meyers et al., 2020), task performance, and innovative behavior (Ding, Yu, Li, 2022). It was also related to subjective and objective organizational performance via turnover intention, work engagement, and job performance (Mubashar, Harzer, 2022). In addition, POS for strengths use was identified as an organizational factor contributing to thriving at work due to giving the employees opportunities for professional development (Moore, Bakker, van Mierlo, 2022).

However, despite the greater research focus on the positive personal and organizational consequences of POS for strengths use, some researchers postulate the combined approach, in which both types of POS are equally valued and developed. Accordingly, ensuring high levels of POS for strengths use and POS for deficit correction in the working environment simultaneously was identified as essential for positive work outcomes, such as greater work engagement, learning, job satisfaction, and lower turnover intention (Els, Mostert, Brouwers, 2016). Following this recommendation, both forms of POS were considered as equivalent and simultaneously examined in this study.

1.2.4. The SUDCO framework in different work models

To date, the whole SUDCO model and its single elements have been investigated in the organizational context in relation to distinct organizational variables. Following a strengths-use approach, prior studies have mainly focused on the potential individual and organizational antecedents and consequences of strengths use at work (Bakker, van Woerkom, 2018). Relatively less research has examined the remaining elements of the SUDCO framework, despite their role in employees' professional growth and fulfilling their potential at work (van Woerkom et al., 2016). Furthermore, no research has been conducted on the differences among employees working within distinct work models (i.e., onsite, hybrid, and remote) in strengths use, deficit correction, POS for strengths use, and POS for deficit correction.

Nevertheless, different job characteristics in individual work models might contribute to discrepancies in developmental efforts and opportunities for professional growth among onsite, hybrid, and remote workers. In other words, distinct work models vary in terms of the perceived features of the work situation (Wontorczyk, Rożnowski, 2022), which might translate into differences in the SUDCO elements. More specifically, onsite work practices lack some appreciated job resources, including flexibility, autonomy, and job control. In contrast, remote work provides higher time control, autonomy at work, work-life balance, and lower stress (Uru, Gozukara, Tezcan, 2022). Similarly to remote work practices, hybrid work offers high

autonomy (Vartiainen, Vanharanta, 2024). Accordingly, in the study comparing work characteristics in those working within distinct working arrangements, fully onsite workers reported lower job control than hybrid workers (Wontorczyk, Rożnowski, 2022).

However, strengths use is positively associated with such valuable job resources as learning opportunities and autonomy at work. Employees, empowered at work due to higher autonomy and participation in decision-making, receive more training opportunities. Consequently, they are more engaged and apt to apply their strong points at work (Bakker, van Woerkom, 2018). Job autonomy also seems to be important for undertaking developmental initiatives, which are core for deficit correction (van Woerkom et al., 2016). In particular, onsite workers – who have limited control over how they perform their work – might not only be less likely to demonstrate their own strong points at work but also to less frequently actively engage in working on their own weaknesses. Consequently, given the differences in the characteristics of different work models, we expected that strengths use and deficit correction would be higher among remote and hybrid employees than onsite employees.

POS for strengths use and POS for deficit correction might also vary among distinct work models. In general, employees give a symbolic meaning to organizational support, treating it as an indicator that the organization values them and takes care of their well-being. Distinct forms of support (organizational, supervisor, coworkers, and technological) were identified as particularly important for remote and hybrid workers, who face different challenges resulting from new, flexible ways of work. For instance, working from home evoked the need to cope with new digital tools, multitasking, the imbalance between career and personal life, and a lack of physical contact with supervisors and other organization members. These changes in work practices, which have become more intense due to the COVID-19 pandemic, force the necessity of a holistic approach to organizational support from managers to ensure effective full and part-time remote work (Errichiello, Pianese, 2021). Prior research supported the role of organizational and managerial support in remote work as an external job resource strengthening positive organizational outcomes (Buonomo et al., 2024; Chatterjee, Chaudhuri, Vrontis, 2022; Brown, Leite, 2023) and alleviating psychological stress arising from remote work (Deepa, Dharshini, 2024). Organizational practitioners are becoming more conscious of the importance of different forms of organizational support in the remote and hybrid work models (Errichiello, Pianese, 2021), which might translate into their higher support for strengths use and deficit correction in the alternative work models than in the onsite work. Moreover, more favorable perceptions of the work characteristics, such as job control, among remote and hybrid employees (Wontorczyk, Rożnowski, 2022) might also contribute to their greater POS for strengths use and POS for deficit in comparison to onsite employees.

1.3. Workload

In occupational health psychology, workload is defined in terms of an individual's subjective perception of their work or as an objective construct, essentially free from personal subjective evaluations. It might take various forms, from quantitative (referring to the amount of one's work) and qualitative (reflecting the difficulty of one's work) to mental (mainly leading to physical illness) and physical (primarily resulting in physical illness) (Bowling, Kirkendall, 2012).

In this study, we analyzed quantitative workload, which is understood as a perceived quantity (amount) of employees' work concerning the pace of volume. This type of workload generally reflects how much work is required from an employee and refers to task characteristics rather than interpersonal relations at work (Spector, Jex, 1998). Quantitative workload represents a job demand, including the need to work fast, multitask, provide quick responses, and simultaneously complete distinct projects (Ingusci et al., 2021).

Regardless of its manifestations, excessive workload (overload) is widely recognized as a severe organizational stressor, bringing negative personal and organizational consequences. In particular, meta-analysis indicated that workload was negatively related to psychological and psychical well-being and affective organizational commitment and positively – to turnover intention, absenteeism, and emotional withdrawal (Bowling et al., 2015). Given the detrimental effects of excessive workload on employees' functioning at work, workload is postulated as a matter of concern for organizational researchers and practitioners (Bowling, Kirkendall, 2012).

1.3.1. *Workload in relation to the SUDCO components*

To date, little research has analyzed only some aspects of the SUDCO model (such as strengths use and POS for strengths use) with regard to organizational stressors or job demands, such as workload (van Woerkom, Bakker, Nishii, 2016). No studies have been conducted on the relationships between quantitative workload and all components of the SUDCO framework, despite the significant role of workload in predicting proactive organizational behaviors (Sonnentag, Spychala, 2012) and perceived organizational support (Bowling et al., 2015).

The potential associations between workload and different aspects of the SUDCO model might stem from limited autonomy and development opportunities linked with excessive workload, which might hamper strengths use and deficit correction (c.f., Bakker, van Woerkom, 2018). In general, quantitative workload refers to the amount of one's work (Bowling et al., 2015), reflecting the number of job tasks and job requirements specific to a given job (Spector, Jex, 1998). As some jobs inherently have higher or lower job autonomy and learning opportunities, they offer distinct chances for undertaking proactive behaviors aimed at professional development, such as strengths use and deficit correction in organizations (Bakker, van Woerkom, 2018). Furthermore, heavy quantitative workload is accompanied by time pressure and/or task overload. Such job conditions might make the employee concentrate on

urgent tasks instead of engaging time and energy in developmental efforts (Bowling et al., 2015). Consequently, those who experience excessive workload in their job could be less prone to invest in their professional growth by actively undertaking proactive behaviors directed to apply own competencies and reduce areas of incompetence at work. Thus, increased workload would be related to diminished strength use and deficit correction.

In addition, high job demands represented by work overload might foster more negative employees' perceptions of the working environment as supportive. Consistently, meta-analysis showed that workload was negatively associated with perceived supervisor support and coworker support (Bowling et al., 2015). Therefore, employees who experience higher workload might perceive fewer chances to do their best at work and evaluate their organization as less supportive and taking care of their professional development. As a result, they might report diminished POS for strengths use and POS for deficit correction. Accordingly, we expected that quantitative workload would be negatively related to strengths use, deficit correction, POS for strengths use, and POS for deficit correction.

1.3.2. Workload in different work models

Quantitative workload refers to the number of job tasks to make (Spector, Jex, 1998). However, it might vary within different work models, which have various job demands or job characteristics (Lamovšek et al., 2025). Remote work could be particularly endangered by work overload due to the accompanying potential imbalance between work and personal lives (Wontorczyk, Rożnowski, 2022). Work overload (encompassing workload and techno overload) was indicated in prior research as a common problem among remote employees, in particular during the COVID-19 crisis. The rapid changes in work practices due to the pandemic (i.e., longer or modified working hours, a need to work faster due to the use of information and communication technology) have enhanced job demands, including perceived workload, within remote workers. Remote employees were also at higher risk of techno-overload, referring to the excessive workload caused by the use of technology, including longer hours and a faster pace of work than usual (Ingusci et al., 2021).

Similarly, hybrid work – as partially located in the remote workspace – contributes to higher workload, longer working hours, and interference of work in personal. In particular, asynchronous communication (mainly via e-mail), popular in hybrid work, enhances distractions at work. Furthermore, digital communication includes different tools and applications, which forces constant availability. Both aspects of communication increase overload within the hybrid work model (Grzegorzczak et al., 2021).

In turn, onsite work is related to a less stimulating work environment, as job complexity is characteristic of flexible work arrangements. As overload accompanies more complex jobs with a wider variety of tasks (Lamovšek et al., 2025), onsite workers might be less exposed to excessive workload than those working remotely or hybrid.

2. Methods

2.1. Research objectives

This study had two aims. The primary aim was to calculate the differences in workload and the SUDCO model components among the three groups of employees, depending on how they perform their work: onsite, hybrid, and remote. In addition, we tested the direct relationships between workload and the elements of the SUDCO model: strengths use behavior, deficit correction behavior, POS for strengths use, and POS for deficit correction. The study was conducted within a broader research project on the correlates of strengths use and deficit correction in the workplace, which received the prior approval of the Ethics Committee of the University of Silesia in Katowice (the number of approval: KEUS.69/01.2021).

2.2. Participants and procedure

In this study, the data was collected from 132 working adults from the Polish general population. Three individuals were removed from the original database, as they were sent on unpaid leave by the employer and were not actively performing work when the study was conducted. As a result, the final sample comprised 129 participants. To estimate the effect size for the sample consisting of 129 participants and $\alpha = 0.05$ in a one-way omnibus ANOVA with fixed effects, we conducted post hoc power analysis in the G*Power version 3.1 software. Its result showed that the sample, including 129 respondents, had excellent power of 99% to detect large effect sizes ($f = 0.40$) and power of 71% to detect medium effect sizes ($f = 0.25$).

In the final sample, 100 (77.5%) individuals were women, and 29 (22.5%) – were men. On average, the respondents were 28.47 years old ($SD = 8.48$, $Me = 25$), ranging from 18 to 58 years. The sample was diverse in terms of the occupational areas of the respondents, including education, information technology, business, public services, and others. The average organizational tenure was 3.43 years ($SD = 4.28$, $Me = 2$), with a maximum value of 21 years and a minimum of less than one year. The average number of their working hours per week was 34 ($SD = 20.68$, $Me = 40$). With regard to the form of employment in the current workplace, 36.4% of participants were working under a permanent employment contract, 31% – under a civil law contract (including mandate contract, contract for a specific work, agency agreement, and management contract), 21.7% under a fixed-time employment contract (including a replacement contract), 6.8% were running one's own business, and the remaining 4.7 % were working under other forms of work. The size of the organizations employing the respondents (determined based on the number of their employees) was differentiated. Most of the participants were working in large enterprises with more than 250 employees (28.7%), followed by 27.1% of respondents working in small enterprises (having from 10 to 49 employees), 24% working in micro-enterprises (having less than 10 employees), and the remaining 20.2% were working in medium-sized enterprises (having from 50 to 249 employees).

With regard to the work model, 68 individuals (52.7%) were working onsite, 36 (27.9%) – were working within the hybrid work model, and 25 (19.4%) – were working remotely. None of the respondents declared working under the alternative work model by selecting the option "No of the above" regarding their current way of work.

Table 1 presents the sociodemographic characteristics of the total sample and the three subgroups analyzed in this study.

Table 1.

The sociodemographic characteristics for the total sample and the employees working within onsite, hybrid, and remote work models

Variable	Total sample (N = 129)	Onsite (n = 68)	Hybrid (n = 36)	Remote (n = 25)	Between-group differences		
	n/M(%/SD)	n/M(%/SD)	n/M(%/SD)	n/M(%/SD)	χ^2	F	p
Age (in years)	28.47 (8.48)	27.96 (8.82)	28.17 (8.53)	30.32 (7.47)	–	0.74	0.479
Sex					2.21	–	0.331
women	100 (77.5%)	51 (75%)	31 (86.1%)	18 (72%)			
men	29 (22.5%)	17 (25%)	5 (13.9%)	7 (28%)			
Organizational tenure (in years)	3.43 (4.28)	3.43 (4.40)	3.38 (4.36)	3.52 (3.99)	–	0.01	0.992
Working hours per week	34 (20.68)	34.65(25.83)	33.64(12.81)	32.72(13.21)		0.09	0.917
Type of work contract					6.57	–	0.584
permanent work contract	47 (36.4%)	23 (33.8%)	12 (33.3%)	12 (48%)			
fixed-time employment contract	28 (21.7%)	16 (23.5%)	8 (22.2%)	4 (16%)			
civil work contract	40 (31.0%)	22 (32.4%)	12 (33.3%)	6 (24%)			
own business	8 (6.2%)	3 (4.4%)	4 (11.1%)	1 (4%)			
other	6 (4.7%)	4 (5.9%)	0	2 (8%)			
Size of the organization					23.98	–	0.020
micro-enterprise (less than 10 employees)	31 (24.0%)	20 (29.4%)	7 (19.4%)	4 (16%)			
small enterprise (from 10 to 49 employees)	35 (27.1%)	23 (33.8%)	7 (19.4%)	5 (20%)			
medium-sized enterprise (from 50 to 249 employees)	26 (20.2%)	11 (16.2%)	12 (33.3%)	3 (12%)			
large enterprise (more than 250 employees)	37 (28.7%)	14 (20.6%)	10 (27.8%)	13 (52%)			

Source: Own study.

The results of the one-way analysis of variance (ANOVA) and Chi-square test (χ^2) demonstrated that most sociodemographic characteristics did not differentiate between onsite, hybrid, and remote employees. Based on the ANOVA, no significant differences between the three compared groups of employees were found in age ($F(2,126) = 0.74$, $p = 0.479$), organizational tenure ($F(2,126) = 0.01$, $p = 0.992$), and working hours ($F(2,126) = 0.09$,

$p = 0.917$). The chi-square test (χ^2) showed no significant differences between those working within distinct work models with regard to sex ($\chi^2 = 2.21, p = .331$) and type of work contract ($\chi^2 = 6.57, p = 0.584$). The only sociodemographic variable differentiating the three analyzed subgroups was the organization's size, described in terms of the number of employees ($\chi^2 = 23.98, p > 0.05$).

The data was collected using the snowball sampling method. The respondents were invited to participate in an online study on the psychological aspects of strengths use in the workplace. Initial participants were recruited via social media (Facebook) and e-mail and included working adults from the Polish general population who differ in sociodemographic characteristics. To provide the diverse snowball sample, they were asked to distribute the study invitation within different social networks, including professional contexts, online platforms, and local communities. Participation in the study was anonymous, voluntary, and without financial compensation. The study was conducted on the Lime Survey research platform and took about 15 minutes. After giving written informed consent to participate in the study, the respondents were asked about the basic sociodemographic data and gave responses in the self-report measures. The study was conducted into a broader research project concerning the organizational and individual correlates of strengths use and deficit correction at work.

2.3. Measures

The Quantitative Workload Inventory (QWI; Spector, Jex, 1998; the Polish adaptation: Baka, Bazińska, 2016) was utilized to measure the employee's perceived amount (quantity) of work. The scale consists of 5 statements assessed on a 5-point response scale (1 – "less than once per month or never," 5 – "several times per day"). The respondent is asked to evaluate the frequency of experiencing five situations at work, e.g., "How often is there a great deal to be done?". Cronbach's alpha was 0.83.

The SUDCO model components were measured with the 24-item Strengths Use and Deficit COrrrection (SUDCO) questionnaire (van Woerkom et al., 2016). Each diagnostic statement is rated on a 7-point response scale, ranging from 0 ("almost never") to 6 ("almost always"). The questionnaire measures four aspects differentiated within the SUDCO model: strengths use (6 items: "I capitalize on my strengths at work"), deficit correction (6 items: "In my job, I work on my shortcomings"), POS for strengths use (7 items: "This organization makes the most of my talents"), and POS for deficit correction (5 items: "In this organization, my development plan aims to better my weaknesses"). The back-translation procedure was used to prepare the Polish version of the measure. Cronbach's alpha was 0.93 for strengths use, 0.86 for deficit correction, 0.95 for POS for strengths use, and 0.82 for POS for deficit correction.

The working model was identified using a single-item measure: "How do you currently perform your professional work?". The respondents were asked to choose one of the options referring to their current way of doing the job: onsite ("I only work at my place of employment."), hybrid ("I work partly at my place of employment and partly remotely from

home, e.g., on selected days of the week."), and remote ("I only work remotely from home"). As the present study was conducted during the prolonged crisis in the job market and the significant reduction in the activity of many organizations due to the COVID-19 pandemic (Kniffin et al., 2021), the respondents could also choose the fourth option: "I was sent on unpaid leave." In addition, the answer "No of the above" was possible to select.

2.4. Statistical analyses

All statistical analyses were conducted in the IBM SPSS Statistics, version 28. Firstly, the descriptive statistics (means, standard deviations, skewness, and kurtosis) and Pearson's correlation coefficients for the study variables in the total sample were calculated. Secondly, we examined the differences between the three groups of employees working within distinct work models (i.e., onsite, hybrid, and remote) in terms of the SUDCO model components and workload using a one-way analysis of variance (ANOVA). We also computed the eta squared values (η^2) to determine the effect size for ANOVA models. In addition, Tukey's HSD post hoc tests were performed to indicate significant differences in the four SUDCO aspects and workload among the onsite, hybrid, and remote employees.

3. Results

3.1. Relationships between the study variables

The descriptive statistics (mean, standard deviation, skewness, and kurtosis) and the zero-order correlations for the SUDCO elements and quantitative workload in a total sample are presented in Table 2.

Table 2.

Descriptive statistics and Pearson's correlation coefficients between the study variables

Variables	<i>M</i>	<i>SD</i>	<i>S</i>	<i>K</i>	1	2	3	4	5
1. Strengths use	32.03	6.96	-0.78	1.03	-				
2. Deficit correction	29.05	6.73	-0.09	-0.64	0.78***	-			
3. POS for strengths use	33.83	9.62	-0.63	0.11	0.88***	0.76***	-		
4. POS for deficit correction	20.77	6.60	-0.23	-0.42	0.52***	0.68***	0.65***	-	
5. Workload	15.42	4.97	0.00	-0.83	0.09	0.16	0.10	0.10	-

Note. POS = perceived organizational support. *** $p < 0.001$.

Source: Own study.

All components of the SUDCO model (i.e., strengths use, deficit correction, POS for strengths use, and POS for deficit correction) were positively intercorrelated. In contrast, workload was not significantly correlated to any of the SUDCO elements. Given these insignificant intercorrelations, we did not conduct the simple regression analyses with workload as a predictor and the four SUDCO components as the outcome variables.

3.2. Differences among onsite, hybrid, and remote employees

Table 3 displays the results of the one-way ANOVA models, with the work model included as the independent variable and the workload and the SUDCO components as the dependent variables.

Table 3.

One-way ANOVA results and Tukey's post hoc test results for the three work model groups

Variables	Onsite (1) (<i>n</i> = 68)		Hybrid (2) (<i>n</i> = 36)		Remote (3) (<i>n</i> = 25)		ANOVA		η^2	Tukey's post hoc tests (significant only)
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>p</i>		
Strengths use	31.43	7.27	32.19	6.54	33.44	6.75	0.78	0.463	0.012	-
Deficit correction	27.79	7.06	29.56	6.32	31.72	5.64	3.38	0.037	0.051	1-3, <i>p</i> = 0.33
POS for strengths use	32.16	9.69	34.75	9.89	37.04	8.25	2.65	0.075	0.040	-
POS for deficit correction	19.09	6.81	21.72	6.07	23.96	5.40	5.92	0.003	0.086	1-3, <i>p</i> = 0.004
Workload	16.46	4.98	14.69	5.01	13.60	4.31	3.68	0.028	0.055	1-3, <i>p</i> = 0.036

Note. POS = perceived organizational support. Work models: (1) onsite, (2) hybrid, (3) remote. η^2 = eta squared.

Source: Own study.

A one-way ANOVA indicated no significant differences in strengths use among those working onsite, hybrid, and remotely, $F(2, 126) = 0.78$, $p = 0.463$. Similarly, POS for strengths use did not differentiate the three analyzed groups of employees, $F(2, 126) = 2.65$, $p = 0.075$.

In contrast, we found significant differences in deficit correction among people working within different models, $F(2, 126) = 3.38$, $p < 0.05$. However, the effect size for deficit correction was small ($\eta^2 = 0.13$). The comparisons of three subgroups using Tukey's post hoc tests demonstrated that deficit correction was significantly higher for remote employees than onsite employees ($p < 0.05$). No significant differences in deficit correction were revealed among the onsite and hybrid groups. Deficit correction also did not differ between remote and hybrid employees.

The ANOVA for the work model on POS for deficit correction was also significant, $F(2, 126) = 5.92$, $p < 0.01$. The effect size was small ($\eta^2 = 0.18$). Tukey's post hoc tests revealed that POS for deficit correction was significantly higher among remote employees than onsite employees ($p < 0.01$) and did not significantly differ from those working hybrid. The difference in POS for deficit correction between hybrid and fully remote employees was also insignificant.

In addition, there were significant differences in workload among the compared groups, $F(2, 126) = 3.68$, $p < 0.05$. The effect size was small ($\eta^2 = 0.14$). Tukey's post hoc tests showed that onsite employees experienced significantly higher workloads than those working fully remotely ($p < 0.05$). Nevertheless, hybrid employees did not significantly differ in workload from the onsite and remote groups.

4. Discussion

4.1. Relationships between the study variables

This study indicated high intercorrelations among the four components of the SUDCO model. These results reflect the common conceptual core of the four constructs that form the SUDCO framework – the general focus on employees' development within the organization (van Woerkom et al., 2016). They are also in line with prior research (Els, Mostert, Brouwers, 2016; Lorenz et al., 2021), which demonstrated a strong predictive role of POS in strengths use for strengths use, and POS for deficit correction for deficit correction, and moderate positive intercorrelations for the remaining pairs of the SUDCO elements.

However, the relationships of workload with the SUDCO domains were insignificant. These findings suggest that quantitative workload might not be a decisive organizational factor contributing to the employees' developmental efforts and the perceived organizational encouragement of them. In particular, individual factors (including personality traits) could determine whether and to what extent an employee undertakes strengths use and correction efforts. For instance, previous research showed that those high in core-self evaluations (Ding, Lin, 2020), extraversion, and emotional stability tend to engage more frequently in strengths use behaviors (Bakker, van Woerkom, 2018). As personality traits are relatively stable across lifespans and situations, they could manifest in the increased employee tendency to use their own competencies and developmental efforts to minimize incompetencies regardless of external organizational factors, such as workload. Alternatively, various people might interpret job demands differently. Thus, workload could be seen as a work stressor or a challenge, depending on the individual subjective interpretation of the work situation (Spector, Jex, 1998). Consequently, employees might differ in their attitudinal and behavioral reactions to workload based on how they perceive it. For example, high workload could be seen as a sign of trust in the employee's competencies from the manager, resulting in increased efforts to do one's best at work, undertaking developmental initiatives, and more positive beliefs about the organization. Conversely, the same large number of tasks at work might be perceived as an attempt to exploit the employee and limit his or her developmental opportunities, leading to diminished strengths use, deficit correction, and less favorable views of the organization.

The lack of significant relationships between workload and the SUDCO domains might also reflect the curvilinear correlation between both variables. Prior research demonstrated that task performance was the highest when workload was medium, suggesting that different levels of workload might promote more or less positive organizational outcomes (Bruggen, 2015). Otherwise, in line with prior research (van Woerkom, Bakker, Nishii, 2016a), workload might be a moderator in the relationships between the SUDCO elements and work outcomes rather than directly predicting the SUDCO components. However, future studies should examine the

potential moderating role of workload on the SUDCO elements and work-related outcomes and whether the linkages between workload and the SUDCO elements are nonlinear.

4.2. Differences among onsite, hybrid, and remote employees

From the organizational theory perspective, this research adds to the knowledge about the differences in proactive organizational behavior and perception of the organizational context among those working within different models. More specifically, the present findings shed new light on the discrepancies in proactive behaviors represented by strengths use and deficit correction at work among onsite, hybrid, and remote workers. They also highlight the differences in the aspects of organizational context (i.e., POS for strengths use, POS for deficit correction, and workload) within distinct work arrangements.

With regard to the tested differences between the three groups of workers, remote employees reported significantly higher levels of deficit correction, POS for deficit correction, and lower workload than their onsite counterparts. These results might reflect that remote work arrangements offer more autonomy as well as learning and developmental opportunities (cf., Bakker, van Woerkom, 2018) due to a more supportive working environment and more favorable working conditions (represented by lower quantitative workload) compared to traditional, onsite work model. Consequently, remote employees more frequently undertake actions aimed at reducing their own incompetence at work than those working onsite. In line with prior research (Vinueza-Cabezas et al., 2022), these differences between both work models might reflect the disparity in work characteristics among the three forms of work. In particular, they seem to stem from the lowest perceived control over the work situation in onsite workers compared to remote workers. Remote work arrangements enable the employees to independently decide from the manager how to organize work and perform tasks to a greater extent than onsite work. Higher perceived influence on the work environment among remote (or even hybrid) workers contributes to their more positive attitudinal and behavioral responses to job tasks at work (including greater work engagement) than onsite workers (Wontorczyk, Rożnowski, 2022). Accordingly, remote workers may be able to shape their work environment in a way that enables them to develop their competencies and minimize incompetence. Thanks to increased job autonomy, they can choose more tailored development activities at work that meet their needs. For example, they can participate in training, workshops, and other learning activities at work or deliberately choose job tasks that help them acquire new skills and knowledge.

In turn, remote work can also encourage employees' engagement in working on their own weaknesses than onsite work, thanks to higher POS for deficit correction in this form of work. Perceived organizational support was identified as an essential element of a remote work environment, contributing to higher motivation, work engagement, organizational commitment, and employee job performance. Full-time and part-time remote employees who receive distinct forms of support (organizational, supervisor, and technological) have the chance to meet the

new and demanding job requirements and face the challenges within remote work arrangements, including changed work routine, virtual relationships, digital work tools, and blended workspace (Errichiello, Pianese, 2021). Accordingly, leadership and organizational support were identified as an external resource that might contribute to alleviating the stress arising from remote work and maintaining high work engagement (Deepa, Dharshini, 2024). Consequently, a supportive and engaging remote work context, which offers a holistic approach to organizational support, might foster developmental initiative among remote workers. In particular, solutions intended for remote work (i.e., training development programs increasing competencies needed in remote work, providing reliable feedback from remote coworkers about individual's strengths and weaknesses, and a performance management system directed to remote workers) could enhance employees' self-awareness and encourage professional development (Errichiello, Pianese, 2021). In contrast, onsite work arrangements might be more endangered by work design disturbances, which might contribute to employees' less favorable subjective evaluations of organizational support for professional growth and their lower tendency to engage in developmental actions (Lamovšek et al., 2025).

No significant differences in strengths use and POS for strengths use among the three forms of work arrangements were found. These findings suggest that individual factors could play a greater role in strengths use and POS for strengths than type of work model. In particular, strengths knowledge, emotional intelligence, and stable personality traits (i.e., proactive personality, emotional stability, extraversion, core self-evaluations) were identified as individual-level predictors of strengths use at work (Bakker, van Woerkom, 2018; Ding, Lin, 2020). These personal characteristics (in particular personality traits) are mainly dependent on the employee and relatively unchanging. Consequently, they might manifest themselves in a relatively stable pattern of strengths use behaviors in a given employee, regardless of the work context, including the work model. Alternatively, other organizational factors might be decisive for a lack of differences in strengths use among remote, hybrid, and onsite workers. In particular, the type of job tasks, task allocation, and higher work autonomy in some jobs could foster strengths use in each work model (Bakker, van Woerkom, 2018).

4.3. Practical implications

Through the lens of organizational practice, the current study highlights the role of organizational support in encouraging an employee to undertake proactive organizational behavior. In line with previous findings and the SUDCO conceptual framework (van Woerkom et al., 2016), POS for strengths use and POS for deficit correction emerged as organizational resources essential for strength use and deficit correction at work. These results suggest that managers should consider the role of their own decisions regarding shaping the work environment in evaluating the willingness to develop the competence level among their subordinates. In particular, this study emphasizes that fulfilling one's own potential and high performance at work through applying one's own strengths and minimalizing deficiencies is

hindered without organizational support. Thus, shaping the workplace that supports and encourages organizational learning by managers seems crucial for sustaining the highly competent workforce in the competitive and changing business environment.

Our findings also demonstrated the differences in the perception of organizational support, the frequency of proactive organizational behaviors aimed at personal development, and quantitative workload among employees working within different work models. In particular, the onsite work model was identified as offering relatively lower developmental perspectives from the employees' point of view than remote work arrangements. Managers, HR specialists, and employees need to address these differences in their daily decisions and actions in the organizations. In managerial and HR practice, knowledge about the specifics of individual work models should be considered when developing strategies to enhance employee growth and shape a supportive work environment. Most notably, the supervisors ought to choose the competency development tools that align with the characteristics of each work model. Moreover, competency and potential assessment should be tailored to individual work arrangements, considering their limitations in terms of professional development opportunities. Thanks to considering differences between work arrangements, it will be possible to accurately identify strengths, weaknesses, training and developmental needs, and potential for growth among those working online, hybrid, and remotely. Adopting such a discriminative approach would also help managers create and support a learning culture in the workplace, in which workers are open to work on their weaknesses, increase their skills and knowledge, and reach their full potential. In the long term, a better understanding of differences in the developmental opportunities between work models would help the managers and HR specialists to more effectively encourage developmental initiatives, enhance engagement, and increase worker job performance.

For employees, a better understanding of the differences in the possibilities of developing competencies between work models would help them make more informed career choices. Knowledge about relative differences in opportunities and support for professional development within distinct work models could also contribute to better person-organization fit. At the selection stage, this is possible thanks to the job candidates' choosing the work environment that aligns with their personal developmental needs and plans. For already employed workers, understanding the differences between the work models increases individual accountability for their own proactive organizational behaviors and professional development.

4.4. Limitations and future directions

The results should be interpreted with regard to several limitations. Firstly, as the current study was preliminary, the sample size was relatively small. Future studies on the differences among distinct work models should be based on larger research samples to grasp the significant results better. Secondly, this study was correlational, which does not allow us to determine

causality and examine changes in employees' proactive organizational behavior over time. Hence, experimental or longitudinal studies should be conducted in the future to establish the cause-effect relationships between workload and strengths use and deficit correction or follow up on those working within different work models over time. In addition, we used the snowball sampling method to collect the data, which does not ensure the sample is representative. We tend to collect a diverse sample by asking the participants to share the invitation to our study on different social networks. However, the respondents might have distributed the invitation among those with similar characteristics. Therefore, it is worth replicating this study using a random sampling method to provide a representative sample.

Another limitation of this study is its theoretical basis, primarily not including additional information about the specificity of the hybrid work of the individual participants. Hybrid (or blended) work models might take various forms in which onsite and remote work arrangements are mixed in different proportions and with different intensities (Hopkins, Bardoel, 2023). As a result, taking into account these subtle differences (e.g., in the number of days or hours spent by an individual working from home per week/month or its frequency) might add to a better understanding of the differences in workload and the SUDCO elements among employees working hybrid. A further potential shortcoming of this study stems from including only one type of organizational stressor: quantitative workload. In addition, there are other categories of job stressors (e.g., interpersonal conflicts, organizational constraints) or job demands (e.g., emotional demands), which might be related to strengths use, deficit correction, and POS for both forms of organizational behavior (Bakker, van Woerkom, 2018; Spector, Jex, 1998). Moreover, POS for strengths use and POS for deficit correction represent organizational factors strongly related to strengths use and deficit correction (van Woerkom et al., 2016). Nevertheless, there are other personal (e.g., core self-evaluations, self-efficacy, self-esteem, positive affect) and job resources (e.g., feedback, role clarity, autonomy, opportunities for development) that could contribute to greater strengths use and deficit correction at work (Bakker, van Woerkom, 2018; Luan et al., 2023).

The results of this study should be analyzed with caution given the unique data collection period. Our study was conducted during the COVID-19 crisis, which constituted a unique context that might not reflect usual work conditions. The pandemic has substantially contributed to the changes in the work environment, especially those involving the popularization of more flexible working arrangements, such as remote and hybrid work models (Grzegorzczak et al., 2021; Sokolic, 2022). At the same time, it was a unique period in the labor market, which might be specific to this socio-economic context. For instance, the pandemic restrictions required emergent changes in work practices (i.e., longer working hours in medical professions; the prevalence of telework; virtual teams, leadership, and management) and for workers (social distancing and loneliness). They also forced employers to send employees on unpaid leave or even dismissal from work in some sectors of the economy (Kniffin et al., 2021). Therefore, our study should be replicated in the post-pandemic conditions to validate the present results.

5. Summary

This study examined how the three basic work models (i.e., onsite, hybrid, and remote) differ with regard to the two forms of proactive organizational behavior (i.e., strengths use and deficit correction), perceived organizational support (POS) for them, and quantitative workload. The present findings demonstrated that remote employees reported significantly higher deficit correction, POS for deficit correction, and lower workload than individuals working remotely. These results suggest that remote work arrangements provide greater opportunities for professional development aimed at eliminating employees' own areas of incompetence in comparison to onsite work. In addition, remote workers had a lower quantitative workload than onsite workers, suggesting more favorable working conditions in terms of the number of required tasks among this group of employees than among those working onsite. Our findings might be applied in the managerial and HR practice, particularly in the area of creating effective employee development strategies and conducting an accurate assessment of employee potential. Moreover, the awareness of the different development opportunities within the individual work arrangements might help the employees make more thoughtful decisions about developing their own professional competencies.

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THE SUBJECT OF COPYRIGHT PROTECTION IN MUNICIPAL OFFICES

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Purpose: Copyright management and protection are an essential element of the activities and development of municipal offices. As part of their functioning, various solutions are created and applied in the field of products of human creative activity, subject to legal protection, which results in the need to ensure proper protection of copyright for authors. The scope and subject of this protection are determined by the provisions of the Act of 4 February 1994 on Copyright and Related Rights (The Act, 2022, Item 2509). The aim of this article is to answer the question of what are the main categories of works created, used and distributed in municipal offices.

Design/methodology/approach: The basis for the considerations is the subject literature and the analysis of the legal provisions in force in the area discussed.

Findings: Copyright protection plays an important role in the activities of the municipal office. In order to ensure the proper functioning of local government units (at all levels), knowledge of copyright protection is a key element. Municipal offices use not only works to which they have exclusive rights, but also those to which other entities (e.g. contractors or parties to administrative proceedings) have copyright. Knowledge of the principles of protection of a work under copyright law can contribute to better implementation of tasks by local government units.

Practical implications: It would be beneficial if local government units raised their awareness of copyright to works both created within these entities and used by them. Raising consciousness and knowledge of respecting copyright can minimize the number of disputes in this regard.

Originality/value: This article addresses the issue of managing intellectual property rights in an organization, which is an important aspect from the perspective of the municipality.

Keywords: intellectual property, copyright, municipal office, work.

Category of the paper: viewpoint, literature review.

1. Introduction

Intellectual property is understood as intangible products of the human mind. It cannot be perceived by the senses, although they can contribute to its better understanding. Cognition itself is of a rational, precisely intellectual nature (Sieniow, Włodarczyk, 2009). Protection covers intangible property (intellectual property), not its manifestation, i.e. the material carrier of the form or content of the work. According to the Supreme Court judgment of 15 November 2012, “copyright protection does not cover the object on which the work was fixed (*corpus mechanicum*)” (Pądzik, 2014). Among intellectual goods, it is worth mentioning such objects of exclusive copyright as: works and related rights, inventions that do not require individual or artistic character, trademarks and industrial marks, as well as protected factual states, such as business secrets (Golat, 2005). Protection covers absolute subjective rights of creators or other authorized entities (including producers, broadcasters, publishers).

Intellectual property rights show some similarity to property rights, in particular to ownership. Despite certain differences (the subjects of ownership are, in particular, tangible objects, while intellectual property only refers to intangible goods), in both cases there is a kind of monopoly of the entitled entity. According to the content of art. 140 of the Civil Code, an owner may, within the limits set by law and the principles of community life, to the exclusion of other persons, use a thing in accordance with the social and economic purpose of his right, and may also collect the profits and other revenues from the said thing. Within the same limits, he may dispose of the thing (The Act, 2024, Item 1061). Therefore, in the case of both ownership and intellectual property, control over the thing and deriving any benefits and bearing burdens related to the use of the protected object is the domain of the entitled entity. In both situations, a third party, i.e. a tenant or licensee, may also derive benefits.

The concept of “intellectual property” was introduced by the provisions of the Stockholm Convention of 14 July 1967 establishing the World Intellectual Property Organization. Article 2, point viii of the above Convention defined intellectual property as rights relating to:

- literary, artistic and scientific works,
- interpretations of interpreting artists, and performances of performing artists, phonograms, and broadcasts,
- inventions in all fields of human endeavor,
- scientific discoveries,
- industrial designs,
- trademarks, service marks, and commercial names and designations,
- protection against unfair competition,

and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields (Convention, 1975).

WIPO (World Intellectual Property Organization) therefore understands intellectual property to include rights relating to, for example, the interpretations of interpreting artists, and performances of performing artists, phonograms and literary, artistic and scientific works, radio and television programs, inventions in all fields of human activity, scientific discoveries, industrial designs, trademarks and service marks, trade names and trade designations, protection against unfair competition.

Under Polish legal regulations, intellectual property covers broadly understood intellectual activity and exclusive rights related to it, which include: copyright and rights related to copyright, database rights, industrial property law relating to inventions, utility models and industrial designs, trademarks, geographical indications and topographies of integrated circuits.

Copyright management and protection are an essential element of the activities and development of municipal offices. As part of their functioning, various solutions are created and exploited in the field of the products of human creative activity, subject to legal protection, which results in the need to ensure proper protection of copyright for authors. The scope and subject of this protection are determined by the provisions of the Act of 4 February 1994 on Copyright and Related Rights (The Act, 2022, Item 2509).

One of the important elements in the activities of municipal offices is taking into account the provisions of copyright law enabling the lawful use of works protected by this law. This article is an attempt to present the issue of copyright protection in a municipal office in the context of the category of works created, used and distributed in municipal offices. The aim of the article is to show what the basic types of these works are in the light of copyright law. The article is based on an analysis of legal regulations and case law.

2. Subject of copyright protection

Municipal offices are public administration institutions operating at the municipal level. They are organizational units of the municipality, with the help of which the executive bodies of the municipalities implement tasks resulting from the Act of 8 March 1990 on Local Government (The Act, 2024, Item 1465). They include two categories of tasks: municipal (local) public tasks and tasks assigned from the scope of government administration. The organization and principles of operation of municipal offices are determined by organizational regulations, issued by the executive bodies of the municipalities by way of orders.

According to Article 1 of the Copyright and Related Rights Act, “The object of copyright shall be any manifestation of creative activity of individual nature, established in any form, irrespective of its value, purpose or form of expression” (The Act, 2022, Item 2509).

The Act lists the categories of works covered by copyright protection. These are works: 1) expressed in words, mathematical symbols, graphic signs (literary, journalistic, scientific, cartographic works and computer programs), 2) artistic works, 3) photographic works, 4) string musical instruments, 5) industrial design works, 6) architectural works, architectural and urban planning works as well as urban planning works, 7) musical works as well as musical and lyrical works, 8) theatrical works, theatrical and musical works as well as choreographic and pantomime works, 9) audiovisual (including film) works (The Act, 2022, Item 2509). It is worth emphasizing, however, that this list is only exemplary, and the catalog of works protected under copyright law is open.

“The claim that a work is a manifestation of ‘creative activity’ means that the work should be the result of creative activity. This premise, sometimes referred to as the premise of ‘originality’ of the work, is fulfilled when there is a subjectively new product of the intellect” (I ACa 800/07). At the same time, “a manifestation of human intellectual activity cannot be considered a work and protected by copyright if it lacks sufficiently individualizing features, i.e. distinguishing it from other products of a similar type and purpose” (III CSK 40/05). Therefore, we will always be dealing with a manifestation of creative activity when the creation of a specific work is the result of “intellectual effort” and not the simple reproduction of an already existing subject of protection (Szczepanowska-Kozłowska, 2010).

When assessing the individuality of a given work, its type should be taken into account (V CSK 337/08). In addition, “the assessment of the individuality of a work should be carried out by examining two conditions. First of all: whether there was a creative space within which the author could create and whether, in shaping the form or content of the work, the author used an area of freedom in the selection and arrangement of components” (Pinkalski, 2010).

In order to assume that a given human product is subject to copyright protection, it is necessary to clearly establish that the work that a given person has put into creating a given work is creative in nature (Górnicz-Mulcahy, 2012). In the opinion of the Court of Justice of the EU, the requirement that a work constitutes a “manifestation of creative activity of an individual character” should be understood as “one’s own intellectual creation” (Laskowska-Litak, 2019). On the other hand, the creative process itself, the method of producing the work or, in “other cases, a newly created creative technique, style or manner are excluded from legal protection under copyright law” (Wojciechowska, 2014).

Importantly, in accordance with Article 1, Section 3 of the Copyright Act, a work is in copyright since being established, even if its form is incomplete (The Act, 2022, Item 2509).

In order to protect a work under copyright law, it is therefore necessary to “establish it”. “Establishment is understood as the conscious activity of the creator of the work expressed in a specific form and enabling, under given conditions, the perception of the work by at least one person other than the creator of the work” (Nowikowska, 2021). This should be understood as the externalization of the work enabling third parties to become familiar with its form or content (depending on the manner of expression). “An artistic work becomes the subject of copyright

when it is established, i.e. when it takes any form, even if it is not permanent, but permanent enough for the content and features of the work to have an artistic effect” (I CR 91/73). Importantly, there is no requirement for the work to take its final form at the time of establishment. Protection can also be provided to an unfinished work, e.g. plans, outlines, sketches, drawings, models and designs. Individual stages of creating the work are also protected, of course provided that they are characterized by a creative and individual character. It is worth emphasizing that copyright protection may cover both entire works and their parts, e.g. chapters (Barta, Markiewicz, Poźniak-Niedzielska, 2017).

There is also no requirement to record the work; it is sufficient for third parties to become familiar with it, e.g., through the recitation of a poem or the performance of a musical piece.

In light of Article 1, Section 2¹ of the Copyright Act, only the manner of expression may be protected, while discoveries, ideas, procedures, methods and principles of operation, and mathematical concepts are not protected (The Act, 2022, Item 2509). A product of the intellect limited to an idea, even if its originality and even individuality are recognized, is not a work within the meaning of copyright law (Markiewicz, 2022).

Art. 4 of the Copyright Act excludes certain categories of works from copyright protection. The following are not subject to copyright: 1) legislative acts and their official drafts; 2) official documents, materials, logos and symbols; 3) published patent specifications and industrial design specifications; 4) simple press information (The Act, 2022, Item 2509). The above exclusion is exhaustive and an extensive interpretation cannot be applied here. Despite the fact that Art. 4 of the Copyright Act does not introduce the necessity to assess whether a given work meets the conditions specified in Art. 1 of the Copyright Act, it should be remembered that “exclusions of protection resulting from art. 4 of the Copyright Act of 1994 cannot be identified with leaving complete freedom to reproduce and distribute the materials listed in this provision. This freedom may be subject to restrictions, but these restrictions will result from other regulations, such as regulations protecting personal rights, secrecy, or counteracting unfair competition. Reproduction or distribution of materials indicated in art. 4 of the Copyright Act of 1994 may also constitute damage, the redress of which may be claimed under general principles” (IV CKN 458/00).

In relation to the municipality, the exclusion of normative acts and their official drafts and official documents and materials from copyright protection is of particular importance. The public interest should be indicated as the justification for introducing the above exclusion. The legislator’s goal was to ensure a universal right to information on legislative processes and access to legal acts and other products created within state institutions. “This exclusion is to ensure that copyright does not become an obstacle to specific communication between the authorities and the citizen” (Pacek, 2019).

The following division of legal acts can be adopted: acts of internal (local) law and normative acts of public international law.

Among the acts of internal law, the first to be mentioned are universally binding normative acts, i.e. those that contain standards of conduct for generally specified addressees. Next, internally binding normative acts, i.e. those that must be consistent with universally binding acts and are addressed to addressees within a state or local government unit. These are, in particular, acts of internal management. Finally, the normative acts of local government should be mentioned (Ślęzak, 2017).

The exclusion from art. 4 of the Copyright Act covers all normative acts: the Constitution, ratified international agreements, acts, regulations, local law acts, as well as sources of internal law: resolutions of the Council of Ministers, orders of the Prime Minister. The provision also covers statutes and regulations in force in state and local government institutions (Ferenc-Szydełko, 2021).

The Supreme Administrative Court indicated that the concept of “an official document should be interpreted in the light of the provisions of Article 244, paragraphs 1 and 2 of the Code of Civil Procedure and Article 76, paragraphs 1 and 2 of the Code of Administrative Procedure. The definitions contained in both codes are identical as to their content. They indicate that an official document is a document drawn up in the prescribed form by state bodies appointed for this purpose within their scope of activity. They constitute evidence of what has been officially stated or certified therein” (III SA 889/96).

The concept of “official material” should be interpreted individually in relation to a specific subject. In the light of the Supreme Court’s case law, official material will be “that which comes from an office or another state institution, or concerns an official matter, or was created as a result of the application of an official procedure” (Supreme Court Judgment of 26 September 2001, IV CKN 458/00). In the legal doctrine, one can encounter the view that an official material can be considered a product of an office, concerning an official matter or such a product which is the result of the application of official procedures (Pinkalski, 2009).

The following are excluded from copyright protection:

- court decisions, including judgments of the Supreme Administrative Court (NSA) (with justifications),
- decisions from state or local government administration bodies (Barta, Markiewicz, Niewięglowski, Poźniak-Niedzielska, 2017),
- announcements, instructions, circulars or explanations (Czub, 2022),
- valuations prepared by property appraisers for the purposes of managing real estate of local government units or the State Treasury (II SA/Gd 897/05),
- decisions on building permits, decisions on changing building permits and decisions on transferring decisions on building permits (I OSK 1856/15),
- other administrative documents, e.g. official letters, certificates, protocols or regulations.

A given material or document acquires an official character at the moment of its introduction into official circulation, e.g. delivery of an administrative decision, submission of a draft for consideration by the appropriate body of a local government unit. The acquisition of official status by a given work constitutes its exclusion from copyright protection, until that moment the people who created it have the full catalogue of copyrights. This moment determines the deprivation of copyright protection (Szewc, 2014).

3. Categories of works

Due to the diverse nature of works, a question should be asked about the categories of works created, used and distributed in municipal offices and protected under copyright law.

The first category of works created, used and distributed in the activities of municipal offices are independent and non-independent works. An independent work should be considered the result of the independent creative work of a given author. Such a work is characterized by originality and is not based on other previously created works (Chudziński, 2013). In judicial practice, the view has been established that “fully independent works not created under the inspiration are those that do not arise in an intellectual vacuum, which means that their author draws on previous scientific or artistic achievements, but does not directly refer to any specific work” (Michalak, 2019).

Independent works may also include inspired works. According to Art. 2 Sec. 4 of the Copyright Act, a work that was created under the inspiration of another author’s work shall not be considered as the derivative work (The Act, 2022, Item 2509). Although they are created under the influence of another work, they exhaust the premise of creativity and are consequently included in the category of independent works (Tischner, Wojciechowska, 2009). “A work created solely as a result of creative stimulation from another work is covered by independent copyright (independent work)” (I CR 659/74). The work uses, in particular, unprotected elements of the original work (idea, theme, technique), and not their protected manner of expression (Czyżewski, 2019).

In the light of judicial practice, the following were considered to be independent works: specification of essential terms of the contract prepared pursuant to the Public Procurement Law (V CSK 337/08), templates and forms (II K 1092/32), draft technical documentation, plans, outlines, sketches, drawings, models and designs (I PRN 47/78), and occupational health and safety instructions (II CR 244/71).

An example of independent works created and used and disseminated in connection with the informational activities of municipal offices may be photographic works, e.g. photographs for an exhibition organized at the municipal office or for an information brochure or poster promoting a municipal event, and photographs published on a website in connection with the

organization of municipal events, e.g. a municipal festival or in connection with the promotional activities of the municipality. Will each of the photographs created in connection with the activities of municipal offices be subject to copyright? According to the Supreme Court, in order to cover a photograph with copyright protection, it is necessary to “demonstrate the existence of a creative and individual contribution of the photographer to the creation of the final work. It is assumed that ‘creative activity’ within the meaning of art. 1 sec. 1 of the Copyright Act, in the field of artistic photography is a conscious choice of the moment of photographing, point of view, image composition (framing), lighting, determining depth, sharpness and perspective, the use of special effects and procedures aimed at giving the photograph a specific character can be considered, as these elements give the photograph an individual mark necessary for the recognition of the existence of a work within the meaning of Copyright Act” (III CKN 1096/00, I C 1270/16). A photograph should be “the result of creative work, and is characterized by inventiveness and artistic independence. Therefore, purely documentative photographs and photographs aimed at faithful reproduction of the original, e.g. works of art, jewellery, structural elements of a building, are not protected” (I CSK 539/13).

The artistic works created in municipal offices in the form of logos are another example of works that can be classified as independent works. It is the logo that most often determines the appearance of all promotional materials of the office as an artistic (compositional) motif that harmonizes with other elements of promotion (Brzozowska, 2010). In the doctrine, traditional advertising gadgets created for the needs of promotional activities, such as mugs, calendars or T-shirts, are considered to be the subject of copyright, provided that they have a creative character, manifested, for example, in the arrangement and selection of photos (Brzozowska, 2010). A guide for the residents of the municipality (e.g. a guide for the residents of Szczecin *Bądź bardziej bezpieczny* (Be safer), available for download as a PDF file, developed on the basis of information materials from the Ministry of Interior and Administration and materials available in the textbook entitled *Zarządzanie kryzysowe, obrona cywilna kraju oraz ochrona informacji niejawnych* (Crisis management, civil defense of the country and protection of classified information) edited by S. Mazur (https://bip.um.szczecin.pl/chapter_50528.asp) or a multimedia presentation (e.g. a multimedia presentation made available on the website of the Zblewo municipality entitled *Poradnik dla mieszkańców gminy Zblewo. Na czas wojny i kryzysu* (Guide for the residents of the Zblewo municipality. For times of war and crisis)), developed, among others, on the basis of sources made available on the website of the Government Centre for Security and the Integrated Educational Platform of the Ministry of National Education (<https://www.zblewo.pl/386,poradnik-dla-mieszkancow-na-czas-kryzysu-wojny>) will also be an independent work.

Once the statutory characteristics of a work are met, the subject of copyright protection in municipal offices will also include legal opinions prepared by office lawyers (Brzozowska, 2010).

A non-independent work includes derivative works, i.e. adaptations constituting an independent work taking over significant creative elements of the original work, e.g. translation, adaptation, modification (Art. 2, Sec. 1., The Act, 2022, Item 2509) and works with borrowings, i.e. using fragments of other works under the quotation license (Art. 29, The Act, 2022, Item 2509). The doctrine emphasizes the special nature of a derivative work, because “by meeting the requirements on which recognition as the subject of copyright protection depends, it owes its creation to a specific relationship between it and the so-called original (parent) work. The specificity of this relationship results from the creative borrowing of some elements of the parent work, i.e. the work that has become the subject of the adaptation” (Poźniak-Niedzielska, Szczotka, 2020). The derivative work should be characterized by creative adoption of elements from the original work (Traple, 2011).

“A derivative work is a modification of an original work. Its basic feature is the recognizability of the work that inspired in the work under inspiration (main idea, plot, characters) and although it still contains elements of the basic work, it also contains the creative contribution of the author of the derivative work. The scope of this contribution may vary” (I CR 659/74). In practice, it can be problematic to distinguish a work under inspiration from a work with borrowings. In legal science, one can encounter the view that the classification of a work into the category of derivative works is determined by the number of fragments of the parent work (Doliński, 2011).

An example of derivative works created in a municipal office may be the preparation, based on existing sources, of a study that meets the characteristics of a work. The creative nature of the study may be manifested in its content and the appropriate selection and arrangement of materials. The subject of copyright is not “a study that is merely an application of even highly specialized technical knowledge, if its content is determined in advance by objective conditions and technical requirements and the nature of the technical problem (task) being implemented (solved) (I ACa 490/06).

As indicated above, works with borrowings use fragments of other works under the quotation license. Within the scope of the activity of the municipal office, works with borrowings using quotations from other works may be created. These works include, among others, works in which fragments of already published works are quoted, e.g. scientific works. These are works with quotations that fall within the quotation law regulated in Art. 29 of the Copyright Act. A work with borrowings in municipal offices may be, for example, a multimedia presentation in which fragments of disseminated works are cited to the extent justified by an explanation or critical analysis. In the case of a quotation justified by an explanation, the fragment of someone else’s work used in the presentation should be necessary for the clarity and full understanding of the argument of the author of the presentation and should be closely related to the work of the citing party, constituting additional evidence of the cited opinions and claims or serving to expand one’s own argumentation (Wachowska, 2008).

What is important, changing the form of recording a work, e.g. from traditional to digital, does not result in the creation of a new work (Safjan, 2012).

In municipal offices we also come across works that have more than one author. These are co-authored works, which are the result of creative cooperation between two or more people. Court decisions indicate that the qualification of a work to the category of a co-authored work is conditioned by the attribution of creative input to the creation of the work to each of the co-authors.

In the case of a work created by two or more people, we may be dealing with a collective work. In order for such a work to be created, it is necessary for each of them to contribute to the creation of the work and for these contributions to be combined to form a coherent whole.

“Co-creation – within the meaning of copyright law – does not occur when the cooperation of a specific person is not creative in nature, but auxiliary, even if the ability to perform auxiliary activities requires a high degree of professional knowledge, dexterity and personal initiative. The specific factual situation determines when the cooperation of several people can be considered co-creation, but in any case co-creation occurs only when there is an agreement between the co-authors to create a joint work by joint effort” (II CR 575/71). According to Art. 9 of the Copyright Act, co-authors are jointly entitled to copyright (The Act 2022, Item 2509).

A collective work is a work comprising works by various authors, within the framework of which the copyrights of the authors of individual works may be transferred to the producer or publisher of the collective work. According to Art. 11 of the Copyright Act, the copyrights to the collective work are vested in the producer or publisher. Examples of collective works include municipal quarterlies, municipal information bulletins and yearbooks issued by municipal offices published on websites, e.g. the Lesznowola Municipality Information Bulletin issued by the municipal office and edited by an editorial team consisting of employees of the Department of Promotion and Communication with Residents, <https://lesznowola.pl/kwartalnik-gminny/>; Bulletin of the Municipal Office in Żabia Wola *Nasza Gmina* (Our municipality), <https://www.zabawola.pl/1037>; quarterly *Wieści* (News) published by the municipal office in Zakrzew, <https://zakrzew.pl/kwartalnik-wiesci/>; and the yearbook published by the Szemud Municipal Office, <https://szemud.pl/lesok-roczniki.html>.

The content of quarterlies and bulletins consists of materials (works) prepared by various authors (both employees of municipal offices and entities from the external sphere of administration, i.e. people from outside the office), combined within the framework of publishing and editorial activities into one whole. Within the framework of editorial activities, it is the editor who decides on the arrangement of works in the quarterly or bulletin. Each issue of the quarterly, bulletin or yearbook appears in a specific composition and graphic design.

According to the Court of Appeal in Warsaw, internet portals are also considered collective works. These platforms are a source of the most important information about the residents of municipalities, which at the same time constitute a factor integrating and uniting the local

community (Winnicki, 2010). In the legal justification for the judgment, the Court of Appeal in Warsaw shared the position of the court of first instance according to which, “creating the layout and graphic form of the portal, as well as improving and changing it during the period of use of the internet portal falls within the definition of a work referred to in Art. 1, § 1 of the Act of 4 February 1994 on Copyright and Related Rights” (I ACa 1145/06). In the context of the activities of municipal offices, local government internet portals should be mentioned, e.g. the Internet Portal of the Dobrzeń Wielki Municipal Office, <https://bip.dobrozenwielki.pl/198/7884/internetowy-portal-urzedu-gminy-dobrozen-wielki-ipu.html>.

Collections of works may also be characteristic of the activities of municipal offices. These collections are protected when they are characterized by the creative nature (originality and individuality) of the selection, arrangement or compilation of collected materials (Poźniak-Niedzielska, Szczotka, 2020). An example of this category of works in municipal offices may be a database of documents in electronic form, including case cards with a description of the procedures necessary to submit a case and electronic applications in a form for printing and editing, e.g. the document database prepared as part of the Internet Portal of the Dobrzeń Wielki Municipal Office, <https://bip.dobrozenwielki.pl/198/7884/internetowy-portal-urzedu-gminy-dobrozen-wielki-ipu.html>.

It is worth emphasizing that databases will not always be subject to copyright protection. A necessary condition will be a creative contribution to the development of the database. In the activities of local government units, examples of databases that are not works are databases relating to: records of localities, streets and addresses, population records, land and building records, geodetic records of land utilities networks (Czub, 2022).

4. Conclusion

Copyright protection plays an important role in the activities of municipal offices. Knowledge of the principles of protection of a work under copyright law can contribute to better implementation of tasks by local government units at all levels.

Knowledge of the protection of these rights is a key element in ensuring the proper functioning of local government units at all levels. It is important that employees in municipal offices grow in awareness of copyright rights to works both created within these entities and used by them. Sensitivity and knowledge of the issue of respecting copyright should contribute to minimizing the number of disputes in this regard.

Works subject to copyright, created, used and distributed in municipal offices include independent works, non-independent works, i.e. derivative works (adaptations) and works with borrowings, co-authored works, collective works and collections of works. These works are

created within the framework of the current activities of municipal offices and may constitute the work of one or more employees of the office. Their creation may also be commissioned to external entities. In such cases, it is necessary to have an appropriate license or to conclude an agreement on the transfer of property copyrights. The transfer of property copyrights will also be necessary in the event that the author of the work is an employee of the office, unless the work was created as part of the performance of employee duties and constitutes a so-called employee work. The copyright status of a specific work therefore translates into the possibility of its use and distribution within the framework of tasks performed in municipal offices.

It should also be pointed out that municipal offices use not only works to which they hold exclusive rights, but also those to which copyrights are held by other entities, e.g. contractors or parties to administrative proceedings.

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EXPERIMENTAL EVALUATION AND ANALYSIS OF 18650 BATTERY ENERGY CAPACITY AND PERFORMANCE PARAMETERS

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Purpose: The primary objective of this paper was to present the research findings on 18650 batteries, with an emphasis on consumer selection practices, as well as the challenges and support mechanisms related to product quality. Additionally, the study aimed to identify critical issues that could inform future legislative changes related to 18650 batteries.

Design/methodology/approach: The study employed a survey-based methodology, wherein participants were queried regarding the battery features they prioritize during their procurement process. The second phase of the study involved technical measurements of selected 18650 batteries, including their actual capacity and mass. A measurement system was designed and implemented, utilizing a solution that optimally replicated the user's real-world battery charging conditions.

Findings: The web-survey allowed for the identification of the most important characteristics of batteries from the customers' perspective. As a result of the research, significant discrepancies were found between the declared and measured parameters of the batteries. It was identified that there is a lack of legal regulations governing the quality parameters that are important to consumers of this type of energy source.

Research limitations/implications: The necessity for establishing appropriate standards for 18650 batteries has been demonstrated.

Practical implications: Considering the number of charge and discharge cycles for these products, batteries with lower capacities impose a substantial environmental and economic burden, as they require more frequent replacement and recycling.

Social implications: The need to enhance production and quality control standards for 18650 batteries has been emphasized to ensure the production of high-quality products that minimize environmental impact while maximizing consumer benefits.

Originality/value: The parameters of 18650 batteries most relevant to consumers are presented, along with discrepancies between the specifications declared by manufacturers and their actual performance. The findings can assist producers in making informed decisions during the prototyping phase to enhance product quality, and guide legislators in developing appropriate legal standards.

Keywords: lithium-ion batteries, energy capacity, quality, customer.

Category of the paper: Research paper.

1. Introduction

The 18650 battery is a cylindrical lithium-ion cell commonly used in applications such as laptop computers, power tools, and electric vehicles. 18650 rechargeable batteries are named for their external dimensions. 18650 batteries offer high energy density, good cycle life and strong discharge capabilities. They are characterized by superior performance in terms of current efficiency and capacity. Energy capacity is one of the key performance indicators of lithium-ion batteries and remains an active area of research. The battery capacity reflects how much energy can be stored into a fully charged battery. The required capacity of this type of batteries depends on its intended application (Axsen, Burke, Kurani, 2010). In this regard, 18650 batteries are increasingly replacing AA and AAA batteries in portable devices and have recently emerged as a preferred choice among consumers for powering a range of devices, including flashlights, electric toys, electric vehicles, and energy storage systems (Gaines, Cuenca, 2000; Maisel et al., 2023). The same batteries are utilized in laptops, power tools, and power banks and even in drones (Czerniak, Gacek, Szopa, 2021, 2023a, 2023b). Their popularity is driven by their high energy density, long life cycle, and relatively low cost. Choosing the right 18650 depends on capacity, discharge rate and application requirements. The batteries discussed in this article, distributed on the Polish as well as the European market, exhibit markedly divergent quality parameters. Quality characteristics such as battery capacity, durability, presence of protective electronics, and even dimensions should be taken into account. Ensuring the quality of these batteries is critical for both safety and efficiency of use.

The motivation for this research originated from an analysis of 2019 data sourced from the Eurostat platform, which assessed the recycling efficiency of batteries and accumulators across all EU Member States. In 2019, Poland ranked second, just behind Croatia, in terms of recycling efficiency (Figure 1). During this period, Eurostat (*Portable batteries and accumulators...*, 2019) reported that Poland's battery collection and recycling rate was 72.6%, which is significant compared to other EU countries. It should be noted that the 2019 data were not available for two Member States. For Romania, the data presented in Figure 1 is from 2018, while for the Netherlands, the data is estimated.

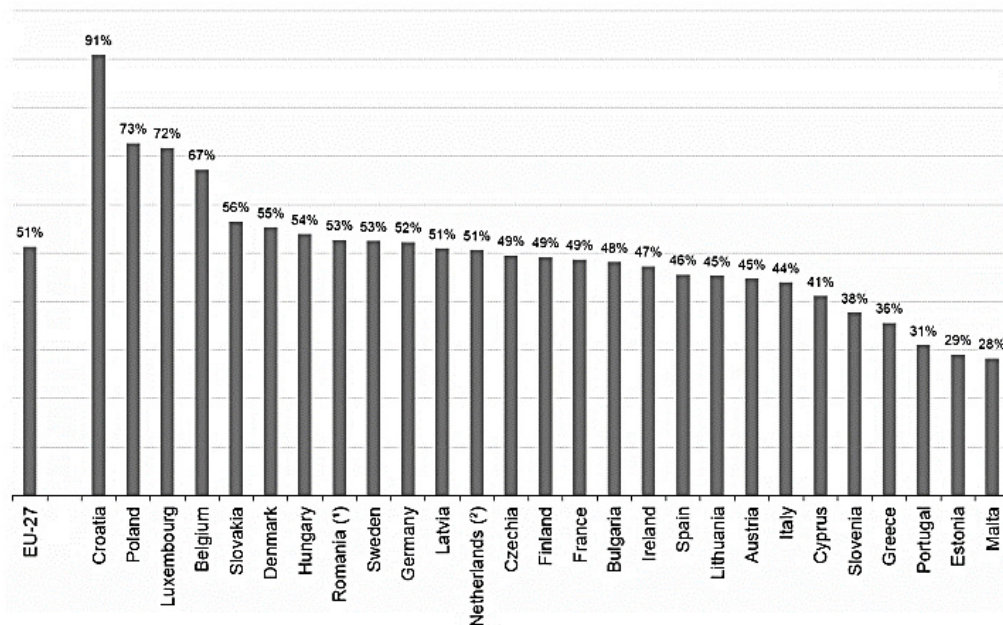


Figure 1. Portable batteries and accumulators collected for recycling (%), EU, 2019.

Source: based on Eurostat Statistic Explained data (Portable batteries and accumulators..., 2019).

The process of recycling batteries significantly impacts both the environment and a country's budget. Consequently, high-quality batteries positively influence their durability and lifespan, leading to economic and ecological benefits (Axsen, Burke, Kurani, 2010; Doolan, Boyden, 2016; Maisel et al., 2023). The primary objective of this paper was to present the research findings on 18650 batteries, with an emphasis on consumer selection practices, as well as the challenges and support mechanisms related to product quality. Additionally, the study aimed to identify critical issues that could inform future legislative changes related to 18650 batteries. The parameters of 18650 batteries most relevant to consumers are presented, along with discrepancies between the specifications declared by manufacturers and their actual performance. The findings can assist producers in making informed decisions during the prototyping phase to enhance product quality, and guide legislators in developing appropriate legal standards. An attempt was also made to assess battery quality using an indirect method based on mass measurements. The method was validated through electrical testing.

2. Literature review

Addressing the topic of establishing criteria for evaluating 18650 batteries to clearly determine the parameters that differentiate their quality, a literature study was conducted. This involved analyzing available sources that cover this subject matter. The initial approach adopted by the authors was to analyze the existing standards (ANSI, 2021; IEC, 2017a, 2017b, 2019; JSA, 2007, 2015; PKN, 2017) which outline the fundamental criteria that manufacturers must adhere to.

Standard dimensions for 18650 batteries follow IEC (International Electrotechnical Commission) and other industry standards. The name itself indicates the size. According to IEC 60086-4 (2025), the typical dimensions are 18.0 mm \pm 0.2 mm diameter and 65.0 mm \pm 0.2 mm length. However, the actual length may vary depending on the type of cell. The length of an unprotected cell is approximately 65.0 mm and a protected cell (with BMS/protection circuit) up to 70 mm.

IEC 62133 (2017a) – the most widely accepted safety standard for lithium-ion batteries – covers electrical, mechanical and thermal safety. The capacity of the 18650 battery is measured in mAh (milliampere-hours) and/or Wh (watt-hours). The typical capacity of this power source is in the range of 1200-3600 mAh and a high capacity cell up to approximately 5000 mAh. IEC 61960 (2024) describes capacity ratings (mAh), discharge rates and cycle life tests, defines energy density and efficiency criteria. Energy density is a common measure of battery energy, measured as the total Wh/kg of the battery (Zubi et al., 2018), and is a fundamental parameter that affects battery performance, dimensional constraints, mass, and operating costs. Nominal voltage for these batteries is in the range of 3.6-3.7 V, fully charged voltage is 4.2 V, and discharge voltage (cutoff) is 2.5-3.0 V. IEC 62660-1 (2019) and IEC 62660-2 (2018) (Automotive Li-ion Battery Standards) describe capacity, impedance, cycling and safety tests for electric vehicle (EV) applications. SAE J2464 (Automotive Safety Standard) (2021) is also used for electric vehicle (EV) and hybrid vehicle battery packs. JIS C 8715-2 (Japanese Industrial Standard) (2019) covers aging characteristics, cycle life and charging efficiency. Typical life for the 18650 battery is estimated at 300-1000 cycles and more, so the range is very wide and depends on how the battery is used. Factors affecting battery life are: depth of discharge (DoD) (very unfavorable 100% discharge), operating temperature (high temperatures degrade cells), charging rate (fast charging shortens life). The ideal operating range for lithium-ion cells is 0°C to 45°C when charging and -20°C to 60°C when discharging. High temperatures can increase capacity fade and cause thermal runaway, while low temperatures reduce discharge capacity. Based on this standard, protection circuitry is required to prevent overcharging, over-discharging, and short-circuiting. For safety, protected cells and proper charging methods should always be used. Common safety and protection issues with 18650 batteries include overcharging (protective circuitry should be used), short circuiting (causes fire/explosion), and deep discharge (shortens life). The following protections are used: PCB (Protection Circuit Board)/BMS (Battery Management System), thermal sensors, and safety ventilation.

18650 batteries can be divided into two distinct groups based on their functionality. The first group features a protruding positive terminal and is designed for compatibility with the sockets found in portable devices. The second group, characterized by a flush positive terminal, is intended for assembly into battery packs. These packs are constructed from multiple batteries connected in series and parallel. The number of batteries is determined by the required voltage and current output, tailored to the specific device. A second feature differentiating the two groups of batteries is the implementation of a protection device within their structure,

in the form of an electronic board, in the first group. This protection circuitry is designed to safeguard the battery against over-discharging and over-charging. The second group of batteries does not incorporate such protection, as this function is managed by the electronics that control the entire pack. There are numerous brands of this type of battery available on the Polish market.

The subsequent step involved reviewing the literature on 18650 batteries, which, however, includes specification of the chemical structure of the batteries and details the tests conducted to determine their technical parameters (Beard, 2019; Czerwiński, 2012). Common 18650 battery types are:

- IMR (Lithium Manganese Oxide – LiMn_2O_4), which are characterized by high discharge rate, safer, medium capacity. They are used in vapes and power tools.
- INR (Lithium Nickel Manganese Cobalt – LiNiMnCoO_2), which are characterized by high capacity and good discharge rate. They are used in EVs (Tesla Model S uses 18650 packs) and power banks.
- ICR (Lithium Cobalt Oxide – LiCoO_2), which are characterized by high capacity but lower discharge rate. They are used in laptop computers and flashlights.
- IFR (Lithium Iron Phosphate – LiFePO_4), which are characterized by long cycle life, high safety and lower energy density. They are used in solar battery banks and e-bikes.

Safety standards are described in UL 1642 (2022), Underwriters Laboratories, USA standard, where we can find instructions on safety tests for lithium-ion cells, including overcharge, short circuit, drop tests, and thermal abuse. UL 2054 (2021) (Battery Packs) applies to complete battery packs and ensures BMS (Battery Management System) safety. UN 38.3 (2023) (United Nations Transportation Standard) requires for shipping lithium-ion batteries includes altitude, thermal, vibration, shock, impact, and overcharge tests. IEEE 1725 and IEEE 1625 (Battery Certification for Mobile Devices and Laptops) define battery reliability, charging efficiency and failure prevention.

Environmental and recycling standards are also inextricably linked to the issue of safety. RoHS (Restriction of Hazardous Substances Directive) (EU & International) describes restrictions on toxic materials such as cadmium, lead and mercury in lithium batteries. EU Battery Directive 2006/66/EC regulates the manufacture, recycling and disposal of lithium-ion batteries. ISO 14001 (Environmental Management Standard) (2024) requires sustainable production & recycling of batteries.

The authors' analysis of the literature also showed that some manufacturers deliberately overstate the mass of their products to give the impression of superior electrical performance. Consumer feedback and examples of such unethical practices are documented on online forums dedicated to this topic. The authors found instances where 18650 batteries were filled with a bulk substance to increase their mass but contained a smaller prismatic battery with low capacity inside (Hartley-Barnes, 2016; Cheap 18650 cells..., 2024; Chinese 18650 Lithium-ion Batteries..., 2024; Test ogni w Li-ion 18650..., 2024). An analysis of the available literature revealed that there are no well-defined criteria for the characterization of 18650 batteries,

but rather general issue about batteries and primary cells. It does not address these batteries as a commercial product or define criteria that could guide customers. The authors failed to identify the standards required to restrict the commercialization of low-quality batteries that may overheat, swell, or leak electrolyte. Consequently, the authors decided to undertake research focused on consumer awareness and expectations regarding this product category. The study is particularly pertinent to the current EU energy policy, which is based on the principles of decarbonization, competitiveness, and sustainability but may have wider application to consumer protection contexts.

3. Materials and methods

The research strategy involved a two-step process: an web-survey and testing of the electrical and physical parameters of 18650 batteries. The authors administered a web-survey to the customers of small batteries, in order to have clearer information on the most important characteristics of batteries and the battery features they consider when making a purchasing decision. Respondents were randomly selected, but limited to people who are members of the world-famous social network. The web-survey was submitted by webpage and was structured in two stages: the first concerned the respondents' awareness of small batteries, while the second part was based on the structure of gender, age, education and place of residence. The research included an online survey with 152 respondents (75 women and 74 men; 3 individuals did not provide gender information). All respondents were under 50 years of age, with 55% under 20 years old, 42% between 20 and 30 years old, and the remaining 3% over 30 years old. Among the respondents, 57 lived in large cities, 50 in rural areas, 39 in small towns, and the rest did not provide information on their place of residence. Most respondents had secondary education (128), while a few had primary, vocational, or higher education.

The next step involved testing the performance and quality parameters of 18650 lithium-ion batteries through laboratory measurements. The 18650 batteries were purchased from a popular auction platform. A measurement system was designed and constructed, which was equipped with three independent measurement tracks, each dedicated to a single battery under test (Figure 2).

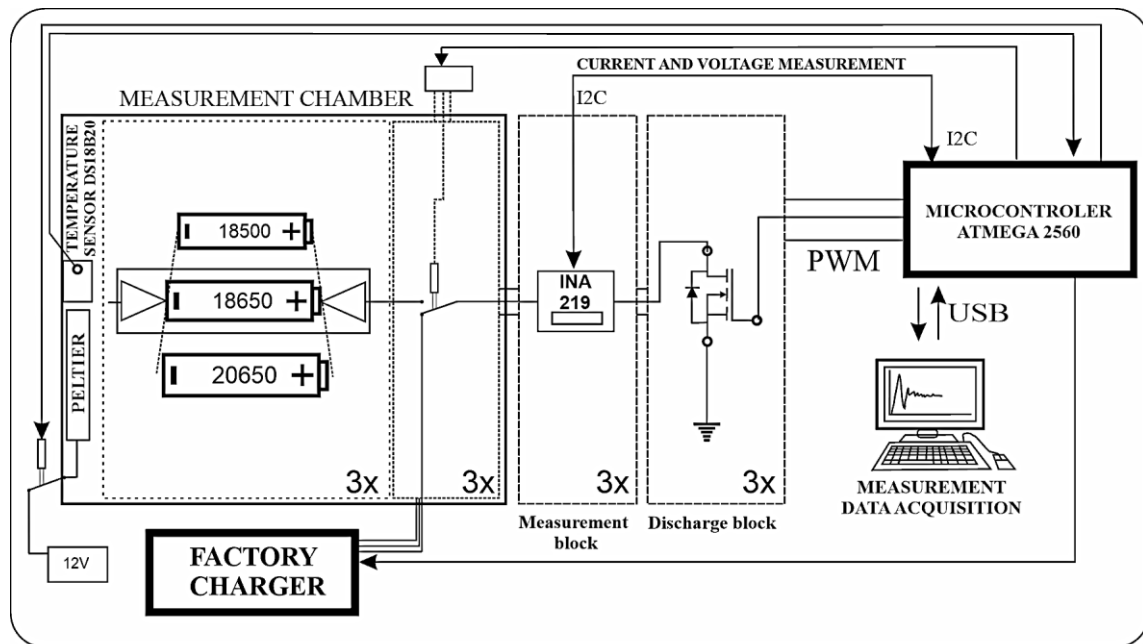


Figure 2. Measurement chamber schema.

Source: own study based on (Czerniak, Gacek, Hnatyszak, 2024).

The test chamber was equipped with temperature stabilization during battery charging and discharging (Bobobee et al., 2023; IEC, 2017a, 2017b). Charging of the test batteries was conducted using a specially adapted factory charger, which charged the batteries to a voltage of 4.2 V, in accordance with widely accepted standards for this type of battery (Fang et al., 2024). The solution adopted ensured the best representation of the user's actual battery charging conditions. The modification of the charger involved integrating components to monitor the charging and discharging processes and replacing its original charging sockets with those located within the temperature-stabilized measurement chamber. Additionally, the charger was modified to enable automatic selection of the charging mode via a computer controlling the measurement process. The second modification involved the automatic selection of the charging mode via a computer that controlled the measurement process. The battery was discharged using a digital load based on a PWM pulse-controlled MOSFET transistor, ensuring a constant discharge current during measurement. Both charging and discharging were monitored by a PC equipped with proprietary software, which not only supervised the measurement process but also archived the data. Current and voltage measurements were conducted using a 12-bit analog-to-digital converter integrated within the INA219 I2C. The results were read via the I2C bus, which was managed by an Atmega 2560 processor (Hoffman, 2018; Margolis, 2020). The entire system was calibrated with professional measuring equipment prior to commissioning and testing. The designed and constructed device enabled simultaneous automatic charging and discharging measurements on three independent tracks. Repeated measurements determined the actual capacities of the batteries, which were then compared with the capacities declared by the manufacturers.

4. Results

4.1. Web-survey

Initially, respondents were asked two main questions regarding their opinions on the most important battery features and the attributes they consider when making purchasing decisions. They were also given the opportunity to provide additional comments beyond the multiple-choice options. The data were processed using one-way analysis of variance (ANOVA) in Statistica 13.3. The responses to the first question are presented in a bar chart (Figure 3).

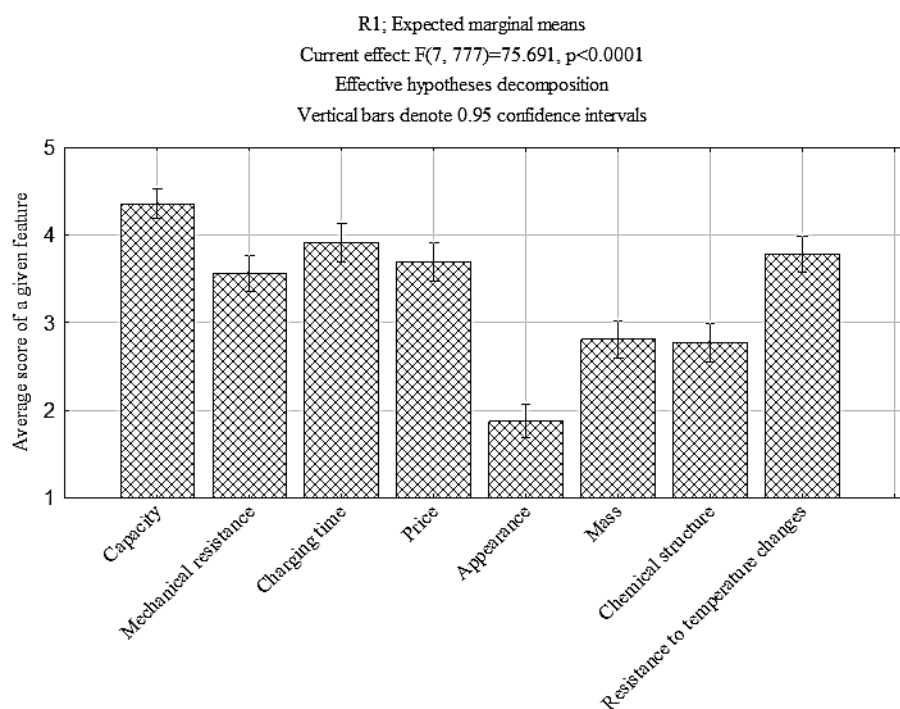


Figure 3. Respondents' average rating of key features of high-quality batteries.

Source: own study.

For the majority of respondents, the most important criteria characterizing a good battery were capacity, charging time, and resistance to low temperatures, while the least important factor was its appearance. The main effects of the analysis of variance, presented in the bar chart, are statistically significant, $F(7.777) = 75.691, p < 0.0001$. To verify the significance of differences between individual means within the series, a post-hoc Fisher's LSD test was conducted, confirming statistically significant differentiation between nearly all criteria. The only criteria not significantly differentiated from each other were ratings concerning price and mechanical resistance; price and charging time; and mass and chemical structure (Table1).

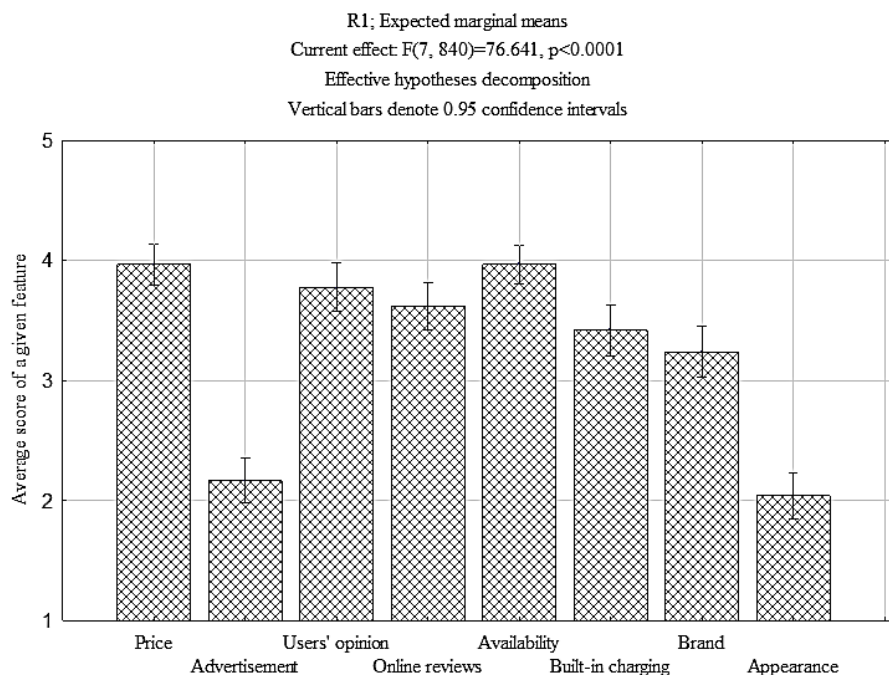
Table 1.*LSD test of respondents' average rating of key features of high-quality batteries*

Cell No.	LSD test; variable: Average score. Probabilities for post hoc tests. Error: between MS = 0,94847, df = 777,00								
	R1	{1} 4,3571	{2} 3,5625	{3} 3,9196	{4} 3,9664	{5} 1,8750	{6} 2,8125	{7} 2,7768	{8} 3,7857
1	Capacity		0,000000	0,000813	0,000000	0,000000	0,000000	0,000000	0,000013
2	Mechanical resistance	0,000000		0,006205	0,303756	0,000000	0,000000	0,000000	0,086716
3	Charging time	0,000813	0,006205		0,086716	0,000000	0,000000	0,000000	0,303756
4	Price	0,000000	0,303756	0,086716		0,000000	0,000000	0,000000	0,492879
5	Appearance	0,000000	0,000000	0,000000	0,000000		0,000000	0,000000	0,000000
6	Mass	0,000000	0,000000	0,000000	0,000000	0,000000		0,783831	0,000000
7	Chemical structure	0,000000	0,000000	0,000000	0,000000	0,000000	0,783831		0,000000
8	Resistance to temperature changes	0,000013	0,086716	0,303756	0,492879	0,000000	0,000000	0,000000	

Note: R1 -repeater factor, Bold - significant values.

Source: own study.

The answers to the second question regarding the most important criteria consumers use when purchasing a battery are presented in a column chart (Figure 4).

**Figure 4.** Respondents' average rating of key battery features in purchases decisions.

Source: own study.

For the majority of respondents, price and availability were the most important criteria determining the decision to purchase a particular brand of battery. The least important criteria were external appearance and the presence of the battery brand in advertisements.

The main effects of the analysis of variance, shown in the column chart, are statistically significant, $F(7.840) = 76.641$, $p < 0.0001$. A post-hoc Fisher's LSD test was performed to examine the significance of differences between the individual means within a given series, which confirmed statistically significant variation between almost all criteria. The ratings for price and user feedback and availability; mass and chemical structure; battery brand and having a built-in charger, were not significantly differentiated from each other (Table 2).

Table 2.

LSD test of respondents' average rating of key battery features in purchases decisions

Cell No.	LSD test; variable: Average score. Probabilities for post hoc tests.. Error: between = 0,92573, df = 840,00								
	R1	{1} 3,9669	{2} 2,1653	{3} 3,7769	{4} 3,6198	{5} 3,9669	{6} 3,4215	{7} 3,2397	{8} 2,0413
1	Price		0,000000	0,124752	0,005131	1,000000	0,000012	0,000000	0,000000
2	Advertisement	0,000000		0,000000	0,000000	0,000000	0,000000	0,000000	0,316549
3	Users' opinion	0,124752	0,000000		0,204643	0,124752	0,004170	0,000016	0,000000
4	Online reviews	0,005131	0,000000	0,204643		0,005131	0,109206	0,002185	0,000000
5	Availability	1,000000	0,000000	0,124752	0,005131		0,000012	0,000000	0,000000
6	Built-in charging	0,000012	0,000000	0,004170	0,109206	0,000012		0,141976	0,000000
7	Brand	0,000000	0,000000	0,000016	0,002185	0,000000	0,141976		0,000000
8	Appearance	0,000000	0,316549	0,000000	0,000000	0,000000	0,000000	0,000000	

Note: R1 -repeater factor, Bold - significant values.

Source: own study.

Summarizing the survey results, the most important characteristics for consumers are battery capacity, price, and availability. To a lesser extent, consumers consider mass and chemical structure. The survey findings prompted the authors to conduct a technical study on 18650 batteries available on the Polish market. These batteries were divided into two price ranges: those priced up to 20 PLN and those above this amount.

4.2. Testing 18650 Batteries

All batteries were repeatedly charged and discharged at a current of 500 mA. The results are presented in a column graph (Figure 5).

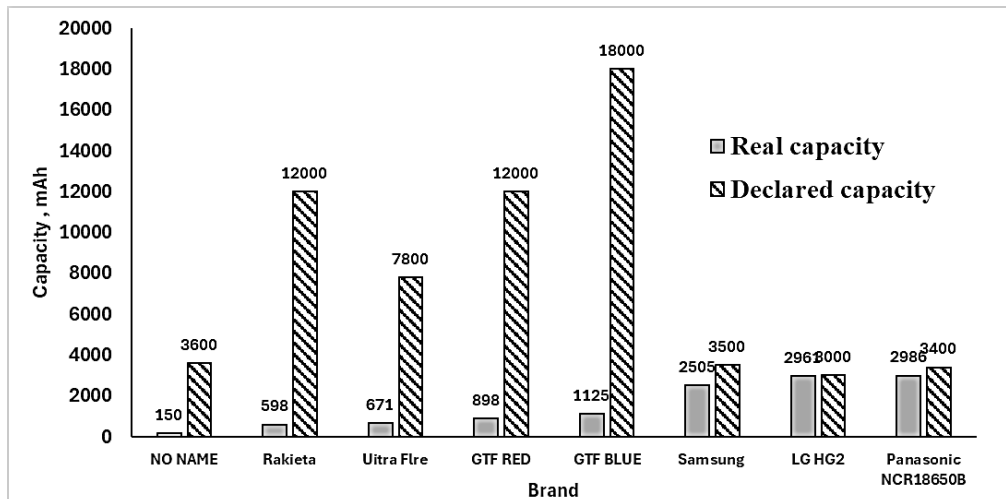


Figure 5. Declared capacity/measured capacity – temperature 21°C.

Source: own study.

As observed in the characteristic curve (Figure 5), the declared capacities significantly deviate from the measured capacities. To more clearly illustrate the differences between the declared capacities and the capacities measured with the testing equipment, the column chart displays the percentage values of the measured capacities relative to the declared capacities (Figure 6).

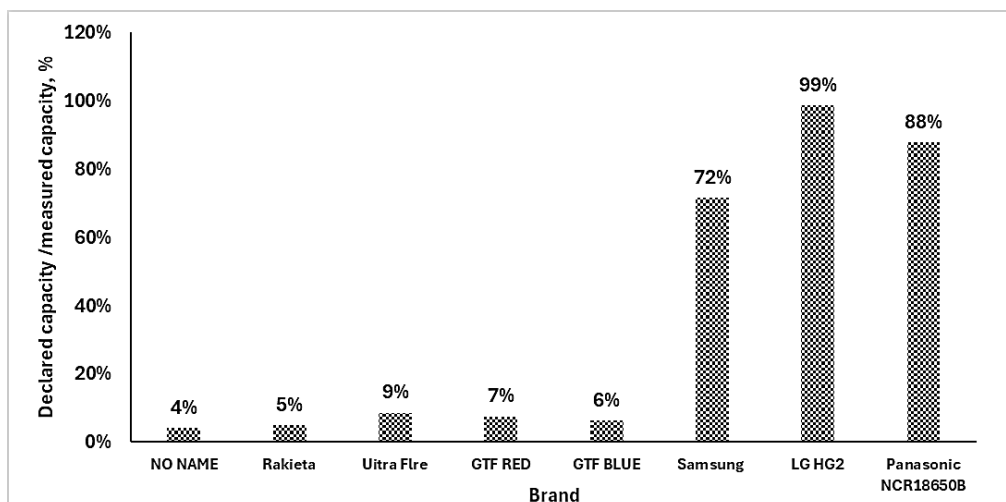


Figure 6. Percentage values of declared capacity vs. measured capacity.

Source: own study.

The first five brands were part of the product group priced below 20 PLN. These products had declared capacities that could not be achieved given the battery's chemical structure. In the second group of products, the difference between declared and measured capacities was minimal. The most favorable capacity was found in the LG brand, achieving 99% of its declared capacity in the study.

In the web-survey, respondents were asked about the importance of various battery characteristics, including mass and capacity. Statistical analysis indicated that mass was less important to consumers than capacity. Consequently, the authors investigated the correlation

between measured capacity and battery mass. Identifying such a correlation could facilitate the selection of the best battery without requiring electrical measurements. The column chart (Figure 7) presents a comparison of these two parameters.

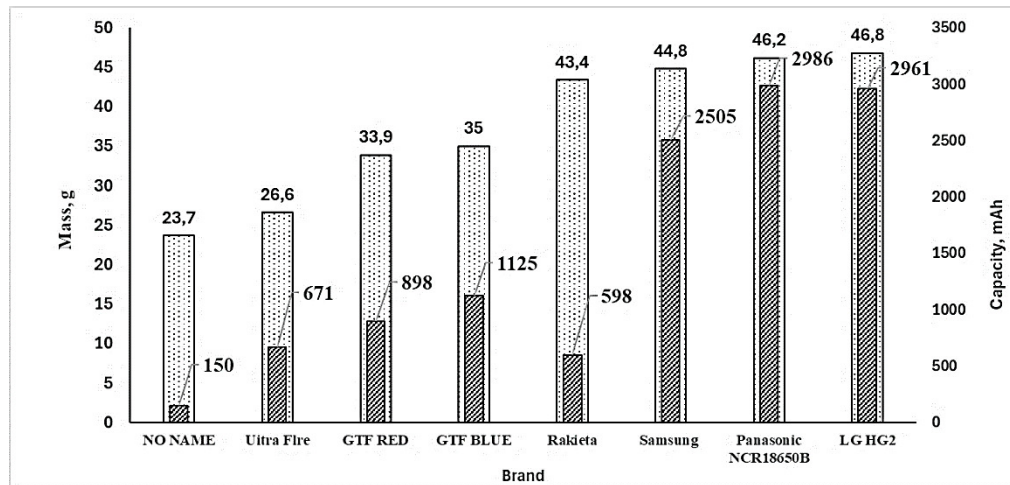


Figure 7. Battery mass – correlation of mass with capacity.

Source: own study.

As shown in the column chart (Figure 7), almost all batteries with a higher mass also exhibit a higher capacity. Only in one instance was a higher mass recorded for a battery with a low actual capacity. According to the design and mass analysis of batteries, mass measurements should be indicative of capacity (Czerwiński, 2012; Beard, 2019).

5. Discussion of Results and Conclusions

As part of this study, the literature on 18650 batteries and relevant standards for lithium-ion batteries were analyzed. It was found that there are no guidelines in the literature or existing standards that explicitly describe the parameters for 18650 batteries. In order to identify the most important features of these batteries from the consumer's point of view, a web survey was conducted asking respondents about the most important features and parameters that influence their purchasing decisions. Statistical analysis of the survey results indicated that the most important features were battery capacity and price. As a result, research focused on low- and mid-range products. The tests were conducted using a device designed to record the charging and discharging parameters of the batteries. The results demonstrated that the capacities of products in the lower price range (below PLN 20) did not correspond to the capacities declared by the manufacturers. The analysis clearly showed that cheaper products exhibited actual capacities less than 10% of their declared values. In contrast, products from the mid-priced range and well-known brands achieved up to 99% of the declared capacity. The research results

indicate that purchasing batteries from reputable manufacturers is more reliable, as the declared capacities correspond to the measured values.

The study also investigated whether using product mass as a criterion could help select higher-quality products without electrical testing. Unfortunately, the research showed that some low-quality products have a mass similar to that of branded products. Manufacturers may achieve this mass through unethical practices, such as adding substances to increase the mass of the battery.

In conclusion, it is crucial to legislate the production of this type of energy source and protect consumers from unfair practices by manufacturers. Currently, there are no such regulations and consumers purchasing these goods in the Polish market rely mainly on opinions posted on auction portals. However, many of these opinions are unreliable due to a lack of knowledge about the electrical parameters of this type of energy source. As a result, consumers often purchase cheaper products that offer only a fraction of the capacity claimed by the manufacturer. Given the number of charge and discharge cycles for these products, lower capacity batteries have a significant environmental and economic impact because they need to be replaced and recycled more frequently. The recycling process is as costly for lower quality products as it is for higher quality products that last longer. The difference lies in their lifetime, which is closely linked to their capacity.

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VALUE IN SHORT FOOD SUPPLY CHAINS

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Purpose: This study examines consumer preferences in Short Food Supply Chains (SFSCs) to identify key factors influencing purchasing decisions. The research aims to bridge the gap in understanding consumer-perceived value in SFSCs and provide practical insights for producers and policymakers.

Design/methodology/approach: The study employs Q-methodology, integrating quantitative and qualitative analysis, to classify consumer viewpoints. A structured survey was conducted among 340 Polish consumers from the Małopolska and Mazowieckie regions who actively purchase via SFSCs. Principal Component Analysis (PCA) was applied to identify distinct consumer perspectives.

Findings: The analysis reveals five consumer viewpoints regarding SFSCs. The most critical purchasing factors are food quality, freshness, and safety, followed by local patriotism. Convenience is moderately important, while direct relationships with producers are ranked lower. The study suggests that marketing efforts should focus on quality assurance, certification, and local product origin, rather than emphasizing producer-consumer interactions.

Research limitations/implications: This study focuses on two Polish regions, which may limit the applicability of its findings to other areas or populations. Selection bias may arise, as only active SFSCs consumers were surveyed, excluding those deterred by price or convenience. Future research should explore broader demographics, regional differences, and alternative SFSC models, including digital platforms.

Practical implications: Producers should emphasize product freshness, safety, and local sourcing in marketing strategies. Expanding distribution options (e.g., home delivery, subscription boxes) could attract convenience-driven consumers. Certification and quality labels can enhance consumer trust and support premium pricing.

Originality/value: This study provides a novel application of Q-methodology to SFSC consumer analysis. Unlike prior studies, it offers a data-driven segmentation of consumer motivations, guiding businesses toward strategic marketing and distribution improvements to enhance SFSC viability. Furthermore, the study expands the understanding of consumer trust, ethnocentric purchasing behavior, and value perception in SFSCs, offering actionable insights for both producers and policymakers aiming to strengthen local food systems.

Keywords: Short food supply chains, value dimensions, Q-Methodology, consumer behaviour, sustainability.

Category of the paper: Research paper.

1. Introduction

Short food supply chains (SFSCs) have emerged relatively recently as a focus of academic research, with the first mention of the term appearing at the beginning of the 21st century (Renting et al., 2003). A significant milestone in this field was the report by Kneafsey et al. (2013), which classified and characterized SFSCs, providing a structured overview of prior knowledge and organizing the discourse on the subject. Building on this foundation, analyses of short supply chains typically are built on general assumptions related to supply chain management, with particular emphasis on food supply in selected regions of the world (Doernberg et al., 2022; Little, Sylvester, 2022; Dorneich et al., 2024). Additionally, several review papers have also contributed significantly to the development of SFSC research. These reviews have explored potential research opportunities and addressed topics such as logistics (Paciarotti, Torregiani 2020), general problems and challenges faced by SFSC participants (Bayir et al., 2022), systematic bibliographic insights (Luo et al., 2021), as well as consumer-related issues (Delicato et al., 2019; Csordas et al., 2022).

Despite these contributions, certain gaps in the literature remain. Specifically, in papers regarding consumer-related issues, neither Csordas et al. (2022) nor Delicato et al. (2019) adequately address the issue of defining SFSC value and examining its essence for consumers or producers. Their discussion is limited to a superficial description of potential values, focusing solely on trust and sustainable development with appropriate origin protection labels, without satisfactorily defining the concept of value – even from the consumer’s perspective (Delicato et al., 2019). Notably, other literature on consumers refers to their attitudes (Giampietri et al., 2016; Elghannam et al., 2019; Benos et al., 2022), trust (Ji et al., 2020), or behaviors (Sadeli et al., 2023). Collectively, these works highlight significant interest in consumer-related aspects of SFSCs. However, they also underscore a critical gap: the lack of comprehensive research into defining value for consumers in SFSCs. This gap extends to the absence of robust attempts to measure what constitutes the greatest value for consumers, a factor that could have significant implications for producers’ marketing activities.

2. Methodology and data

The Q methodology was selected as the research tool, adapted to interlink qualitative and quantitative approaches to explore five key aspects of values in SFSCs that are also present in value based food chains regardless of the region in which the research was conducted (Peterson et al., 2022; Jackson et al., 2024). These aspects, which are in line with findings of O’Connor et al. (2024), were identified through a comprehensive literature review and consultation with experts:

1. **Convenience:** This aspect encompasses factors related to the ease of access to goods, minimizing consumer effort, providing flexible payment options, and enabling the purchase of diverse products in one place (Paloviita, 2010; Cranfield et al., 2012; Mack, Tong 2015; Giampietri et al., 2016; Koutsou, Sergaki, 2019; Stanco et al., 2019; Gonzalez-Azcarte et al., 2021; Benos et al., 2022).
2. **Local patriotism:** Referring to consumer attitudes driven by ethnocentric behaviours, this aspect emphasizes purchasing locally produced goods from one's home region or country (Paloviita, 2010; Pearson et al., 2011; Cranfield et al., 2012; Giampietri et al., 2016; Elghannam et al., 2019; Koutsou, Sergaki, 2019; Gonzalez-Azcarte et al., 2021).
3. **Lifestyle:** A multifaceted aspect that reflects factors influencing social status, adherence to global trends, and aspirations for an elevated standard of living (Paloviita, 2010; Pearson et al., 2011; Cranfield et al., 2012; Giampietri et al., 2016; Stanco et al., 2019; April-Lalonde et al., 2020; Gonzalez-Azcarte et al., 2021; Benos et al., 2022).
4. **Relations with the food producer:** This aspect highlights the importance of reliability and transparency, encompassing knowledge about the producer's background, the offered products, opportunities for direct communication, and support for socially significant issues such as senior activity or female entrepreneurship (Paloviita, 2010; Cranfield et al., 2012; Mack, Tong 2015; Giampietri et al., 2016; Ji et al., 2020; Gonzalez-Azcarte et al., 2021).
5. **Food quality and safety:** This aspect pertains to consumer trust in the safety and nutritional value of food, emphasizing attributes like superior taste and certified product quality, often linked to purchasing directly from the producer (Paloviita, 2010; Pearson et al., 2011; Cranfield et al., 2012; Giampietri et al., 2016; Stanco et al., 2019; April-Lalonde et al., 2020; Gonzalez-Azcarte et al., 2021).

Building on the five defined aspects of value in short supply chains, a survey was developed to assess consumers' ratings of the importance of statements related to specific aspects of value. These statements were informed by insights from a literature review and expert consultations.

The analysis draws on data from 340 survey responses collected from Polish citizens residing in the Małopolska and Mazowieckie regions, who engage in short value chains by purchasing directly from the farmer - either at the farm, at the market or bazaars, or through home deliveries. Respondents who did not buy through short value chains or lived outside the Małopolska or Mazowieckie regions were excluded from the sample. The sample was intentionally diverse, designed to reflect the national population's demographic composition, including factors such as gender, age, education, city size, household size, and income. A detailed overview of the sample characteristics is provided in Table 1.

Table 1.*Descriptive statistics and representativeness of the sample*

	Number of respondents	Share of respondents		Number of respondents	Share of respondents
Total	340	100%	Total	340	100%
Sex			Region		
Female	184	54.12%	Małopolska	167	49.12%
Male	156	45.88%	Mazowieckie	173	50.88%
Age			Household size		
18-24	48	14.12%	1	52	15.29%
25-34	68	20.00%	2	101	29.71%
34-44	74	21.76%	3	69	20.29%
45-54	73	21.47%	4	69	20.29%
55-64	37	10.88%	5+	49	14.41%
65+	40	11.76%	Monthly household net income		
Education			Refuse to answer	48	14.12%
Incomplete primary or without formal education	1	0.29%	Less than 1000 PLN	5	1.47%
Completed primary	4	1.18%	1000-1999 PLN	7	2.06%
Lower secondary	4	1.18%	2000-2999 PLN	14	4.12%
Vocational or technical secondary	32	9.41%	3000-3999 PLN	21	6.18%
Secondary or post-secondary	118	34.71%	4000-4999 PLN	37	10.88%
Higher	181	53.24%	5000-7499 PLN	62	18.24%
City of residence			7500-9999 PLN	50	14.71%
Countryside	84	24.71%	10,000-12,499 PLN	49	14.41%
City below 50,000 residents	59	17.35%	12,500-14,999 PLN	26	7.65%
City with 50,001-100,000 residents	27	7.94%	15,000-17,499 PLN	8	2.35%
City with 100,001-500,000 residents	29	8.53%	17,500-19,999 PLN	6	1.76%
City above 500,000 residents	141	41.47%	Over 20,000 PLN	7	2.06%

Due to the relatively small number of quantitative studies (Luo et al., 2021) on short supply chains, the exact number of consumers purchasing through this form of product distribution in any region of the world is not known. Studies described in the literature often lack information on the sample selection method (Bougherara et al., 2009; Kawecka, Gębarowski, 2015; Koutsou, Sergaki, 2019; Santulli et al., 2019; Lioutas, Charatsari, 2020; Raftowicz et al., 2020), while the available data contained in scientific articles indicate that the number of customers making purchases within short supply chains varies and ranges from 0.5% to 7% of all customers, depending on the research methods adopted and the region studied (Blanquart et al., 2010; Pearson et al., 2011; Mack, Tong, 2015; Giampietri et al., 2016; Aggestam et al., 2017; Kallas et al., 2019; Gonzalez-Azcarate et al., 2021; Benos et al., 2022). Using available data from the Central Statistical Office (GUS, 2020) relating to Polish agribusiness, 2.8% of farms operate within the Agricultural Retail Trade and farms conducting this type of activity usually use short supply chains as part of their distribution activities, preferring sales at markets and

sales from a farm shop or roadside sales in the absence of a specially designated sales point at the place of production. Based on these calculations, it can be assumed that the ratio of the number of customers is similar to the ratio of the number of producers and amounts to about 2-3% of all customers. Based on the quoted estimates and statistical calculations, the research sample comprised 340 respondents, of whom 167 came from the Małopolska region and the remaining 173 people from the Mazowieckie region. These specific regions were selected because they contain the largest cities in Poland and usually denizens of the largest cities have the greatest possibility of choosing different forms of purchasing goods which is consistent with the philosophy of short food supply chains (Jarzębowski, Klepacki, 2013; Matwiejczuk, Tłuczak, 2020; Szymańska, Lukoszova, 2019).

The survey also explored respondents' shopping preferences, detailed in Table A1 of the appendix, providing further insight into their behavior and attitudes toward short value chains. Additionally, the survey included a Likert scale assessing the importance of various agricultural goals. The results, illustrated in the Box and Whisker Plots in Figure 1, reveal that respondents prioritize providing safe, healthy, and high-quality food as the most crucial agricultural goal, with an average ranking of 6.12. In contrast, creating economic growth and jobs in rural areas was ranked as the least important, with an average score of 5.65. Although the seven proposed agricultural goals were rated relatively similar, suggesting a general consensus, this observation raises concerns about the effectiveness of the Likert scale in clearly differentiating the importance of each goal. The closely clustered ratings could imply that all goals are viewed as nearly equivalent, which complicates the task of establishing a clear hierarchy of factors. Therefore, to more accurately address the research question of ranking the factors influencing willingness to buy from short value chains, we opted to employ Q-methodology.

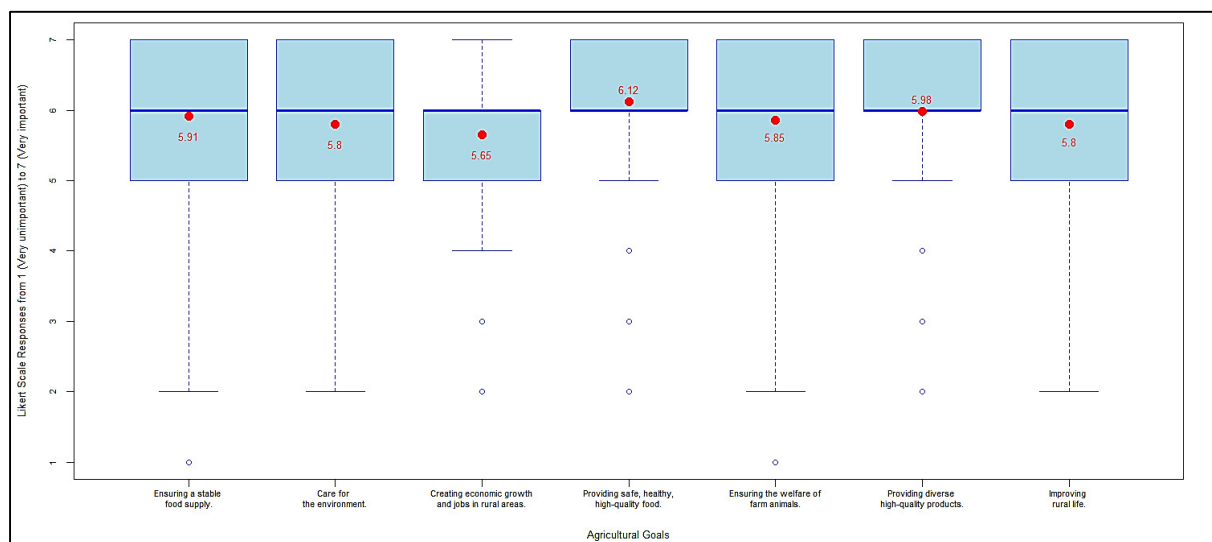


Figure 1. Box and Whisker Plots for Likert Scale Responses Regarding Importance of Agricultural Goals.

The Q-methodology is widely employed to examine subjectivity, aiming to uncover social viewpoints in a systematic manner (Brown et al., 2008). This approach uniquely bridges qualitative and quantitative research by combining the rigorous statistical factor analysis with the nuanced qualitative task of ranking a series of statements. While traditionally rooted in the social sciences, Q-methodology has recently found applications in agricultural and environmental research (Sneegas et al., 2021). For instance, Schulze et al. (2024) investigated how information about ecosystem services influences food labeling frameworks within the European Union's Farm to Fork Strategy. The other examples concern Sudau et al. (2023), who explored the factors that shape the acceptance rate of spatial planning instruments designed to manage soil quality or Schulze & Matzdorf (2023), who examined the perceptions of farmers, policymakers, and intermediaries regarding the contract's features of agri-environmental policies. The aforementioned examples underscore the ultimate goal of Q-methodology, which concerns the identification of a spectrum of opinions and linking them to distinct groups within the population or specific stakeholder groups.

A key distinction of our study lies in its more quantitative rather than qualitative approach. While Q-methodology is typically employed in relatively small samples (so-called P-set), often with no more than 20 responses, we opted to conduct our analysis on a substantially larger sample of 340 respondents. We contend that this larger sample size will yield more reliable and robust results, offering valuable insights into the factors influencing the willingness to buy from short value chains. In contexts where the focus is on small, specific groups (such as policy stakeholders), in-depth interviews or focus groups are appropriate. However, when examining the opinions of a broader population, like participants in short value chains, such qualitative methods may lead to unreliable or biased conclusions due to the limited sample size relative to a larger population. Thus, we believe that adapting the traditional Q-methodology by expanding the sample size (at the expense of its qualitative nature) is both a reasonable and necessary adjustment in this context.

Our Q-methodology aims to capture a comprehensive, holistic view of subjective opinions regarding the most and least important factors when purchasing food directly from a farmer (i.e., from short value chains), and in designing the experiment, we adhered to the guidelines provided by Zabala et al. (2018). However, deviating from the traditional approach, we did not require respondents to rank all statements simultaneously on a bell curve-shaped diagram. Instead, we presented them with a series of sequential questions to simplify the decision-making process. This modification was informed by qualitative pretesting during a pilot study with 22 respondents, which indicated that simplifying the research task would enhance clarity and engagement. Therefore, respondents were presented with a Q-set of 25 statements in the Q-methodology module and asked to identify the nine most important statements. Subsequently, participants faced separate questions in which they selected the two most important and three second-most important factors. Similarly, respondents were asked to identify nine unimportant factors, followed by selecting the two least important and three

second-least important factors. This approach allowed us to gather data equivalent to classical Q-methodology, which typically involves a bell-shaped distribution (2-3-4-7-4-3-2) across 25 statements, ranked from the least to most important.

The Q-set, consisting of 25 statements, was carefully curated through a literature review, as detailed in Chapter 2. The complete list of statements can be found in Table 2. Notably, during the preparation of the concourse, these statements were categorized into five distinct groups, each representing different influencing factors: convenience of purchase, local patriotism (emphasizing proximity to the place of production), lifestyle (encompassing dietary preferences and trends), relations with the producer, and food safety and quality. Notably, the order of statements presented to respondents was randomized, and there was no information on which of the five groups the statements were categorized.

Table 2.
Descriptive statistics regarding statement ranking

Statements	Mean	Standard deviation	Median	Skew	Kurtosis	Standard error
#1 Ease of access to the selling point	2.78	1.73	3	0.06	-0.79	0.09
#2 Ease and flexibility in selecting the purchase date	2.80	1.40	3	-0.09	-0.45	0.08
#3 Ease and flexibility in choosing the payment method	2.17	1.47	2	0.22	-0.74	0.08
#4 Possibility to purchase all required products	2.94	1.41	3	0.05	-0.35	0.08
#5 Possibility to choose from a diverse range of products	3.09	1.28	3	0.02	0.16	0.07
#6 Possibility to purchase products from the local region	3.04	1.46	3	-0.19	-0.33	0.08
#7 Possibility to purchase products directly from the producer, bypassing intermediaries	3.74	1.61	4	-0.43	-0.46	0.09
#8 Possibility to support the local community	3.41	1.45	3	-0.30	-0.24	0.08
#9 Possibility to buy national products	3.89	1.54	4	-0.56	-0.22	0.08
#10 Possibility of direct financial support for the producer (farmer)	3.06	1.34	3	0.02	-0.13	0.07
#11 Availability of high-quality food, rich in nutritional value	3.83	1.45	4	-0.15	-0.47	0.08
#12 Availability of ecological products	3.29	1.50	3	-0.11	-0.34	0.08
#13 Possibility to boast to friends about the source of the purchase	1.21	1.34	1	0.87	-0.17	0.07
#14 Availability of products with the highest quality regardless of their price	2.82	1.43	3	0.19	-0.22	0.08
#15 Availability of unique products not available elsewhere	2.71	1.37	3	0.17	-0.17	0.07
#16 Opportunity to meet and converse directly with the producer (farmer)	2.21	1.53	2	0.39	-0.53	0.08
#17 Opportunity for repeat purchases from the same producer (farmer)	2.68	1.49	3	0.12	-0.65	0.08
#18 Opportunity to learn about the origin of products and the farm's history	1.99	1.44	2	0.56	-0.21	0.08
#19 Opportunity to support women's entrepreneurship	2.16	1.36	2	0.17	-0.43	0.07
#20 Opportunity to support senior entrepreneurship	2.37	1.49	2	0.25	-0.43	0.08
#21 Certainty that the purchased food is free from excessive additives and is not processed	4.05	1.52	4	-0.44	-0.39	0.08
#22 Certainty that products are fresh	4.63	1.52	5	-1.11	0.54	0.08
#23 Certainty that food has proper certificates and quality marks	2.46	1.41	3	0.27	0.00	0.08
#24 Certainty that products taste better than those found in stores	3.82	1.50	4	-0.39	-0.41	0.08
#25 Certainty that products are in superior condition compared to store-bought alternatives	3.83	1.45	4	-0.39	-0.33	0.08
Groups	Mean	Standard deviation	Median	Skew	Kurtosis	Standard error
Group A: Convenience (statements 1:5)	2.76	0.76	3	0.22	-0.41	0.04
Group B: Local patriotism (statements 6:10)	3.43	0.77	3	-0.03	-0.30	0.04
Group C: Lifestyle (statements 11:15)	2.77	0.65	3	-0.01	-0.44	0.04
Group D: Relations with the food producer (statements 16:20)	2.28	0.68	2	0.28	-0.33	0.04
Group E: Food safety and quality (statements 21:25)	3.76	0.75	4	-0.44	-0.28	0.04

Note: The statements were ranked from 0 (least important factors) to 6 (the most important factors).

The results presented in Table 2 indicate that the most important factor when buying directly from the farmer was the assurance of product freshness, with statement #22 (“Certainty that products are fresh”) receiving the highest average score of 4.63 (out of 6). Similarly, other statements related to food quality and health were highly ranked. Statement #21 (“Certainty that the purchased food is free from excessive additives and is not processed”) scored an average of 4.06, while statement #11 (“Availability of high-quality food, rich in nutritional value”) received a score of 3.83. Additionally, respondents emphasized the superior quality of products sold directly by farmers, with statement #25 (“Certainty that products are in superior condition compared to store-bought alternatives”) and statement #24 (“Certainty that products taste better than those found in stores”) both scoring 3.83 and 3.82, respectively. Respondents also demonstrated a strong preference toward locality, as evidenced by the ratings for statement #9 (“Possibility to buy national products”), which scored 3.89, and statement #8 (“Possibility to support the local community”), which scored 3.41. Another key factor influencing purchases from short value chains was the opportunity to buy directly from the producer, with statement #7 (“Possibility to purchase products directly from the producer, bypassing intermediaries”) receiving a rating of 3.74.

On the contrary, the least important factors predominantly involved direct interactions with the producer. Statement #16 (“Opportunity to meet and converse directly with the producer (farmer)”) received an average score of 2.21, while statement #19 (“Opportunity to support women's entrepreneurship”) was rated 2.16, and statement #18 (“Opportunity to learn about the origin of products and the farm's history”) scored 1.99. These results suggest that respondents were more focused on their well-being and buying high-quality, healthy products rather than on fostering relationships or supporting producers directly. Other factors deemed less important included statement #3 (“Ease and flexibility in choosing the payment method”), with a score of 2.17, and statement #13 (“Possibility to boast to friends about the source of the purchase”), which received the lowest score of 1.21. Figure 2 visually summarizes the ranking of these statements through a radar chart.

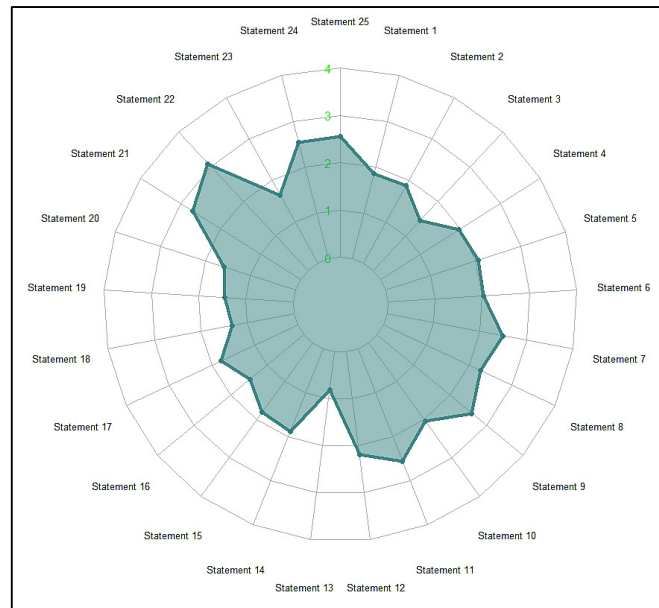


Figure 2. Radar chart presenting ranking of the statements – individual factors.

When designing the concourse and Q-set, we deliberately grouped the statements (based on a thorough literature review, agricultural expert conclusions, and a pilot study) to ensure they represent distinct perspectives without disproportionately emphasizing any category. This approach was intended to simplify and facilitate the interpretation of the results, allowing us to identify which of the five strategies for promoting short value chains might be the most effective. Among these groups, Group E (“Food safety and quality”) emerged as the highest-ranked, with an average score of 3.76. This indicates that the primary motivation for purchasing directly from farmers is the intrinsic desire to obtain the healthiest and highest-quality food. Interestingly, the second-highest ranked group of factors was Group B (“Local patriotism”), which scored 3.34, while Group D (“Relations with the food producer”) received the lowest score of 2.28. This suggests that while respondents are inclined to support their local community and economy by purchasing local products, they are less interested in building and fostering direct relationships with farmers. The remaining groups, Group A (“Convenience”) and Group C (“Lifestyle”) received similar scores of 2.76 and 2.77, respectively. Figure 3 visually represents the ranking of these statement groups using a radar chart.

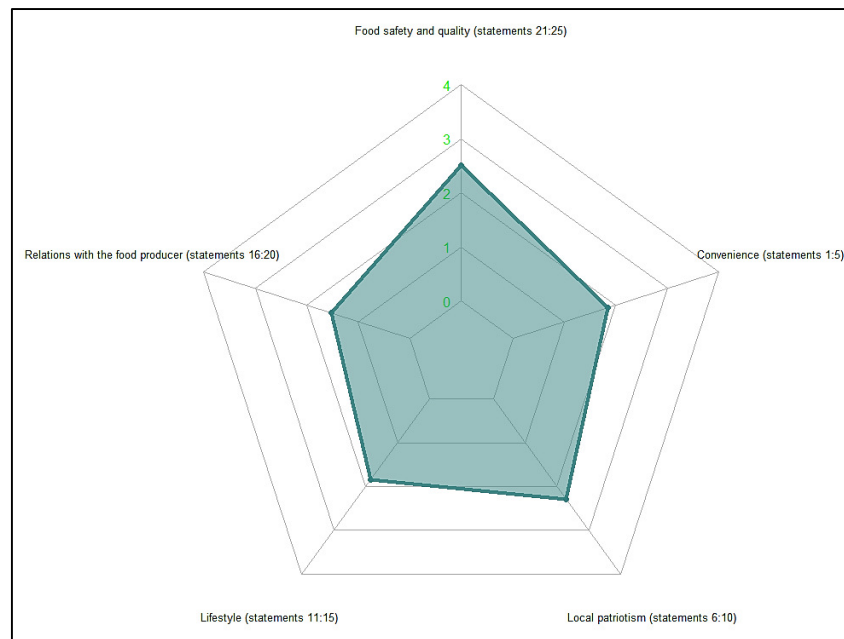


Figure 3. Radar chart presenting ranking of the statements – grouped statements.

3. Results

The data was analyzed with Principal Component Analysis (PCA) through the “qmethod” package in R (Zabala, 2014). To determine the number of distinct viewpoints, we adhered to several established guidelines, including the Kaiser-Guttman criterion and Humprey’s Rule, ensuring that eigenvalues exceeded one and that the explained variance was substantial (Guttman, 1954; Brown, 1980; Kline, 2014; Zabala, 2018). Table 3 provides a summary of the five identified viewpoints (regarding the most and the least important factors when purchasing food directly from a farmer), detailing the number of Q-sorts loading on each viewpoint, along with their corresponding eigenvalues and explained variance.

Table 3.

Statistics regarding identified viewpoints, including the number of loaded Q-sorts, eigenvalues, and explained variance

	Number of loaded Q-sorts	Eigenvalues	Explained variance
Viewpoint #1	71	52.211	15.356%
Viewpoint #2	55	43.082	12.671%
Viewpoint #3	46	41.576	12.228%
Viewpoint #4	17	17.00	5.00%
Viewpoint #5	11	15.70	4.62%
Total	200		49.875%

Note: When conducting a principal component analysis, we decided to apply varimax rotation.

Notably, out of 340 Q-sorts, only 200 were associated (loaded) with one of the five viewpoints identified viewpoints. The remaining Q-sorts, which either aligned with multiple viewpoints or did not align with any, were excluded from further analysis as they did not contribute meaningfully to identifying a specific viewpoint. Table 4 presents a summary of the five distinct viewpoints, along with the ranked scores of each statement. The final five rows display the average scores for groups of statements that were artificially constructed to facilitate the interpretation of the results.

Table 4.

List of statements and viewpoints on short value chains (with factor scores)

Statements	Viewpoint #1	Viewpoint #2	Viewpoint #3	Viewpoint #4	Viewpoint #5
#1 Ease of access to the selling point	0	4	3	5	0
#2 Ease and flexibility in selecting the purchase date	2	3	3	1	3
#3 Ease and flexibility in choosing the payment method	1	3	1	1	3
#4 Possibility to purchase all required products	2	4	3	2	3
#5 Possibility to choose from a diverse range of products	3	4	3	3	2
#6 Possibility to purchase products from the local region	3	3	4	3	2
#7 Possibility to purchase products directly from the producer, bypassing intermediaries	3	4	6	5	6
#8 Possibility to support the local community	4	2	5	4	3
#9 Possibility to buy national products	5	3	6	5	0
#10 Possibility of direct financial support for the producer (farmer)	4	2	5	2	3
#11 Availability of high-quality food, rich in nutritional value	5	5	3	4	2
#12 Availability of ecological products	4	3	2	6	1
#13 Possibility to boast to friends about the source of the purchase	0	0	0	1	5
#14 Availability of products with the highest quality regardless of their price	3	2	2	3	5
#15 Availability of unique products not available elsewhere	3	3	2	0	4
#16 Opportunity to meet and converse directly with the producer (farmer)	1	1	1	4	4
#17 Opportunity for repeat purchases from the same producer (farmer)	2	2	3	3	6
#18 Opportunity to learn about the origin of products and the farm's history	1	1	1	3	3
#19 Opportunity to support women's entrepreneurship	2	1	2	2	1
#20 Opportunity to support senior entrepreneurship	3	0	3	3	1
#21 Certainty that the purchased food is free from excessive additives and is not processed	6	6	4	4	3
#22 Certainty that products are fresh	6	6	5	6	5
#23 Certainty that food has proper certificates and quality marks	3	3	0	3	2
#24 Certainty that products taste better than those found in stores	5	5	4	0	4
#25 Certainty that products are in superior condition compared to store-bought alternatives	4	5	4	2	4
Groups	Mean score				
Group A: Convenience (statements 1:5)	1.6	3.6	2.6	2.4	2.2
Group B: Local patriotism (statements 6:10)	3.8	2.8	5.2	3.8	2.8
Group C: Lifestyle (statements 11:15)	3	2.6	1.8	2.8	3.4
Group D: Relations with the food producer (statements 16:20)	1.8	1	2	3	3
Group E: Food safety and quality (statements 21:25)	4.8	5	3.4	3	3.6

Table 5 provides a summary of the sociodemographic characteristics of respondents who were identified to exhibit one of the distinctive viewpoints. For instance, viewpoint 1 has a higher proportion of women (72%), while viewpoints 4 and 5 are predominantly male, with 65% and 64% men, respectively. This data can be instrumental in identifying differing perspectives among citizens, enabling tailoring more targeted strategies to promote short value chains. However, caution must be exercised when interpreting these findings, as they may be misleading due to the law of small numbers (Tversky, Kahneman, 1971). In small samples,

even a few additional or missing observations within a group can disproportionately overrepresent or underrepresent particular consumer segments. Although our effort to expand the research sample to 340 aimed to mitigate this bias, it does not entirely eliminate the risk of such distortions.

Table 5.
Distribution of respondents across viewpoints

	All	% share	Viewpoint #1	% share	Viewpoint #2	% share	Viewpoint #3	% share	Viewpoint #4	% share	Viewpoint #5	% share
Total	200	100%	71	100%	55	100%	46	100%	17	100%	11	100%
Sex												
Female	118	59%	51	72%	31	56%	26	57%	6	35%	4	36%
Male	82	41%	20	28%	24	44%	20	43%	11	65%	7	64%
Age												
18-24	29	15%	9	13%	11	20%	6	13%	2	12%	1	9%
25-34	40	20%	17	24%	12	22%	5	11%	2	12%	4	36%
34-44	41	21%	14	20%	8	15%	11	24%	6	35%	2	18%
45-54	45	23%	14	20%	14	25%	13	28%	3	18%	1	9%
55-64	24	12%	9	13%	7	13%	6	13%	1	6%	1	9%
65+	21	11%	8	11%	3	5%	5	11%	3	18%	2	18%
Education												
Incomplete primary or without formal education	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Completed primary	2	1%	0	0%	1	2%	0	0%	0	0%	1	9%
Lower secondary	1	1%	1	1%	0	0%	0	0%	0	0%	0	0%
Vocational or technical secondary	14	7%	4	6%	5	9%	2	4%	2	12%	1	9%
Secondary or post-secondary	78	39%	30	42%	20	36%	20	43%	5	29%	3	27%
Higher	105	53%	36	51%	29	53%	24	52%	10	59%	6	55%
City of residence												
Countryside	48	24%	19	27%	10	18%	13	28%	4	24%	2	18%
City below 50,000 residents	33	17%	16	23%	8	15%	5	11%	3	18%	1	9%
City with 50,001-100,000 residents	19	10%	8	11%	2	4%	5	11%	1	6%	3	27%
City with 100,001-500,000 residents	17	9%	4	6%	4	7%	7	15%	2	12%	0	0%
City above 500,000 residents	83	42%	24	34%	31	56%	16	35%	7	41%	5	45%
Region												
Małopolska	108	54%	38	54%	35	64%	25	54%	8	47%	2	18%
Mazowieckie	92	46%	33	46%	20	36%	21	46%	9	53%	9	82%
Household size												
1	33	17%	10	14%	10	18%	8	17%	4	24%	1	9%
2	56	28%	17	24%	16	29%	15	33%	4	24%	4	36%
3	42	21%	15	21%	11	20%	11	24%	2	12%	3	27%
4	46	23%	17	24%	13	24%	10	22%	5	29%	1	9%
5+	23	12%	12	17%	5	9%	2	4%	2	12%	2	18%
Monthly household net income												
Refuse to answer	29	15%	6	8%	12	22%	9	20%	1	6%	1	9%
Less than 1000 PLN	4	2%	2	3%	1	2%	0	0%	0	0%	1	9%
1000-1999 PLN	1	1%	0	0%	1	2%	0	0%	0	0%	0	0%
2000-2999 PLN	8	4%	1	1%	1	2%	2	4%	4	24%	0	0%
3000-3999 PLN	12	6%	3	4%	4	7%	2	4%	2	12%	1	9%
4000-4999 PLN	21	11%	8	11%	2	4%	8	17%	1	6%	2	18%
5000-7499 PLN	45	23%	15	21%	18	33%	8	17%	4	24%	0	0%
7500-9999 PLN	28	14%	13	18%	5	9%	7	15%	1	6%	2	18%
10,000-12,499 PLN	25	13%	11	15%	6	11%	5	11%	1	6%	2	18%
12,500-14,999 PLN	16	8%	8	11%	4	7%	3	7%	1	6%	0	0%
15,000-17,499 PLN	4	2%	2	3%	0	0%	0	0%	0	0%	2	18%
17,500-19,999 PLN	4	2%	1	1%	0	0%	1	2%	2	12%	0	0%
Over 20,000 PLN	3	2%	1	1%	1	2%	1	2%	0	0%	0	0%

Viewpoint #1: Healthy life no matter what

The first viewpoint is shared by 71 respondents (35.5%) and accounts for 15.356% of the explained variance. While factor Group A (“Convenience”) and Group D (“Relations with the food producer”) received the lowest average scores of 1.6 and 1.8, respectively (on a scale from 0, least important, to 6, most important), Group E (“Food safety and quality”) was rated the highest, with an average score of 4.8, when purchasing directly from farmers. This group's two top-ranked statements include statement #21 (“Certainty that the purchased food is free from excessive additives and is not processed”) and statement #22 (“Certainty that products are fresh”). This observation highlights that many individuals who buy directly from farmers prioritize quality, believing these products are free from excessive additives, minimally processed, fresh, and superior in taste compared to supermarket alternatives. Furthermore, the low importance assigned to statement #1 (“Ease of access to the selling point”), and, overall, of all factors from Group A (“Convenience”), suggests that convenience is not a key consideration for this group when making purchases. Interestingly, the second most important factor group for this viewpoint is group B (“Local patriotism”), as respondents also valued that the products were sourced from Poland and contributed to supporting the local community.

Viewpoint #2: Healthy food at your fingertips

The second viewpoint is shared by 55 respondents (27.5%) and explains 12.671% of the variance. Similar to the first viewpoint, Group E (“Food safety and quality”) received a high score of 5, while Group D (“Relations with the food producer”) scored low, with an average of 1. The key difference, however, lies in the increased emphasis on Group A (“Convenience”). In the first viewpoint, convenience was considered relatively unimportant when purchasing directly from farmers, scoring just 1.8. In the second viewpoint, it received a score of 3.6, making it the second most important factor group. Additionally, individuals aligned with this viewpoint place moderate value on local patriotism and lifestyle, though slightly less than those in the first viewpoint. Overall, the perspective aligned with the second viewpoint highlights that while respondents prioritize product quality, they also place significant value on the convenience of the purchasing process, including easy access to the point of sale and flexibility in choosing shopping days. Moreover, this group appreciates the ability to complete their shopping in one location, offering various products and enabling them to purchase all necessary ingredients in one trip.

Viewpoint #3: Diet of local patriotism

The third viewpoint is shared by 46 respondents (23%) and accounts for 12.228% of the explained variance. Respondents with this viewpoint rated statement #7 (“Possibility to purchase products directly from the producer, bypassing intermediaries”) and statement #9 (“Possibility to buy national products”) as the most important factors. Similarly, statement #8

(“Possibility to support the local community”) and statement #10 (“Possibility of direct financial support for the producer (farmer)”) were rated as the second-most important. This resulted in an average of 5.2 for factors in Group B (“Local patriotism”), the highest score for any factor group across all five viewpoints. The second-highest rated group, Group E (“Food safety and quality”), received an average score of 3.4, underscoring that respondents in this viewpoint prioritized local patriotism above all else. Notably, this viewpoint rated group C (“Lifestyle”) as the least important factor, with an average score of 1.8, lower than any other viewpoint. Thus, while individuals in this group valued product quality, their primary concern was that the products were sourced from Poland or the local region, allowing them to support the local community and directly benefit regional farmers.

Viewpoint #4: Local patriotism but not at all cost

The fourth viewpoint, shared by 17 respondents (8.5%), explains 5% of the variance. All factor groups received similar ratings, with Group B (“Local patriotism”) achieving the highest score of 3.8 and Group A (“Convenience”) receiving the lowest at 2.4. Respondents identified the availability of ecological products (statement #12) and the assurance of product freshness (statement #22) as the most important factors when purchasing products directly from farmers. Unlike the previous three viewpoints, but in line with the fifth, Group D (“Relations with the food producer”) ranked relatively high, with an average score of 3. The balanced distribution of both the most and least important factors across groups suggests that some respondents may not have strong preferences for any single group.

Viewpoint #5: Eating organic products is not only healthy but also trendy

The fifth and final viewpoint is shared by 11 respondents (5.5%), accounting for 4.62% of the explained variance. Similarly to viewpoint #4, all factor groups received comparable scores. Group E (“Food safety and quality”) was the highest-ranked, while Group C (“Lifestyle”) was the second-highest, with a score of 3.4 – the highest across all viewpoints. The most important factors for this group were statement #7 (“Possibility to purchase products directly from the producer, bypassing intermediaries”) and statement #17 (“Opportunity for repeat purchases from the same producer (farmer)”), indicating a preference for supporting specific producers. Interestingly, statement #13 (“Possibility to boast to friends about the source of the purchase”) was rated as the second-most important factor when purchasing directly from farmers, in contrast to its ranking as the second-least important factor in other viewpoints. This suggests that some individuals might be motivated not only by the freshness and quality of products but also by the current trends and the opportunity to showcase their purchases to friends or on social media. Although this viewpoint represents only 5.5% of respondents, it implies that lifestyle considerations may also influence the promotion of short value chains, potentially accelerated by the rise of technology and social media.

4. Discussion

The research results presented in this paper and the specified preliminary segmentation of consumers based on five different viewpoints and consumer behavior can be used not only by researchers for further extended scientific research but also by producers selling their goods within short supply chains.

Producers who want to use the presented research results in practice should focus their activities on the aspects most desired by customers, i.e. those related to food safety and quality and ethnocentric attitude. Products offered by farmers should continue to be characterized by excellent taste, lack of various preservatives and freshness resulting from offering products that have not been subjected to storage activities and are sold immediately after the production or harvest process. Taking into account the marketing aspect, producers promoting their products should not only emphasize their higher quality resulting from the lack of additives, freshness and better taste, but also the extremely important aspect of the local origin of the products. While the history of the origin of the products or the farm itself may be of less importance to customers, the ethnocentric element related to the proximity of the product's origin to the consumer's place of residence is of great importance. Focusing on these two aspects in marketing activities should provide producers with a competitive advantage in the market.

When considering reaching a larger number of consumers, producers should take into account the division of consumers according to different viewpoints presented in the article. While some consumers will make purchases of food, provided it is of appropriate quality, regardless of price or distance, for others, convenient shopping is much more important. In order to reach consumers who prefer access to products that do not require much effort, producers should consider the potential expansion of their distribution and marketing activities. This is possible by increasing expenditure on advertising, not necessarily related to the products themselves, but informing potential consumers that there is a possibility of buying goods in a given place at a specific time. At the same time, it is worth considering using other forms of distribution within the SFSC, such as box schemes or community supported agriculture, rather than just selling at the market, at the place of production or with the direct delivery to the customer.

The research methodology presented in the article and the subject of the research itself show the possibilities of conducting further quantitative research on value in short supply chains by future researchers. An extremely important and interesting aspect of future research would be to examine the perception of value, using possibly the same or very similar research tools, by people living in other regions of Poland, Europe and the world. An interesting aspect of future research would be to compare different attitudes and points of view of residents of different regions of the world and to analyze these behaviors taking into account the cultural aspect. It is also possible to extend the research to other methods of distribution within SFSC,

which were not examined in the article due to their low popularity in Poland, and which are used in other countries. Another, potentially possible direction of further research on value for customers in SFSC is the potential definition of other factors of consumer perception of value or their different categorization.

Our study focused on two regions of Poland (Małopolska and Mazowieckie regions), examining the preferences of citizens who purchase directly from farmers, whether at farms, markets, bazaars, or through home deliveries. The decision to limit the study to these regions was primarily driven by the need to ensure an adequate sample size within the studied population. Given Poland's nearly 40 million inhabitants, a sample of 340 respondents would be insufficient for broader representativeness. However, this regional focus may also introduce selection biases. Nonetheless, since we do not observe significant discrepancies in preferences toward SFSCs between these two regions, we believe our findings remain relevant beyond this specific sample. Still, preferences may vary across other Polish regions and internationally. Nonetheless, despite the study's limited geographic scope, we hope it provides valuable insights for producers and serves as a foundation for further research on consumer behavior and short food supply chains.

5. Summary

Short food supply chains (SFSCs) offer an alternative to conventional food systems by enabling direct interactions between producers and consumers, emphasizing localism, sustainability, and food quality. This study explores consumer perceptions of value within SFSCs through a mixed-method approach combining Q-methodology and quantitative analysis. Five dimensions of value - convenience, local patriotism, lifestyle, producer relationships, and food quality and safety - were identified through narrative literature review and expert consultations. A survey of 340 participants from Poland's Małopolska and Mazowieckie regions revealed that food safety and quality, particularly freshness and the absence of additives, emerged as the most valued attributes. Local patriotism also ranked highly, highlighting consumer preference for supporting local communities and purchasing products of local origin. Conversely, relational aspects with producers were less significant. The findings provide actionable insights for producers to tailor marketing strategies, focusing on quality, sustainability, and locality. The study also offers a foundation for further cross-regional and cultural research to enhance understanding of consumer behavior in SFSCs.

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Appendix

Table A1.
Respondents' shopping preferences

	Number of respondents	Share of respondents
Total	340	100%
Most frequent place of shopping		
Hypermarket	91	26.76%
Discount Retailer	122	35.88%
Local (Smaller Supermarket)	55	16.18%
Corner Store	28	8.24%
Organic Store	6	1.76%
Market / Bazaar	30	8.82%
Online Shopping	7	2.06%
Other	1	0.29%
Shopping directly from the farmer (multiple choice)		
If no → rejected from the survey		
At the bazaar or market	287	84.41%
Visiting a farm	64	18.82%
Home delivery	30	8.82%
Other	14	4.12%
How often do you shop for groceries for yourself or your household?		
Never	1	0.29%
Everyday	73	21.47%
Several times a week	194	57.06%
Once a week	58	17.06%
Once every two weeks	8	2.35%
Once a month	3	0.88%
Less than once a month	3	0.88%
Types of products purchased (multiple choice)		
Bread – e.g., bread, rolls, tortillas	306	90.00%
Canned/Jarred Food – e.g., spaghetti sauce, pickled vegetables, canned meat	195	57.35%
Dairy Products – e.g., cheese, milk	300	88.24%
Dry and Granular Products – e.g., cereals, flour, sugar, pasta, dried fruits, nuts	259	76.18%
Meat – e.g., poultry, beef, pork	274	80.59%
Plant-Based Meat Substitutes – e.g., tofu, soy, tempeh, seitan	118	34.71%
Fruits – e.g., apples, oranges, bananas	302	88.82%
Vegetables – e.g., lettuce, potatoes	295	86.76%
Other	5	1.47%

DECARBONISATION OF WAREHOUSE PROCESSES BY LOGISTICS SERVICE PROVIDERS

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Purpose: The purpose of the research was to analyse the methods of decarbonising warehouse processes in the activities of logistics service providers and to identify the main barriers on the way to achieving the assumptions of the concept of green warehouse.

Design/methodology/approach: The article consists of two parts: literature research and empirical research using an interview questionnaire among 3PL providers. The literature research included bibliometric analysis using the Scopus database and VOSviewer software focusing on TSL industry and sustainability. The literature review outlined the main assumptions of the green warehouse concept. In empirical part of the research an interview questionnaire was employed. This approach enabled the identification of the main decarbonisation methods and the barriers associated with their implementation in warehouses.

Findings: The article outlines initiatives undertaken by 3PL providers to decarbonize warehouse processes. The measures identified primarily focus on implementing energy-efficient solutions. The research allowed to establish the barriers associated with these methods. Those barriers were categorized into three main areas: organizational, technical, and financial.

Research limitations/implications: A main limitation encountered during the research was the small number of enterprises that agreed to participate. This limitation was primarily due to the extended duration of the interviews. Future research could potentially be expanded to include a broader range of 3PL service providers.

Practical implications: The research findings exemplify practical actions for logistics service providers to implement the green warehouse concept. The decarbonization methods presented offer inspiration for other companies in the TSL sector. It should be emphasized that the surveyed entities were interested in further cooperation in identifying new areas where decarbonization tools could be implemented.

Originality/value: The article presents an analysis of the decarbonisation methods used in warehouse operations by 3PL providers and main barriers concerning achievement of green warehouse assumptions.

Keywords: logistics service provider, sustainable development, green warehouse.

Category of the paper: research paper.

1. Introduction

Due to the growing economic development, the TSL industry is becoming increasingly important. The industry is growing both from the perspective of B2C and B2B relations. However, it should be noted that the development of the logistics industry is also facing numerous challenges, of which one of the most important is currently meeting the requirements for sustainable development. This challenge results both from increasingly stringent legal requirements, but also from changes in the awareness of customers, for whom the choice of a given logistics service is no longer determined only by price and quality, but also by the level of the carbon footprint. Logistics service providers, i.e. companies that offer comprehensive logistics services, while taking over the obligations of their customers in the field of organizing the distribution process, are particularly influenced by the growing requirements of stakeholders. 3PL services are outsourced logistics solutions that handle transportation, warehousing, and distribution for businesses (Qureshi, 2022). Due to the high importance of the topic of sustainable development in scientific research (Cano et al., 2022), it is worth undertaking research on the environmental impact of 3PL. Research on the assumptions of green warehouse has been conducted by many researchers (Indrasiri et al., 2015; Malinowska et al., 2018; Xin et al., 2019; Ren et al., 2023), however, in the literature there is a lack of sufficient qualitative studies that focus directly on the methods of decarbonization of warehouse processes. Based on the identified research gap, two research questions were formulated:

- Q1 - what are the methods of decarbonizing warehouse processes in the activities of logistics service providers?
- Q2 - what are the main barriers to achieving the assumptions of the green warehouse concept in the activities of logistics service providers?

The main aim of the article is to analyse the methods of decarbonising warehouse processes and to identify the main barriers on the way to achieving the assumptions of the concept of green warehouse. To answer the research questions, literature and empirical research was conducted. The literature research included bibliometric analysis using the Scopus database and VOSviewer software, focusing on the TSL industry and sustainable development. The literature review presented the classification and importance of warehouse processes in 3PL services and the main assumptions of the green warehouse concept. The literature review also focused on the sources of carbon dioxide emissions in warehouse processes. Based on the conducted literature research, an interview questionnaire was created. In the empirical part of the research, an interview questionnaire was used, which allowed for determining decarbonization methods and barriers to their implementation in warehouse processes. The conclusions summarize the conducted research and identify their main limitations.

2. Sustainability in 3PL services

Sustainable development is a widely discussed topic in many scientific publications. It can be defined as a growth that meets present needs without compromising the ability of future generations to meet their own (Chichilnisky, 1999). In the literature, sustainable development is most often divided into three main pillars: environmental, social and organizational (Sachs et al., 2022). Each of the initiatives undertaken in the above pillars can interact with each other and has an impact on the implementation of sustainable development goals of an organization. Sustainable development in logistics activities is the subject of a growing number of studies in both domestic and foreign literature. These studies are conducted in various aspects, but mainly focus on environmental issues. These activities should focus mainly on trying to decarbonise transport and warehouse processes. To meet the requirements of stakeholders, logistics service providers often have separate departments dealing with sustainable development. Departments are directly involved in the formation and supervision of the implementation of the sustainable development strategy. Strategies should take the form of publicly available documents that clearly define the goals of the organization's sustainable development and describe how the organization intends to achieve them (Ji et al., 2023).

To learn more about the relationship between sustainable development and the logistics industry, a bibliometric analysis was conducted using the Scopus database and VOSviewer software. As part of the analysis, 6591 scientific publications in the period from 2006 to 2024 were distinguished, which in their keywords had issues related to logistics and sustainable development at the same time. To increase the level of transparency of the relationship map, it was decided to include only keywords that appeared at least 70 times in the entire set. The visualization of the relationship is presented in Figure 1. The issues presented in the visualization show the most frequently discussed topics among scientific publications, but also present the methods for their analysis, among which the most used are survey questionnaires and interview questionnaires.

It is also worth noting that warehouses are places where there is a risk of various types of disruptions, which may hinder the implementation of the main warehouse functions. These disruptions may appear at different stages of the storage process and have different sources of origin. They may concern inaccurate forecasting of demand for a given stock and difficulties related to the flow of materials within the warehouse. Eliminating these disruptions is one of the challenges faced by warehouse managers (Bendkowski, 2015).

Warehouses can have different purposes and take many forms. Due to the wide range of processes taking place in a warehouse, its classification can be made according to many categories. The main one is the classification according to the purpose of the warehouse, within which it can be distinguish: industrial, distribution and reserve warehouses (Niemczyk, 2008). Warehouses are also classified according to the conditions of storing supplies. There are warehouses in which specialist conditions should be maintained, such as appropriate temperature and humidity, and warehouses for hazardous materials, which should be protected against the penetration of stored loads into the external environment, which could pose a threat to fauna and flora. Warehouses can also be divided according to the form of stored loads: cargo units, bulk materials, liquids and gases (Gubała, Popielas, 2005).

The warehouse process is defined in the literature as the systematic management of activities like receiving, storing, picking, and shipping goods to ensure efficient logistics operations (Polim, Lestari, 2023). The warehousing process begins with the receiving phase. The first aspect of this phase that must be determined is delivery planning and setting the exact time at which the supplier is to arrive with the load. The warehouse manager should determine the most appropriate time at which deliveries should be made, considering available staff resources, the number of shifts, available equipment and the specifics of the warehouse. The IT systems used in warehouses to manage the warehouse, WMS (Warehouse Management System), most often have modules designed for delivery planning (Gwynne, 2016). The storage phase is closely linked to the main function of the warehouse, which is the storage of loads. It consists of the organized arrangement of loads in the warehouse using the existing warehouse infrastructure. Warehouse workers working in the storage zone use available means of transport to transport the delivered loads to the storage zone, where they arrange them according to the adopted method (Adeodu et al., 2023).

The picking phase refers to all activities related to receiving goods from the storage location and combining them, thus creating an order. Picking activities can take place in a designated picking zone or directly in the product storage zone. During this phase, one of fixe principles of issuing is applied: FIFO (First In, First Out), LIFO (Last In, First Out), FEFO (First Expired, First Out), LOFO (Lowest In, First Out), HIFO (Highest In, First Out). The duration of the picking process depends on many factors: the arrangement of loads and the size of the order and the route the warehouse worker takes to pick the order has a great impact on the picking time. Therefore, it is very important to correctly determine the way in which the employees involved in picking move (Gwynne, 2016).

In the picking phase, two solutions can be distinguished in terms of the degree of automation: PTG and GTP. "Person-to-goods" (PTG) is the way in which the warehouse worker who picks products in the warehouse aisles moves. The person responsible for picking walks between the shelves, picking subsequent products, then goes to the main picking point where he gives the order. Another method of picking is the "goods to person" (GTP) method, which is an automatic system that allows for picking by means of a machine (Krnjaic et al., 2024).

The last phase of the storage process is the issuing phase, in which several activities related to the issuing of previously completed orders occur. At the beginning, loads intended for issuing are transported to the appropriate storage fields in the issuing zone. The next step is to organize the loads in such a way as to facilitate loading when the semi-trailer is attached to the dock. Then, an inspection is carried out, during which the quantity of loads is checked for compliance with the order. When the inspection is completed, the loads are additionally secured with foil or mat. When the semi-trailer is provided, they are loaded using available means of warehouse transport. The loads are secured in such a way that they do not move during transport to the recipient. Special tapes are often used for this purpose, which are attached to the semi-trailer and loading units. The final stage of this phase is filling in the documentation, containing data such as the date and time of collection, the number of loads issued and the data of the receiving driver and company. An important element supporting the warehousing process is the efficient flow of information. This flow should cover the supply chain of a given company, and all logistics processes should be properly integrated in it (Maryadi et al., 2024).

In the implementation of warehouse processes, the use of appropriate IT software plays an extremely important role. Researchers emphasize that ERP systems play a significant role in optimizing warehouse processes (Tonq et al., 2023). They integrate and automate key operations, improving efficiency, accuracy, and inventory management. WMS systems support the process and allow for efficient management of the flow of loads in the warehouse. WMS programs are compatible with other programs for managing processes in companies, which will enable efficient data exchange between the warehouse and other departments of the company. These systems deal with, among other things, checking the quantity of loads during deliveries and deliveries, managing available warehouse space, dividing work between warehouse workers and supervising many other warehouse activities (Minashkina, Happonen, 2023).

2.2. Decarbonisation of logistic processes

Despite the significant importance of warehouse processes in the activities of a logistics service providers, it is worth emphasizing, that those processes are the source of the carbon footprint. In the literature, the concept of carbon footprint is defined as total amount of greenhouse gases emitted directly or indirectly by an individual, organization, or activity (Wiedmann, Minx, 2008).

The carbon footprint is created in mainly due to energy consumption, fuel usage in transportation, and emissions from warehouse operations. The list of the main factors that cause the carbon footprint in the activities of a logistics service providers is presented in Table 1. This comparison focuses on two main processes performed by 3PL providers: transportation and warehousing (Wang, Cho, 2014). The factors that determine the level of CO₂ emissions in transport processes are mainly focused on fuel consumption, transport distance and delivery frequency. Inefficient route planning and empty runs additionally increase these emissions. Warehouse processes contribute to emissions mainly through energy consumption for lighting, heating and cooling (Ersoy, 2018).

Table 1.

List of factors causing carbon footprint in logistics processes

Transportation	Warehousing
<ul style="list-style-type: none"> - Fuel consumption in vehicles - Emissions from trucks, ships, and planes - Type of fuel used (diesel, gasoline) - Distance travelled - Frequency of transportation trips - Empty vehicle returns - Vehicle maintenance and efficiency - Traffic congestion delays - Poor route planning - Use of non-renewable energy for operations 	<ul style="list-style-type: none"> - Energy consumption for lighting and heating - HVAC system operations - Refrigeration for temperature-sensitive goods - Warehouse equipment (e.g., forklifts) fuel usage - Packaging materials used - Waste generation and disposal - Storage system efficiency - Energy source for warehouse operations - Frequency of inventory restocking - Transportation of goods between warehouses

Source: own elaboration based on: Wang, Cho, 2014, pp. 14-22; Ersoy, 2018, pp. 21-44.

Considering the above factors, it is worth focusing on tools and methods for reducing carbon footprint emissions. Particular attention in this area should be paid to the concept of decarbonisation, which is defined in the literature as a process aimed at reducing or eliminating carbon dioxide emissions (Jankowska, 2016). Researchers point out that this concept can be applied both in the energy policy of a given country or region, but can also refer to processes occurring in enterprises (Kotyński, 2007). The level of carbon dioxide emissions is most often expressed in tCO₂e (tonne of CO₂ equivalent), which is a unit measuring the global warming impact of greenhouse gases, standardized to the effect of one tonne of CO₂. One of the first steps that a logistics service provider should take in this aspect is to define realistic goals that it intends to achieve in reducing emissions in its operations. However, to reduce emissions, enterprise should know direct and indirect greenhouse gas emissions. Direct greenhouse gas emissions of an organization come from sources owned or controlled by the organization. Indirect greenhouse gas emissions result from the organization's activities but occur at sources it does not own or control (La Notte et al., 2018).

Understanding the difference between Scope 1, 2, and 3 of CO₂ emissions is essential for logistics service providers to accurately measure their total carbon footprint. Differentiating these scopes ensures compliance with environmental regulations and corporate sustainability reporting standards. The difference between the scopes is explained in Figure 2. Scope 1 covers direct emissions from sources owned or controlled by a company, such as fuel combustion in

company vehicles or factories. Scope 2 includes indirect emissions from purchased electricity, heat, or steam, while Scope 3 encompasses all other indirect emissions across the value chain, including supply chain activities, product use, and business travel (Bacas, Dylla, 2024).

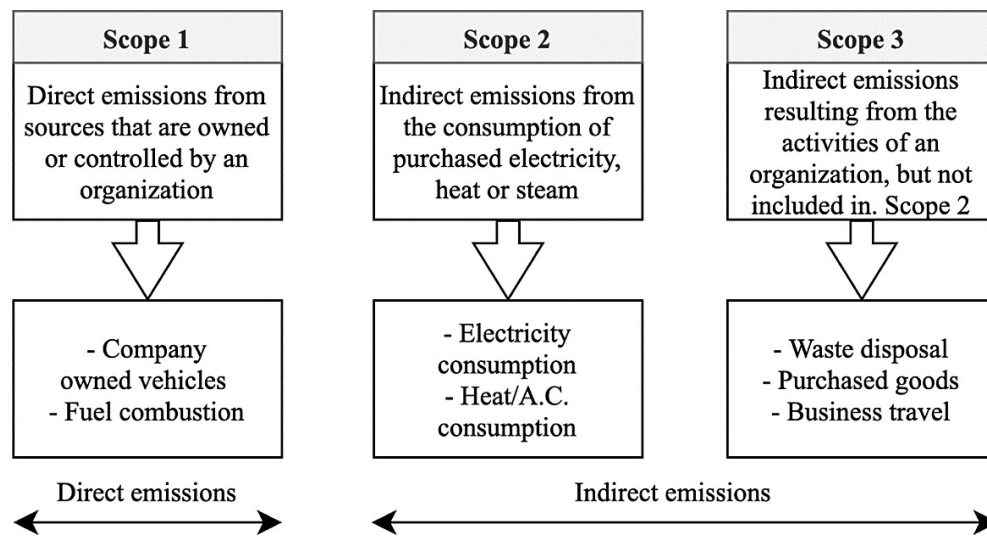


Figure 2. Scopes of carbon emissions.

Source: own elaboration based on: Feist, 2018, pp. 24-26.

In warehouse processes, Scope 1 emissions come from on-site fuel combustion. This scope is particularly relevant for gas heating systems and diesel forklifts. To reduce or eliminate Scope 1 emissions, researchers emphasize the role of switching to renewable electricity-based alternatives. Scope 2 emissions in warehouses most often result from purchased electricity used for lighting, heating, and cooling. Scope 3 emissions result from supply chain activities, including freight transport, waste disposal, and employee commuting. Implementing real-time energy monitoring can further reduce overall carbon dioxide emissions. Information about the company's emission reduction goals in each scope should be communicated to external stakeholders of the organization, so that the solution meets not only the environmental but also the social goals of sustainable development (Rüdiger et al., 2016). To reduce Scope 2 and 3 emissions in warehouse processes, some researchers emphasize the role of offsetting and carbon credits. A carbon credit is defined in this aspect as measurable, verifiable reductions in carbon dioxide emissions from certified climate projects. These projects reduce, avoid, or remove greenhouse gas (GHG) emissions. However, it should be emphasized that the use of offsetting should only take place after the reduction of Scope 1 emissions (Tan et al., 2009).

2.3. Green warehouse assumptions

One of the goals of ecologically conscious logistics service providers should be to strive to implement the assumptions of a green warehouse. A green warehouse is a relatively new concept and can be understood as a warehouse that meets environmental requirements and considers ecological solutions in operational processes (Xin et al., 2019). According to the

definition presented, the main assumptions of this concept include (Knez et al., 2010; Malinowska et al., 2018; Ren et al., 2023):

- Conducting regular environmental audits.
- Conducting employee training.
- Designing warehouse layouts to reduce unnecessary movement and fuel use.
- Encouraging paperless operations through digital documentation.
- Environmental friendly plot area.
- High level of warehouse automation.
- Implementing of modern IT systems (ERP, WMS, SCM).
- Implementing smart ventilation systems.
- Installing green roofs to improve insulation and reduce heat absorption.
- Installing of roof skylights.
- Introducing low-emission means of transport, such as electric forklifts.
- Monitoring CO₂ emissions in real time to effectively reduce them.
- Optimizing warehouse insulation to reduce energy consumption.
- Using ecological packaging and recycling systems.
- Using energy-efficient LED lighting and intelligent energy management systems.
- Using motion sensors and timers to optimize lighting and energy consumption.
- Using of rainwater for irrigation.
- Using renewable energy sources, such as solar panels and heat pumps.
- Utilizing biodegradable or compostable packaging materials.

Ren et al. emphasize that to fully meet the green warehouse assumptions, external factors (architecture, space, lighting, heating) and internal factors (logistics processes, warehouse layout, inventory management) must be considered. Indrasiri et al., based on a study of 1200 warehouses, distinguished 11 factors that have the greatest impact on the implementation of the green warehouse assumptions, among which they mentioned, among others, emission reduction resulting from heating, green lighting practices, but also green practices in HR and IT, which indicates that these activities can also have a social character (Indrasiri et al., 2015). According to the cited results, the green warehouse assumptions are strongly related to decarbonisation methods. To learn about the currently implemented initiatives and barriers regarding the decarbonisation of warehouse processes in the activities of logistics service providers in Poland, it is necessary to conduct appropriate research.

3. Methods

To achieve the aim of the article, which is to analyse the methods of decarbonisation of warehouse processes in the activities of logistics service providers and to identify the main barriers to achieving the assumptions of green warehouses, it was decided to get to know the perspective of 7 3PL providers operating in the Silesian Voivodeship using interview questionnaires. The research involved enterprises that were characterised by at least European scope of providing logistics services. Their selection was made based on their position in the rankings of logistics operators in Poland and the number of environmental certificates received. The interviews were conducted both remotely and in person, and were answered by people representing the management staff. 3PL providers participating in the study wished to remain anonymous. The research was carried out from July to November 2024. The average time it took to conduct an interview using the questionnaire was 30 to 50 minutes. Based on the conducted literature research, an interview questionnaire was created. The questionnaire was divided into three main parts. The first part concerned aspects related to the type and nature of services provided by a given company and the general assumptions of the sustainable development strategy (Q.1-Q.5). This part of the research raised the question of the goals set by the 3PL providers in particular GHG scopes. The second part focused on the analysis of warehouse processes and identification of methods of their decarbonisation (Q.6-Q.12). The third part of the questionnaire aimed to get to know the main barriers to the implementation of green warehouse assumptions in the activities of logistics operators (Q.13-Q.15). The interview questionnaire is presented in the Table 2.

Table 2.
Interview Questionnaire

Id.	Interview questions:
Q.1	What range of logistics services does the company provide?
Q.2	Has the company set sustainability goals for its operations?
Q.3	Are the company's sustainability goals adequately communicated to stakeholders?
Q.4	Does the organization use green warehouse principles?
Q.5	What carbon reduction targets has your company set in each of GHG scopes?
Q.6	What energy sources are used in the warehouse?
Q.7	Does the warehouse use energy-saving technologies? If so, which ones?
Q.8	What actions is the warehouse taking to decarbonise its processes?
Q.9	Have recycling and waste reduction systems been implemented in warehouses?
Q.10	What automation technologies help reduce the carbon footprint in warehouse processes?
Q.11	Does the warehouse use eco-friendly packaging materials?
Q.12	What actions are being taken to reduce water consumption in the warehouse?
Q.13	What are the main barriers to implementing decarbonisation of warehouse processes in an organization?
Q.14	What support would be needed to facilitate the transformation towards a green warehouse concept?
Q.15	Which stakeholders should cooperation take place to achieve the objectives of a green warehouse?

Source: own elaboration.

4. Results

The results of the questionnaire surveys were used to analyze the methods of decarbonisation of the warehouse processes. The type and properties of the stored goods among 3PL providers differed, which allowed for learning different perspectives on the warehouse processes. Two of the surveyed entities specialized in storing FMCG products, while the others had a much wider range of stored stocks, including electronics and consumer products. Surveyed managers were aware of the importance of the green warehouse assumptions and had appropriately communicated strategies for sustainable development in their organisations. Surveyed 3PL providers set specific time frames for achieving their carbon reduction goals. One of the entities set a goal of achieving complete carbon neutrality in Scope 1 & 2 by 2030.

The second phase of the study focused on implemented initiatives concerning the decarbonisation of warehouse processes. All of the surveyed entities implemented solutions in this aspect to a varying extent. The solutions most often focused on reducing energy consumption. The most common solution in warehouses was the installation of energy-saving lighting and motion sensors, but companies were also increasingly installing photovoltaic panels on the roofs of warehouses. In addition to these solutions, companies implemented initiatives that were included in Chapter 2.3. The organisations emphasised that the changes introduced are not only influenced by legal regulations, but also by the growing requirements of customers in terms of the sustainability of logistics services. The third part of the research focused on identifying the main barriers to achieving the assumptions of the green warehouse concept. The answers obtained from representatives of 3PL providers in this aspect were most often very similar, and the barriers could be related to one of three categories: organizational, technical or financial, which was shown in Figure 3.

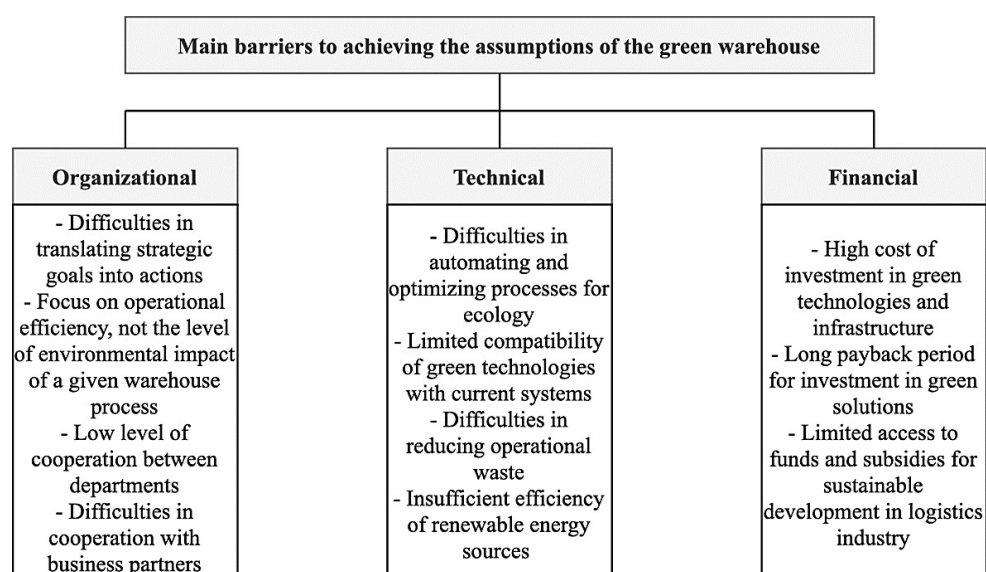


Figure 3. Main barriers to achieving the assumptions of the green warehouse.

Source: own elaboration.

5. Discussion and Conclusion

The presented results of the questionnaire surveys are the basis for formulating conclusions regarding methods of decarbonisation of warehouse processes in the activities of 3PL providers. The main limitation in conducting the research was the limited number of organisations that were willing and had time to be interviewed. Nevertheless, the answers obtained allowed to learn about the perspective of companies on the issue of decarbonisation of warehouse processes and to identify the main barriers in this area. All of the organisations surveyed were aware of the need for changes that should be undertaken in warehousing and were familiar with the green warehouse concept. Companies had set goals for reducing greenhouse gas emissions. It should be emphasised that the answers obtained from logistics operators mostly coincided with the initiatives that were identified during the literature research (Knez et al., 2010; Malinowska et al., 2018; Ren et al., 2023) in Chapter 2.3. Companies mainly try to focus on eliminating emissions in Scope 1. The most common solution in this area were energy saving activities and the use of energy-efficient lighting and motion sensors. These results are consistent with the factors identified by Indrasiri et al. in their study on a sample of 1200 warehouses (Indrasiri et al., 2015). In addition, an increasing number of entities tried to use recycled packaging in their processes. During the interview, company representatives also emphasized that not only the environmental aspect is important to them, but also the social aspect in accordance with the CSR assumptions. As part of the conducted research, the main barriers regarding the decarbonisation of warehouse processes were identified, which were divided into three main categories: organizational, technical and financial. As part of the organizational barriers, the surveyed organizations omitted factors related to the difficulty of translating strategic goals regarding emission reduction into specific actions and the difficulties in cooperation with partners in the case of Scope 3. The technical barriers of companies included difficulties in ensuring compatibility with solutions currently functioning in the company. The financial barriers of representatives of logistics operators included high costs of investment in sustainable technologies and a long payback period. As emphasized by the organization's representatives, these barriers are significant, but with the development of technology and the gradual reduction of their costs, it is possible to overcome them.

The presented research findings are highly relevant for 3PL providers. The results highlight potential activities for reducing environmental impact and serve as a foundation for further scientific exploration. The conclusions are important in the face of sustainable development of the logistics industry. The decarbonization methods presented also offer inspiration for other enterprises in the logistics sector. The study underscores the necessity of continued efforts to overcome existing challenges and implement more sustainable and efficient practices. Expanding future research to a broader range of 3PL organisations could provide a more in-depth understanding of the issue and support the industry's transition toward greener operations.

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IDENTIFICATION AND COMPARISON OF HYGROSCOPIC PROPERTIES OF SELECTED VARIETIES OF PEPPER AS AN ELEMENT OF THE STRATEGY FOR REDUCING ITS LOSSES

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Purpose: This study focused on identifying and comparing properties of the raw material, the knowledge of which will help reduce food losses during storage and transport. Its aim was to establish cornerstones for determining differences in pepper quality and safety as affected by storage and transport conditions.

Design/methodology/approach: It entailed the comparison of selected hygroscopic parameters of pepper samples using two sorption models and identifying a correlation between product type and its storage stability. To achieve this aim, the pepper samples were analyzed for water content and water activity, and water sorption isotherms were determined.

Findings: The study results indicate that both the site of pepper cultivation and the processing technology used differentiated its sorption properties and, thereby, its stability in storage and transport conditions. It is recommended to maintain air humidity at 16-27% during transport and storage of pepper.

Research limitations/implications: Findings should be deemed a starting point while planning and implementing pepper transport, and a cornerstone for storage recommendations.

Practical implications: The conducted research yielded results of practical importance. The presented recommendations can be used during the transport and storage of pepper to reduce its losses resulting from the hygroscopic properties of the raw material.

Social implications: Over than 30% of food is wasted annually. In times of dynamically growing population, reducing food losses and waste is important. Significant reductions in it are possible by identifying critical loss points and undertaking targeted actions to optimize production, storage and transport, which was done in this work.

Originality/value: The article presents practical recommendations for spice carriers regarding their transportation and storage conditions. The obtained research results can be the basis for managing the logistics process.

Keywords: pepper; hygroscopicity; BET and GAB models; storage stability; food losses.

Category of the paper: Research paper.

1. Introduction

The FAO reports that 1.3 billion tons of food suitable for consumption is wasted across the globe every year, which accounts for 30% of all food produced (FAO, 2019). Food losses and waste should be treated as a global problem, manifesting itself throughout the entire food chain, from primary production, through postharvest operations, storage, processing, transport and distribution, to consumption in households and restaurants (Łaba et al., 2022). Thus, it may be stated that food losses and waste occur at all links of the food chain; however, the scale of these losses varies. This situation is observed in all countries across the globe, both those striving with chronic malnutrition and excessive consumption (Kwasek et al., 2016). According to preliminary estimates by the FAO, 13.3% of the global food production of 2020 was lost in the first stages of the agri-food chain, i.e., after harvest and before reaching the retail. Only 15% of the food waste came from food processing and as much as 60% from households (Łaba et al., 2020).

Porkka et al. (2013) have pointed out that feeding the world's population is a challenge that will probably become even more complicated in the future than before. In 2018, the world population exceeded 7.6 billion and is expected to reach 9.2 billion by 2050, with a projected 59-102% increase in food demand (Pawlak, Kołodziejczak, 2020). Therefore, reducing food losses and waste in primary production will be an increasingly important issue in the coming decades. It will aim to support a sustainable nutrition model for the growing world population (Nicastro, Carillo, 2021; Buzby, Hyman, 2012), because – from the standpoint of economy – the costs of one ton of wasted food are much higher than the costs of its production (Łaba et al., 2022).

The interest in the issues of food losses and waste observed in recent years has resulted in many definitions of these concepts being found in the literature on the subject. Food loss is defined as the reduction in the quantity or quality of food resulting from the decisions and actions of food suppliers in the agri-food chain, excluding retailers, food service providers and consumers (FAO, 2022). Therefore, empirically, food loss refers to all food that is discarded, burnt or otherwise removed from the food supply chain, i.e., from harvest/slaughter/catch to, but not including, the retail level, and is not reused for other production purposes, e.g., as animal feed. If, for example, grain raw material previously intended for human consumption is used to produce animal feed due to its reduced processing value caused by unfavorable weather conditions or improper storage conditions, it will not be classified as waste or loss. However, if it is ultimately intended for composting, it will be considered wasted food (Łaba et al., 2022). In turn, food waste is defined as a reduction in the quantity or quality of food resulting from the decisions and actions of retailers, catering services and consumers (FAO, 2022).

The first step in preventing food waste is to reduce potential losses. Some food products are not harvested already at the first stage of the agri-food chain, i.e., during primary production, because they fail to meet commercial or quality requirements (Delgado et al., 2021; Parfitt et al., 2010). Primary production is the stage in which the abovementioned phenomena are least recognized and at the same time most difficult to estimate. This is chiefly due to the fact that agriculture depends on variable and unpredictable weather conditions. Crops vary from year to year in their quality, level, product form, and harvest date due to the effects of weather conditions, pests as well as plant and animal diseases. Consumer preferences and needs change as well, as influenced by many economic and noneconomic factors (Świecka et al., 2021). Nonetheless, all the above-mentioned factors contribute to food losses and waste (Borowski, 2018). Some of the losses that occur during transport and storage at farms may be prevented by optimizing production, storage and transport of food products (Kwasek, Łaba, 2020).

Minimizing the scale of the phenomena discussed above is consistent with the implementation of the sustainable development mission, which states that it is the responsibility of the current generation to care for the fate and sustenance of future generations. The United Nations Member States have developed a document called the “2030 Sustainable Development Goals Agenda”, establishing goals with individual targets assigned. Reducing food losses and waste is a key to achieving the 12th Sustainable Development Goal: “Ensure sustainable consumption and production pat-terns”, including its target 12.3: “By 2030, halve per capita global food waste at the re-tail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses” (Kwasek, Kowalczyk, 2023). The essence of the 12th Sustainable Development Goal is to develop a sustainable model of production and consumption. This postulate entails completing many tasks, the first of which concerns reducing food waste by half per capita on a global scale at the retail level, food consumption and limiting losses arising in the production and distribution process. This also applies to limiting losses incurred during the harvest of agricultural produce and appropriate management of the resulting waste (Łaba et al., 2022; Goryńska-Goldman et al., 2021). A significant reduction in food losses is only possible by identifying critical loss points and taking appropriate actions (Garske et al., 2020). To this end, efforts need to be made to collect statistical data at individual stages of the agri-food chain (primary production, harvesting, storage, transport, processing and wholesale) (Kwasek, Kowalczyk, 2023).

This work focuses on identifying and comparing the properties of the raw material, the knowledge of which may contribute to reducing food losses during transport. To achieve these goals, it is necessary to explain the notions of transport and broadly understood logistics. And so, the term logistics has emerged over a hundred years ago and was related to the movement of troops and their supplies (Stevenson, 2010). The logistics approach to the business activities of enterprises was presented in 1955 by O. Morgenster, who defined a logistics operation as providing strictly defined quantities of physical goods and services for specific types of activity (Mroczko, 2016). Today, this term is used to describe all flows of physical

goods (Bendkowski, 2013) and covers the entire cycle of preproduction, production and postproduction activities. Therefore, food logistics is an important element in both the food supply chain and meeting consumer requirements as a result of providing the right product, in the required quantity, on time and at low costs, which translates directly into the price offered to consumers (Hajj et al., 2020; Jagtap et al., 2021). Its scope includes logistics at ambient and lower temperatures, planning, execution and effective monitoring to meet consumer expectations and reduce losses and waste. In recent years, logistics companies operating in the food industry have mainly implemented IT technologies, which allowed them to improve the management process in the strive for meeting food safety regulations, adapting to changing transport conditions, improving the level of services, but also considering environmental aspects. Customer requirements prompt the implementation of advanced management systems, which is related to, among others, globalization, demographic changes, and demand for personalized food products generally available only at the site of cultivation, or limitations resulting from product's shelf life (Topczewska, Krupa, 2022). The food supply chain includes several phases, from the purchase of agricultural raw materials at the level of primary production through processing, packaging, storage, distribution and redistribution to final consumers (Jagtap et al., 2021). At the same time, sustainable development can be achieved via the implementation of best management practices, innovative technologies allowing for the optimization of transport conditions, and systems related to the improvement of social and environmental conditions (Topczewska, Krupa, 2022). The food market in Poland and around the world is subject to continuous improvement. The development of new food production technologies and storage conditions is the cornerstone of the global market evolution. Already implemented, conventional systems enable supervising production conditions and practices, to make the food produced free from any hazards (Malinowska, 2012).

Actions aimed at improving the food supply chain include continuous monitoring and research on the optimal conditions for food transport. Hygroscopic foods represent a particularly interesting group of products. The water present in food determines chemical, physical and biological (including microbiological) changes in its ingredients. The availability of water and its influence on the reactions in food is determined based on water activity (a_w), which is defined as the ratio of the water vapor pressure above the solution to the water vapor pressure above pure water, under conditions of constant temperature and pressure. Water activity affects the consistency, appearance, taste and odor, but above all, the susceptibility of food to spoilage (Ueda et al., 2023). Its continuous control enables achieving the highest quality and maximal stability of food, as well as minimizing the use of food preservatives (Kowalska et al., 2011; Janowicz et al., 2007). The hygroscopic nature of food is associated with the tendency to absorb water in a humid environment or release it in a dry environment, which triggers a change in the water content of a food product. The water vapor adsorption and desorption capacities are product specific features determined by its chemical composition and structure (Domian, Lenart, 2000; Kowalska et al., 2011).

In view of the considerations presented above, this study aimed to identify and compare parameters describing differences in the hygroscopicity of pepper as an inherent feature, critical for its quality and safety. Pepper (*Piper nigrum* L.) belongs to the group of most known and most frequently used spices in Poland and across the globe. Today, the largest exporters of peppercorns across the world include Vietnam (42.6% of the global production), Brazil (17.5% of the global production) and Indonesia (8.6% of the global production). In turn, the largest importers include the United States (15%), India (10.2%) and Germany (6.3%). According to The Observatory of Economic Complexity (OEC), pepper imports to Poland in 2022 amounted to 1.87% of the global production, accounting for 7.400 t which is 70% of the tonnage of Polish spice imports and 80% of their value. Pepper is imported to Poland mainly from Vietnam (41%), Germany (38.9%) and France (7.67%) (OEC, 2025). This means that the quality of pepper is determined by conditions during a complex logistics process. Typically, this product does not reach the consumer directly from the country where it was produced.

Three pepper types are most often found as utile for transport and cuisine, i.e. black pepper, white pepper and green pepper, all three derived from the same plant species but differing in the production technology of the final spice (Jagella, Grosch, 1999). Pepper becomes a highly hygroscopic product due to the significant reduction in water content after technological processes that make it ready for consumption. Hence, the hygroscopic properties are specific to pepper grains, which are most often transported pepper commodity (Jagella, Grosch, 1999; Kędzia, Kędzia-Hołderna, 2017).

The aim of this study was to establish cornerstones for determining differences in the quality and safety of four different pepper samples during their storage under the same transport conditions. It entailed the comparison of selected hygroscopic parameters of four pepper samples using two sorption models and identifying a correlation between the type of product (including raw material origin and processing technology used), and its stability in transport conditions. To verify the aim of the study, the following research hypotheses were formulated: H₁. The origin of the raw material from which the pepper was obtained significantly differentiates its sorption properties. H₂. The processing technology used for the raw material from which the pepper was obtained significantly differentiates its sorption properties.

2. Materials and Methods

The experimental material included representative samples of black and green pepper from India and Vietnam, purchased in a specialist shop with spices and seasonings in Gdynia, Poland. The quantity of the sample accepted for testing was not less than 2 kg. The test material was stored in non-perforated polyethylene single packages. Pepper is characterized by considerable variability resulting from both heterogeneity in its physical structure and the chemical

composition of its corns that determine its sorption properties. Therefore, every pepper sample was first determined for water content and water activity, and results of these determinations were expressed as arithmetic mean and standard deviation from three parallel determinations. The significance of differences between the mean values was analyzed with ANOVA and post-hoc Tukey's test (Łomnicki, 2006).

The initial water content (g H₂O/100 g d.m.) of the samples was determined with the method of thermal drying to a constant mass at temperatures of 373-378 K (100-105°C) under normal pressure, using an SML/30/250 type laboratory dryer (Zakład Aparatury Laboratoryjno-Medycznej ZALMED, Warsaw, Poland) and a WAA 100/C/2 analytical scale (Zakład Mechaniki Precyzyjnej RADWAG, Radom, Poland) (Ociecek et al., 2021).

Water activity of the samples was determined using an AquaLab 4TE meter (version AS4 2,14.0 2017, Decagon Devices, Inc., Pullman, WA, USA) with ± 0.0003 accuracy, at a temperature of 293 K (20°C) ± 2.5 K (Ociecek et al., 2022).

To achieve reliable results enabling the comparison of the hygroscopicity of pepper samples, sorption isotherms were determined in temperature of 293.15 K (20°C) using the method presented by Flis et al. (2023). Data from these analyses were used to plot sorption isotherms, which describe a correlation between the water content and water activity typical of each dry substance. Graphical models of the isotherms were compared with the Student's t-test of differences between means for bonded pairs. Differences were found statistically significant at $p \leq 0.05$.

Empirical data was explored using two theoretical models: Brunauer, Emmet and Teller (BET); and Guggenheim, Anderson and de Boer (GAB), commonly used to describe sigmoidal isotherms [34].

BET equation (1):

$$v = \frac{v_m C_{BET} a_w}{(1 - a_w)[1 + (C - 1)a_w]} \quad (1)$$

where:

a_w – water activity (–),

v – equilibrium water content (g H₂O/100 g d.m.),

v_m – water content in the monolayer (g H₂O/100 g d.m.),

C_{BET} – energy constant (Paderewski, 1999; Figura, Teixeira, 2007).

GAB equation (2):

$$v = \frac{v_m C_{GAB} K a_w}{(1 - K a_w)(1 - K a_w + C_{GAB} K a_w)} \quad (2)$$

where:

a_w – water activity (–),

v – equilibrium water content (g H₂O/100 g d.m.),

v_m – water content in the monolayer (g H₂O/100 g d.m.),

C_{GAB} – Guggenheim energy constant,

k – constant correcting properties of multilayer molecules compared to the liquid phase (Paderewski, 1999).

Parameters of the analyzed equations were determined based on empirical data, using non-linear regression and Monte Carol algorithm, which enabled avoiding the arrestment of the estimation process by the local minimum. Minimization of root sum of squares (RSS) (3) was assumed as the objective function, as this criterion is most widely applied in the statistical analysis. The root mean square error (RMSE) (4), expressed in %, was also used as an equally important criterion in the statistical analysis.

$$RSS = \sum (v_e - v_0)^2 \quad (3)$$

$$RMSE = \sqrt{\frac{\sum \left(\frac{v_e - v_0}{v_e}\right)^2}{N}} \cdot 100\% \quad (4)$$

where:

N – number of data,

v_e – experimental equilibrium water content (g H₂O/100 g d.m.),

v_0 – equilibrium water content predicted with the model (g H₂O/100 g d.m.).

Calculations were performed in Excel 2013 calculating sheet, using a Solver macro-command. Errors in parameters determined for particular equations were estimated with the SolverAid macro-command. The BET model parameters were estimated for a_w range from 0.05 to 0.45, whereas those of the GAB model – for the entire a_w range tested (Andrade et al., 2011).

Knowing the volume of water vapor adsorbed at a temperature lower than the boiling point and the so-called water setting surface, the specific surface area of the adsorbent was computed based on equation 5 (Paderewski, 1999):

$$a_{sp} = \omega \frac{v_m}{M} N \quad (5)$$

where:

a_{sp} – specific sorption area (m²/g),

N – Avogadro number ($6.023 \cdot 10^{23}$ molecules/mol),

M – molecular weight of water (18 g/mol),

ω – water cross-section area ($1.05 \cdot 10^{-19}$ m²/molecule).

The size and volume of capillaries of the analyzed material were determined for the capillary condensation area using Kelvin's equation assuming the cylindrical shape of capillaries (Paderewski, 1999; Figura, Teixeira, 2007):

$$\ln a_w = \frac{2\sigma V}{r_k RT} \quad (6)$$

where:

σ – surface tension of the liquid at temperature T (N/m),

r_k – capillary radius (nm),

R – universal gas constant (kJ/mol·K),

T – process temperature (K),

V – molar volume of the adsorbate (m³/mol).

3. Results and discussion

Sorption properties of spices are the resultant of multiple factors determining the affinity of material surface to vapors and gases. The factors determining the sorption phenomenon, which affect pepper quality and safety during storage also under transport conditions, include water activity and water content. They both determine trends and dynamics of processes occurring during transport (Flis et al., 2023).

The presence of water in the organic matrix is a natural phenomenon. Herein, water occurs in the bound form, incorporated into the structure of matrix particles, and affects their specific character. It may also occur as free water, filling compartments between matrix particles, thereby influencing matrix stability. The initial water content and water activity determine also the nature of the sorption phenomenon, which may follow the pattern of either adsorption or desorption. Results of mean water content and activity of pepper samples are provided in Table 1. The highest water content was determined in black pepper from India (10.87 g H₂O/100 g d.m.), and the lowest one – in green pepper from India (6.92 g H₂O/100 g d.m.). Differences found in water content among the samples were statistically significant, except for the green pepper.

The activity of water, reflecting its thermodynamic state, was the highest in the black pepper from India (0.59), and the lowest in the green pepper from Vietnam (0.47) (Table 1). Differences observed in water activity among all analyzed samples were statistically significant. Since water activity is determined by both the chemical composition and physical structure of particles coordinating water molecules, which in the examined model may differ significantly because of pepper origin and raw material processing technology, it was tentatively established that the sorption of the analyzed products was largely determined by the relationship (expressed as a ratio) between the content of water and water activity it generates.

The analysis of this relationship showed that water molecules entered into strongest reactions with the surface of particles of black pepper from India (18.58). In turn, the water molecules exhibited the weakest affinity to the particles of green pepper from India (13.74). It was also found that the water-matrix interaction was stronger in the case of black pepper (18.58 and 17.91) compared to green pepper (15.07 and 13.74), regardless of raw material origin. Results of investigations on sorption properties and storage stability of ground pepper available in retail showed it had a higher water content and water activity, on average, compared to the pepper grains (Ociecek et al., 2020).

Table 1.

Initial water content and activity in the analyzed pepper samples

Product	Parameters	
	Initial water content \pm SD (g H ₂ O/100 g d.m.)	Initial water activity \pm SD (-)
Black pepper from India	10.8724 \pm 0.2486 ^c	0.5851 \pm 0.0012 ^d
Green pepper from India	6.9158 \pm 0.3945 ^a	0.5035 \pm 0.0114 ^b
Black pepper from Vietnam	9.8476 \pm 0.1908 ^b	0.5497 \pm 0.0018 ^c
Green pepper from Vietnam	7.0539 \pm 0.1374 ^a	0.4682 \pm 0.0056 ^a

Explanatory notes: Table shows mean values \pm standard deviations; mean values denoted by different letters differ statistically significantly at $p \leq 0.05$.

Source: own research.

Water activity of all analyzed samples ensured their storage stability, as it was lower than 0.6, which is a value deemed critical for the microbiological safety and stability of food products since $a_w < 0.6$ of food prevents microbiota development. The minimal a_w values for the development of bacteria, yeast and most molds have been reported at 0.9, 0.8 and 0.7, respectively (Tapia et al., 2020). Food products are the most stable at a_w ranging from 0.07 to 0.35 and water content ranging from 2 to 15%. The present study results indicate that the analyzed samples were microbiologically safe and stable, which is particularly important given the possibility of presence of various microorganisms on pepper particles. It needs to be emphasized, however, that such products should be considered as metastable under the environmental conditions, including primarily water vapor presence in the air.

Technological operations typical of black pepper production do not include processes which potentially increase water content and, consequently, water activity; hence, the relatively high water content determined in black pepper in the present study cannot be attributed to the production technology. It may be hypothesized that it could be due to inappropriate transport and/or storage conditions. Pałacha and Malczewska (2010) achieved similar results of initial water activity and water content of black pepper samples. Therefore, the state of a product such as pepper does not depend only on the properties of the raw material and the parameters of the technological process. It can change many times due to the influence of environmental conditions and should be treated as metastable.

Figure 1 presents the course of water sorption isotherms plotted for the analyzed pepper samples. The points describing sorption isotherms represent mean values of measurements, whose variability coefficients ranged from 0.06% to 1.3% for black pepper from India, from 0.01% to 0.25% for green pepper from India, from 0.03% to 2.4% for black pepper from Vietnam, and from 0.01% to 0.42% for green pepper from Vietnam.

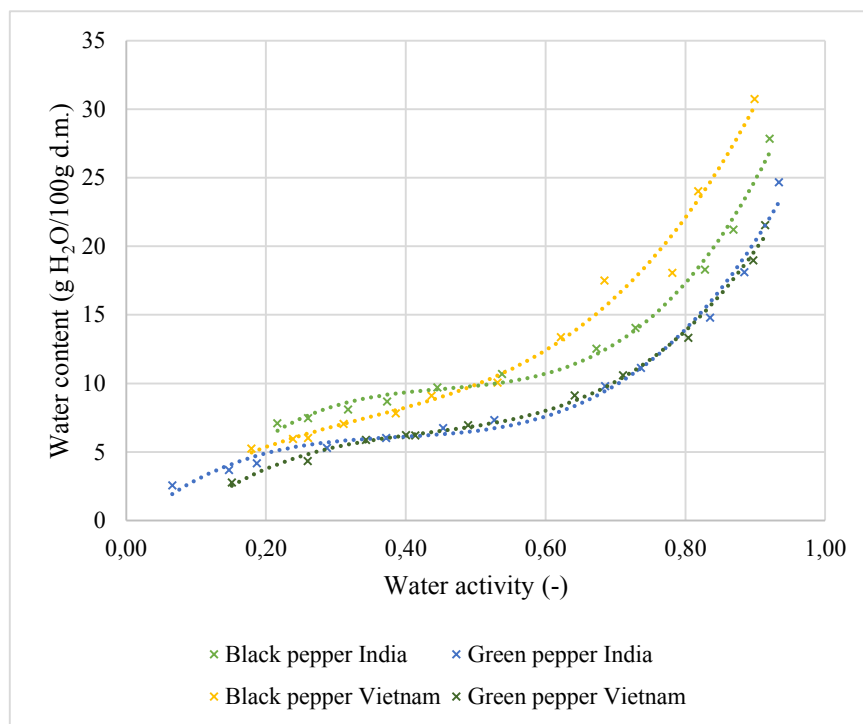


Figure 1. Isotherms of water sorption in the analyzed pepper samples.

Source: own research.

The course of water sorption isotherms plotted for all analyzed pepper samples allows concluding that they were strongly hygroscopic materials capable of absorbing high volumes of water. Regardless of pepper type, the plotted water sorption isotherms had a typical sigmoidal shape, characteristic for type II isotherms acc. to classification by Brunauer et al. (1938). Type II isotherms are typical of food products rich in starch, protein or their mixtures. This shape of isotherms indicates that water sorption proceeded in three stages.

Graphical evaluation of the course of sorption isotherms demonstrated that green pepper samples were more similar to each other than the black pepper samples in terms of their hygroscopicity. This finding may suggest that the technological process applied to produce green pepper from raw material had a significantly stronger impact on its native traits compared to the technological operations applied during black pepper production. In contrast, the statistical analysis of sorption isotherm course data showed that the samples differed from each other in their hygroscopicity to a various extent. The results of Student's t-test for differences between mean values for bonded pairs enabled concluding that these differences were statistically significant.

Another and a more advanced means allowing not only to identify but also compare hygroscopicity, based on specified parameters expressed in numerical values, is the presentation of isotherms using parameters of mathematical models. In the present study, water vapor sorption isotherms were described with two theoretical sorption models: Brunauer, Emmet and Teller (BET); and Guggenheim, Anderson and de Boer (GAB) (Ociecek et al., 2020).

The BET equation is a theoretical model that filled the gap in the interpretation of sorption isotherms and therefore has been accepted as a general method for determining the surface area of adsorbents from sorption data (Ociecek et al., 2021). The choice of the classical BET model was driven by the fact that, despite its limitations, it is still used for monolayer calculations in various areas of physicochemical research, owing to which the results achieved may be compared. Moreover, this model is approved by the International Union of Pure and Applied Chemistry (IUPAC) (Flis et al., 2023). Due to its linear form, which unfortunately tends to overestimate the predicted amount of vapor adsorbed by the sorbent under high pressure, the BET model is an effective tool for estimating the amount of water bound in specific polar regions. Therefore, taking into account its limitations, it was used to describe the studied phenomenon in the water activity range of 0.07 to 0.45, which is indicated in the literature as the range of its utility (Andrade et al., 2011). The model parameters and the degree of its fit to the empirical data are expressed as the root sum of squares (*RSS*) and root mean square error (*RMSE*) and presented in Table 2.

Table 2.

Parameters of the BET equation for the analyzed pepper samples

Product	C_{BET} (kJ/mol)	v_m (g H ₂ O/100 g d.m.)	a_w corresponding to v_m (-)	<i>RSS</i> (-)	<i>RMSE</i> (%)
Black pepper from India	1.66E+11±1.40E+19	5.4704±0.0444	0.1671	0.0524±0.1619	1.23
Black pepper from Vietnam	15.0041±4.8897	5.4743±0.2701	0.1982	0.1322±0.25711	2.49
Green pepper from India	22.6004±4.9103	4.0131±0.1074	0.1751	0.1108±0.2354	2.90
Green pepper from Vietnam	3.5475±1.3832	0.5266±0.3405	0.0287	0.4969±0.4985	6.62

Source: own research.

The comparison of *RSS* pointed to a relatively good fit of the model to empirical data. However, taking into account the limitations of this indicator in assessing model's fit to empirical data, the values of the root mean square error (*RMSE*) were estimated as well. Assuming that an *RMSE* value of less than 10% indicates good fit of the model to empirical data in the selected range of water activities, the BET model was found to well describe the experimental data of all pepper samples. Thus, the generated parameters of the BET model can be considered reliable and comparable, and their interpretation gains application value.

Similar results of BET model fitting to empirical data describing the sorption isotherms of ground pepper available in retail were obtained by Ociecek et al. (2020).

Relatively low values of the energy constant (C_{BET}) estimated for 3 of the 4 analyzed samples enable concluding that the investigated process was physical in nature and that the identity of the adsorbed water molecules did not change significantly. The very high C_{BET} estimated for one of the samples can probably be attributed to the mathematical compensation of its value performed in order to obtain an optimal solution for the remaining parameters (Andrade et al., 2011).

The second of the estimated parameters was the capacity of the monomolecular layer (v_m). Its highest value was determined in both samples of black pepper, whereas a considerably lower one – in the green pepper samples (Table 3). Consequently, the results obtained and a critical analysis of the literature (Kędzia, Kędzia-Hołoderna, 2017; Ociecek et al., 2020; Flis et al., 2023) enable formulating conclusions being of practical importance when optimizing actions aimed at stabilizing the quality and safety of pepper during its maritime transport. The key conclusion is that with the same water content of all analyzed pepper samples, the highest water activity will be determined in green pepper. Assuming that the average water content of green pepper samples was 7 g H₂O/100 g d.m., as shown by the initial water content analysis, it may be concluded that their water activity will reach 0.6, which is deemed a critical level for the microbiological safety. Meanwhile, although the average water content of black pepper was 10 g H₂O/100 g d.m., it generated water activity of 0.55, which prevents the proliferation of microorganisms. Given the fact that it is not the water content but its activity that determines the possibility of occurrence and dynamics of certain reactions, black pepper should be considered more stable during storage and safer for consumers, even if it was periodically stored under unfavorable conditions during transport.

Because the BET model is a special case of the GAB model (Kludsky et al., 2018) and because it has certain limitations in describing sorption isotherms, the sorption parameters were estimated also based on the GAB model (Tab. 3), the use of which requires a broader range of data ($a_w < 0.93$). The application of the GAB model to food sorption isotherms shows a good fit up to $a_w = 0.9$. The simplicity and physical meaning of the GAB model makes it very useful for describing and interpreting water sorption isotherms for food. The GAB model values are more general and have more physical meaning (Timmermann, 2003).

Table 3.

Parameters of the GAB equation for the analyzed pepper samples

Product	C_{GAB} (kJ/mol)	v_m (gH ₂ O/100g d.m.)	K (-)	a_w corresponding to v_m (-)	RSS (-)	$RMSE$ (%)
Black pepper from India	1.49E+10± 1.83E+18	5.4964± 0.2080	0.8632± 0.0114	0.1679	5.3081± 0.8146	5.41
Black pepper from Vietnam	9.7869± 7.1055	6.3731± 1.0764	0.8953± 0.0526	0.2778	11.4414± 1.1959	6.43

Cont. table 3.

Green pepper from India	43.7173± 26.6214	3.8121± 0.1494	0.9023± 0.0080	0.1601	2.1048± 0.5129	7.59
Green pepper from Vietnam	15.7816± 8.0414	4.1832± 0.2663	0.8788± 0.0139	0.2499	2.1120± 0.5138	9.17

Source: own research.

The RSS values were compared analogously to the procedure for assessing the BET model suitability for describing the obtained data, and this comparison showed a good fit of the model to the empirical data. This was confirmed by the estimated $RMSE$ values, which were lower than 10% for all samples. Comparison of these results indicates that the GAB model described all sets of results more evenly than the BET model, which makes the obtained estimates more reliable. Therefore, the interpretation of the GAB model parameters has an application value. Similar results were obtained in studies carried out with ground pepper (Ociecek et al., 2020).

According to Lewicki (1997), the energy constant (C_{GAB}) should exceed 5.67, which is one of the prerequisites of this model's applicability. This condition was met in all samples analyzed in the present experiment. The significantly higher energy constant (C_{GAB}) estimated for the black pepper from India was, most likely and similarly to the BET model, due to the mathematical compensation of its value. At the same time, there are no additional indications that the investigated process was of a non-physical nature and that the identity of the adsorbed water molecules was modified to a significant extent (Lewicki, 1998).

The K values were higher than 0.24, which according to the findings made by Lewicki (1997), is the second condition for the applicability of the GAB model and indicates that the GAB equation was correctly applied to describe the present experiment.

In turn, the values describing the monolayer capacity (v_m) based on the GAB model confirm that black pepper grains, regardless of the origin of the raw material they were produced from, showed a greater affinity for water and capability for its strong coordination. This makes this pepper more stable under unfavorable storage conditions determined by a high water content of the air.

The last part of the study entailed estimation and comparison of parameters describing the microstructure of the surface of the analyzed pepper grains (Table 4).

Table 4.

Characteristics of the surface microstructure of the analyzed pepper samples

Product	Specific sorption area (m ² /g)		Total volume of capillaries (mm ³ /100 g d.m.)	Capillary radius filled at $a_w = 0.6$ (g H ₂ O/100 g d.m.)
	BET	GAB		
Black pepper from India	192.2	193.1	107.32	1.38
Black pepper from Vietnam	192.3	223.9	114.86	3.86
Green pepper from India	141.0	133.9	87.49	0.99
Green pepper from Vietnam	18.5	147.0	82.56	1.01

Source: own research.

The first analyzed parameter of microstructure was the specific sorption surface area, which was calculated based on the size of the monolayer determined from the BET and GAB equations. Black pepper had a larger specific sorption surface area compared to the other samples. Moreover, the total capillary volume was estimated using the GAB model and based on data from the range corresponding to the capillary condensation area. This parameter indicates the amount of water that will fill the capillaries and will constitute the fraction of structured water with a high activity. The results indicate that the surface of black peppercorns was more porous than that of green peppercorns. Next, the radiuses of the capillaries that were filled after the beginning of the capillary condensation phenomenon were estimated using the Kelvin's equation. The results indicate that the black pepper from Vietnam had the most open structure, allowing it to effectively bind large amounts of water when its content in the atmosphere increases.

The above findings are particularly important given the fact that pepper is usually transported by sea, which entails its relatively long-lasting exposure to water in the form of both vapor and liquid. Such conditions usually trigger changes in product quality, primarily due to increased microbial counts and the accumulation of their metabolites, which are often toxic to the human body. Therefore, it is very important to state that these changes can occur in seemingly similar products (green and black pepper from different regions of the world) under the influence of the same conditions but with different dynamics and to a different extent. Therefore, it should be emphasized that the quality of pepper as a commodity available on the global market is largely determined by the conditions of its storage during transport (Hammouti et al., 2019). It should also be noted that the quality of any product is not a constant parameter, and this is particularly true for pepper and similar products, such as cereals, which are traded on a mass and global scale.

Meanwhile, in logistics processes, attention is paid mainly to whether the goods arrived at the destination within the specified time, while no consideration is given to its quality, which in the case of food includes primarily safety for consumers. Emphasizing this aspect is important because in the case of pepper, as a product characterized by a compact structure and a low water content, it is very often difficult to notice signs of spoilage, while its level of safety is very questionable. Therefore, although the literature in the field of logistics indicates the need to implement advanced management systems (Topczewska, Krupa, 2022), the present study results enable concluding that sustainable development can only be achieved by using knowledge from natural and technical sciences in management processes.

Managing logistics processes in which food is the object of the process requires specialist knowledge and acquaintance of new technologies that allow optimizing transport conditions. Considering the management process only as activities related to the transfer of information and its collection on paper or even electronic media has exhausted its possibilities. It is necessary to take a step back, i.e., return to the implementation of the best management practices in engineering. The results of engineering works will be a driving force for further

progress in achieving the concept of sustainable development because they allow making rational decisions whose effects will be measurable. Transferring responsibility to other elements of the system (e.g., insurance) in an increasingly complex system does not solve anything (Flis et al., 2023). Problems should be solved where they arise, and not be just pushed away. The food market is continuously improving, while novel food production technologies and storage conditions underlay the evolution of the global food market. Therefore, it should be emphasized that the education of management specialists, i.e., engineers with thorough knowledge from natural sciences and technology, will pose a real challenge for the modern world.

4. Conclusions

The results obtained in this study should be a starting point when planning and implementing pepper transport by sea, as well as storage recommendations of varying degrees of usefulness, related to: reloading works, the packaging process and, ultimately, the pursuit of meeting consumer expectations. Optimizing logistics processes for pepper can significantly reduce cargo losses and, therefore, food losses and waste. They are also a cornerstone for further research aimed at identifying risk factors and estimating its level related to the transport of loads with sorption properties, especially in various temperature conditions.

The results obtained during the research allowed for a positive verification of both research hypotheses. H₁. The origin of the raw material from which the pepper was obtained significantly differentiates its sorption properties. H₂. The processing technology used for the raw material from which the pepper was obtained significantly differentiates its sorption properties. The analysis of the results obtained using both models indicates that Water vapor sorption isotherms of all tested types of pepper could be considered type II sorption isotherms, according to the classification of Brunauer and colleagues. This means that pepper represents a material with predictable quality changes related to the impact of the environment with specific parameters during transport. The initial water activity determined for both black pepper samples tested was at a level that did not pose any microbiological hazard. This does not mean, however, that the microbiological and toxicological quality of the tested material was satisfactory. Both mathematical models used described the sorption data for the tested types of pepper very well. This means that the research procedure presented in this work allows identifying differences in the sorption properties important for the stability of dry hygroscopic cargoes during transport. Black pepper from India had the greatest specific sorption surface area, which made it the most stable product during storage or transport. The obtained results allow concluding that both the site of pepper cultivation and the processing technology used differentiate its sorption properties and, therefore, its stability in transport conditions.

It is recommended to maintain air humidity at 16-27% during transport and storage of pepper, this value should be constantly monitored using digital hygrometers.

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A BIBLIOMETRIC ANALYSIS OF THE THEORY OF DIGITALIZATION OF HUMAN RESOURCE MANAGEMENT PROCESSES

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Purpose: The aim of the study is to analyse the existing scientific literature on the digitalization of human resource management processes to identify the most researched topics, gaps in the literature and key research and technology trends that can inform future research in this area.

Design/methodology/approach: A systematic literature review is a suitable method for exploring interest in the topic of digitalization of HR processes and the emergence of possible HR process models, as it allows for a comprehensive examination and synthesis of existing knowledge in this area, identifying key aspects, methods and research gaps.

Findings: This study highlights key links between the digitization of HR processes and key management theories and practices, identifying important trends, influential publications and emerging research gaps. Through a comprehensive bibliometric analysis, the study not only approximates the current state of knowledge in HR digitization but also provides valuable insights for future research on modern and sustainable HR management practices.

Research limitations/implications: The database queries were restricted to articles published in English for 2018 up to 2024. Although the topic is frequently raised at conferences and widely discussed, there is still a lack of scientific research, as evidenced by the small number of articles in relation to the number of papers given.

Originality/value: The findings reveal that digital transformation encompasses advanced recruitment technologies, HR analytics, and the development of digital competencies, all of which are crucial for organizational success in a rapidly evolving environment. The study highlights the COVID-19 pandemic's role as a catalyst for remote work and e-recruitment, emphasizing the need for organizations to adapt quickly to new operational models.

Three thematic clusters were identified: the strategic integration of digital technologies, the impact on HRM processes, and the adaptation of competencies in response to technological changes. This article contributes to the field by synthesizing existing models, addressing gaps, and proposing future research directions that focus on advanced technologies, employee well-being, and organizational culture transformation.

Keywords: Digital transformation, human resource management, bibliometric analysis, HR analytics, remote work, digital competencies.

Category of the paper: Literature review.

1. Introduction

Today's organisations operate in a dynamically changing environment in which digital technologies are playing an increasingly important role. Digital transformation is one of the main drivers of civilisation, encompassing almost all spheres and processes, including education, science and human resource management (Ergasheva et al., 2024). The fourth industrial revolution (Industry 4.0) is transforming the world of work, business models, strategies, stakeholder relations and processes and skills. The introduction of new technologies is causing widespread automation and irreversible changes in the structure of workplaces (Poisat et al., 2024).

Digital transformation brings both opportunities and threats to organisations (Straková et al., 2022). Opportunities include increased efficiency, innovation and competitiveness, as well as better alignment with customer needs (Ergasheva et al., 2024). However, there are also challenges related to the need to adapt to new technologies, changes in work structures and potential threats to privacy and data security (Karwehl, Kauffeld, 2021).

Recruitment in the context of digital transformation is under significant change, evolving from traditional methods to advanced digital techniques. Increasingly, e-recruitment, or online recruitment, is being used to offer new opportunities in candidate selection (Habachi et al., 2022; Vedernikov et al., 2022). In this context, Smart HR Recruiting technology is being used for remote staff selection (Vedernikov et al., 2022). Transformation driven by technological advances creates new opportunities but also challenges, requiring companies to be flexible, invest in new technologies and continuously develop the competencies of HR teams (Chin et al., 2024; Wodecka-Hyjek et al., 2024).

Competence development is a key element in the context of digital transformation and the changing labour market (Ergasheva et al., 2024; Karwehl, Kauffeld, 2021). In the digital age, it becomes particularly important to develop digital competences. These competencies include digital literacy as well as the ability to adapt to a changing digital environment (Boiko et al., 2023). In the context of remote working, developing digital competences and work organisation skills is particularly important. Companies need to invest in the development of their employees' competencies to remain competitive and meet the challenges of the digital economy (Ergasheva et al., 2024; Karwehl, Kauffeld, 2021; Zhang, Chin, 2024).

Today, HR analytics is becoming one of the key trends. Data analytics uses advanced technologies to analyse data about employees, HR processes and the organisation, enabling the identification of trends and optimisation of HR activities (Erro-Garcés, Aramendia-Muneta, 2023). Key applications include performance measurement, process optimisation decision support, talent identification and cost reduction (Malik et al., 2023). Implementing HR analytics requires competence, infrastructure and awareness of the challenges of data protection and interpretation of results (Ergasheva et al., 2024; Erro-Garcés, Aramendia-Muneta, 2023).

The COVID-19 pandemic significantly accelerated the digital transformation of human resource management, forcing organizations to rapidly implement remote work solutions. This shift highlighted the need for advanced e-recruitment methods, virtual onboarding processes, and digital tools for workforce management (Vedernikov et al., 2022; Al-Alawi et al., 2023). As companies adjusted to these changes, they faced challenges related to employee engagement, trust-building, and the development of digital competencies, underlining the crucial role of strategic HR management during times of crisis (Poisat et al., 2024; Urbaniec et al., 2022).

Despite the growing interest in the digitisation of HR processes, there is still a lack of in-depth research into the specific challenges and opportunities of implementing technology in specific HR areas and the concerns of employees towards these changes. There is a need to develop digitisation models that take into account the employee experience, the development of digital competences and integrate the different stages of transformation. Furthermore, there is a lack of an organisational culture transformation model to support the effective implementation of digital change in HR management.

This article reviews the literature on these issues, exploring the complexity of digital transformation in the context of human resource management. The analysis covers both theoretical and empirical aspects, providing insights into the latest trends and challenges in this rapidly evolving field.

The aim of the study is to analyse the existing scientific literature on the digitalization of human resource management processes to identify the most researched topics, gaps in the literature and key research and technology trends that can inform future research in this area. Research questions to understand the current state and future directions of the field are:

RQ1: What key research trends related to HR digitization identify emerging areas for future research?

RQ2: What are the gaps in the current literature on HR process digitization?

RQ3: What issues related to the digitization of HR processes are most researched and of greatest interest today?

The article has the potential to make an innovative contribution by synthesising existing models of HR digitalisation and identifying their shortcomings, particularly in relation to employee experience, digital competence development and organisational culture transformation, which is a gap in the current literature. Furthermore, innovative approaches require the inclusion of advanced HR analytics, including artificial intelligence, to optimise processes. The study located research gaps using Miles' (2017) gap typology.

The structure of this manuscript is organized as follows: Chapter 2 presents a review of the literature on TPB and CE. Chapter 3 outlines the research methodology. Chapter 4 analyzes the findings, highlighting research gaps, limitations, and directions for future studies. The manuscript concludes with the final chapter summarizing the key points.

2. An overview of the literature

Digitalisation of HR processes is the process of transforming traditional HR functions and practices through the implementation of digital technologies (Zhao et al., 2024). Sources emphasise that digitisation is not just a simple transfer of analogue processes to a digital environment, but represents a fundamental change in the way HR functions and delivers value to the organisation (Nicolás-Agustín et al., 2021). Digitalisation is seen as a factor that significantly affects HRM processes, but detailed models that comprehensively capture these changes are lacking. Sources highlight that the digitisation of HR includes the automation of routine tasks, the implementation of e-HRM systems, improved communication and collaboration (Nematollahi et al., 2024), the use of data analytics (Malik et al., 2023), the development of digital competencies, and adaptation to remote recruitment and onboarding (Boiko et al., 2023). HR experts see digitalisation as a key societal trend (Ruiz et al., 2024), which affects business at all levels, highlighting the uncertainty that accompanies it (Demir et al., 2022). As an external force driving change, digitalisation poses challenges for managers, requiring new HR competencies and flexible operating models (Vardarlier, 2020).

Modern technologies, such as big data, artificial intelligence and machine learning, make it possible to perform tasks that require cognitive abilities (Makridakis, 2017). Imphan HRM processes, predictive analytics makes it possible to anticipate staffing needs, the risk of employees leaving, and monitor their performance (Ma, 2023). Sources show correlations between the use of analytics data and various aspects of HRM. In the context of HR analytics, sources point to the potential of data in HR decision-making. Data analytics can support the processes of recruitment, selection, employee development, as well as monitoring performance and engagement (Anghel, 2023; Bril et al., 2021; Karwehl, Kauffeld, 2021). It makes it possible to predict future staffing needs, analyze the risk of employees leaving, and forecast employee performance (Erro-Garcés, Aramendia-Muneta, 2023; Nematollahi et al., 2024). However, there is a lack of comprehensive models for using advanced data analysis techniques such as machine learning and artificial intelligence in HR processes. It is predicted that in the future, HRM systems will be able to predict HR needs, monitor employee sentiment and adapt HR strategies to the changing environment (Ma, 2023).

In the context of strategic human resource management, sources (Zhao et al., 2024) emphasize the importance of human capital as a key resource of the company. The development of HRM is analyzed in relation to the resource theory of the firm, which focuses on unique resources and competencies as sources of competitive advantage. Changes in the employment structure are also analyzed, where the role of the human factor in the value creation process is important alongside automation. In this context, knowledge management and the development of employee competencies to meet the demands of the new reality are also important. Sources note the importance of training and developing employees in a changing environment.

In addition, ethical use of data and protection of employee privacy are important (Karwehl, Kauffeld, 2021; Zhang, Chin, 2024).

The literature indicates that the pandemic acted as a catalyst for adopting digital HR practices, particularly in remote recruitment and employee development (Vedernikov et al., 2022). Studies also emphasize the importance of Smart HR Recruiting technologies, enabling companies to maintain operational efficiency while adapting to rapidly changing environments (Al-Alawi et al., 2023). This period of transformation has underscored the long-term value of digital competencies for both HR professionals and employees.

Over the past decade, office work has undergone a transformation, with routine tasks being replaced by more flexible and knowledge-based ones. Research indicates that effective information management, ensuring employees have access to the right data at the right time, should become a priority for organizations, just as industrial automation was key in the past (Attaran et al., 2020). In the future, technology will continue to support flexible work arrangements. This could lead to a minimization of demand for physical offices and an increased role for virtual teams (Kim et al., 2021). Digitization may lead to a work model in which, employees are less dependent on traditional organizational structures and have more autonomy to manage their own tasks (Zhang, Chen, 2023).

The literature points to the need for a holistic view of the impact of digitization on HRM. The development of innovative models that address technological, social and cultural challenges is essential if digital transformation is to effectively support the development of organizations. At the same time, HR remains a key element in supporting employees in adapting to new working conditions and organizational strategies (Al-Alawi et al., 2023).

In conclusion, the literature review points to the urgent need to develop innovative models that holistically capture the impact of digitalization on HRM, as well as address the challenges and opportunities of digital transformation in organizations. Zhao et al. noted that even for traditional manufacturing companies, digitalization is inevitable at this stage of strategic transformation (Zhao et al., 2024). Mihova and Ivanova (2020) point out that industrial companies must invest in HR digitization to gain a competitive (Mihova, Ivanova, 2020). Digitization brings significant social change, highlighting the indispensable role of technology in maintaining competitiveness and market position (Halid et al., 2020). Organizations are gradually adopting digital technologies to optimize HR processes, but there is still great potential for further development and implementation of advanced digital solutions (Carlisle et al., 2021).

3. Research methods

A systematic literature review is a suitable method for exploring interest in the topic of digitalization of HR processes and the emergence of possible HR process models, as it allows for a comprehensive examination and synthesis of existing knowledge in this area, identifying key aspects, methods and research gaps (Figure 1). It enables the development of new theoretical frameworks and the validation of applied theories, which fosters the search for innovative solutions. Through a structured approach, the review can help to understand the complexity of the topic and set directions for future research (Paul, Criado, 2020). For the purposes of bibliometric analysis, the research utilized the Scopus database. Scopus is a database frequently utilized in academic research places a strong emphasis on social science content (Ungaro et al., 2024).

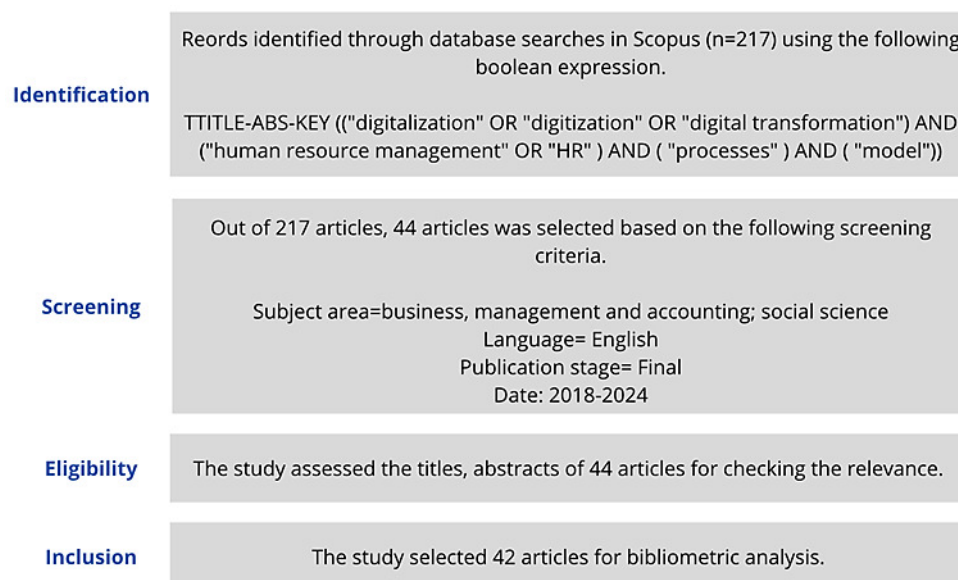


Figure 1. Stages of the research procedure.

Source: developed by authors.

The database queries were restricted to articles published in English for 2018 up to 2024. Although the topic is frequently raised at conferences and widely discussed, there is still a lack of scientific research, as evidenced by the small number of articles in relation to the number of papers given.

4. Performance analysis and science mapping

Bibliometric analysis is based on two fundamental approaches: performance evaluation and science mapping (Donthu et al., 2021). Performance analysis and science mapping are complementary methods of analysing the literature, providing insights into the development and structure of the field. Performance analysis assesses the impact of publications through citations, influential authors, journals, and trends, using bibliometric and statistical tools, without content analysis. Science mapping visualizes the structure of a field by analysing citations and co-citations to identify key areas, author collaborations and thematic changes (Paul, Criado, 2020).

To calculate the APY, it is necessary to have data on the number of publications per year. Then, the years of publication can be summed and divided by the number of publications to obtain the average publication year (Donthu et al., 2021). The co-occurrence analysis conducted in the study used the following formula to calculate the average publication year (APY):

$$APY = \frac{\sum(ti \cdot ni)}{\sum ti}$$

where if a topic *t* appears in two articles in 2020, three articles in 2021, and five articles in 2022, then its APY value is 2021.3 [(2X2020)+(3X2021)+(5X2022)/10].

The study used VOSviewer for science mapping to better understand research trends, collaborative networks, and thematic clusters. Based on the literature review, the main research gaps in the research on the digitalization of human resource management processes were identified. Reference was made to D.A. Miles's (2017) typology of research gaps: evidence gap, knowledge gap, practical knowledge conflict gap, methodological gap, empirical gap, theoretical gap, and population gap (Miles, 2017).

5. Results of the research

5.1. Performance Analysis

Analysing the results of scientific publication searches identifies current research trends, gaps in the literature, and new developments, which is crucial to conducting innovative research. It facilitates the building of a solid theoretical foundation, monitoring progress in the field, and assessing the quality and impact of existing work. This allows researchers to plan their projects more consciously, avoid duplicating existing research, and develop knowledge more effectively (Ungaro et al., 2024).

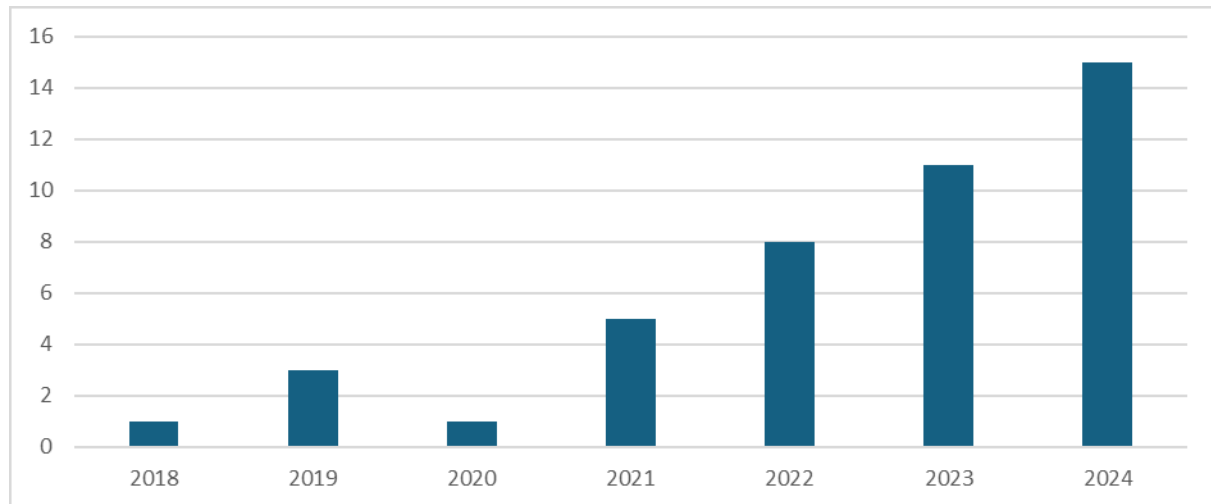


Figure 2. Number of publication between 2018 and 2024.

Source: developed by the authors.

In Figure 2, the upward trend in publications suggests that interest in topics related to the digitisation of human resource management processes is significantly increasing year after year.

Table 1.

Overview of source title

Source title based on number of published articles			
Title	Documents	Total citation	Average citation per document
IEEE Transactions on Engineering Management	3	52	17.3
Sustainability (Switzerland)	3	48	16.0
SA Journal of Human Resource Management	2	11	5.5
International Journal of Human Capital in Urban Management	2	0	0.0
International Journal of Data and Network Science	2	11	5.5
Emerald Emerging Markets Case Studies	2	2	1.0

Source: Author's creation based on Scopus data.

Table 2.

Overview of the source title

Title	Authors	Source	Citation	Average citation per year
Organisational effectiveness and agility	Holbeche, L.S.	Journal of Organizational Effectiveness	80	13.33
The role of human resource practices in the implementation of digital transformation	Nicolás-Agustín, Á., Jiménez-Jiménez, D., Maeso-Fernandez, F.	International Journal of Manpower	74	37.00
Ageing workforce effects in Dual-Resource Constrained job-shop scheduling	Berti, N., Finco, S., Battaia, O., Delorme, X.	International Journal of Production Economics	52	17.33

Cont. table 2.

Sustainability and digitalization of corporate management based on augmented/virtual reality tools usage: China and other world IT companies' experience	Zhao, H., Zhao, Q.H., Ślusarczyk, B.	Sustainability (Switzerland)	46	9.20
Team Formation for Human-Artificial Intelligence Collaboration in the Workplace: A Goal Programming Model to Foster Organizational Change	La Torre, D., Colapinto, C., Durosini, I., Triberti, S.	IEEE Transactions on Engineering Management	31	31.00

Source: Author's creation based on Scopus data.

5.2. Science mapping

Science mapping analysis starts with a co-authorship analysis to explore the interactions among researchers in a specific field, assessed by the number of publications they have co-authored. This analysis investigates the scientific collaborations between researchers and the connections among them, considering their institutional and national affiliations. As co-authorship represents a formal form of intellectual collaboration, understanding how scientists engage with one another is crucial (Donthu et al., 2021).

Table 2 lists the top authors of 44 documents, ranked by the total link strength of their coauthorship among the 133 authors.

Table 3.

Top 5 most collaborative authors

Author name	Document	Citations	Total link strengths
Hagemann Vera	2	14	8
Ruiner Caroline	2	14	8
Hesenius Marc	2	14	8
Klumpp Mathhias	2	14	8
Schaper Martina	2	14	8

Source: Author's creation based on Scopus data.

The co-authorship analysis shows that the collaboration of researchers plays a key role in exploring the topic of digitalisation and HRM, bringing together different perspectives and specialisations. Researchers such as Vedernikov, Bazaliyska, Zelena, Volianska-Savchuk and Boiko focus on the digital transformation of HRM. Krzywdzinski and Jo emphasise the importance of the local context in international knowledge transfer (Krzywdzinski, Jo, 2022). Straková, Talíř and Váchal study digitisation in SMEs (Straková et al., 2022), and Kafel, Wodecka-Hyjek and Kusa in the public sector (Wodecka-Hyjek et al., 2024). Joint work indicates that digitalisation affects HRM effectiveness and employee relations, as evidenced by research on e-recruitment and digital HRM (Aminudin et al., 2024; Vedernikov et al., 2022). The authors contribute to the development of new research methods and concepts to support the understanding and management of digital transformation (Al-Alawi et al., 2023).

5.3. Bibliographic coupling

The study identified three research clusters. This division allows for a better understanding of the thematic scope of each source and their linkages.

Table 4.
Research themes based on bibliographic coupling

Theme	Authors	Title	Total citations
Digital Transformation and Digitalization of HRM	Nicolás-Agustín, Á., Jiménez-Jiménez, D., Maeso-Fernandez, F.	The role of human resource practices in the implementation of digital transformation	74
	Zhao, H., Zhao, Q.H., Ślusarczyk, B.	Sustainability and digitalization of corporate management based on augmented/virtual reality tools usage: China and other world IT companies' experience	46
	Straková, J., Talíř, M., Váchal, J.	Opportunities And Threats of Digital Transformation of Business Models In SMES	27
Impact of technology on HRM	Holbeche, L.S.	Organisational effectiveness and agility	80
	La Torre, D., Colapinto, C., Durosini, I., Triberti, S.	Team Formation for Human-Artificial Intelligence Collaboration in the Workplace: A Goal Programming Model to Foster Organizational Change	32
	Karwehl, L.J., Kauffeld, S.	Traditional and new ways in competence management: Application of HR analytics in competence management	22
Adaptation and innovation	Berti, N., Finco, S., Battaia, O., Delorme, X.	Ageing workforce effects in Dual-Resource Constrained job-shop scheduling	52
	Al-Alawi, A.I., Messaadia, M., Mehrotra, A., Sanosi, S.K., Elias, H., Althawadi, A.H.	Digital transformation adoption in human resources management during COVID-19	21
	Dang-Pham, D., Hoang, A.-P., Vo, D.-T., Kautz, K.	Digital Kaizen: An Approach to Digital Transformation	16

Source: Author's creation based on Scopus data.

The first thematic cluster (12 articles) emphasises that successful digital transformation requires not only investment in technology but, above all, strategic human resource management, promoting innovative employee behaviour and adapting HRM practices to the requirements of the digital age (Nicolás-Agustín et al., 2021). The use of digital technologies in business management has many benefits, such as improving efficiency, optimising processes and increasing employee engagement. These innovative tools also support sustainability by reducing emissions and optimising resources, changing the way companies operate and offering new opportunities in different areas (Zhao et al., 2019). The digital transformation of business models in SMEs is an inevitable process that presents many opportunities to increase efficiency and competitiveness, but also brings risks, such as imbalances in the digitisation of processes and the need for investment. Adequate preparation, digital strategy and flexibility are key to success, allowing SMEs to exploit the potential of digitisation and achieve sustainable growth (Straková et al., 2022).

The Second thematic cluster (12 articles) discusses the impact of technology on all hr processes. Research indicates that undervaluing human resource management (HRM) in the manufacturing and service sectors negatively affects the profitability of companies, while the digitisation of HRM brings significant benefits, increasing the efficiency and competitiveness of companies (Straková et al., 2022). The purpose-driven programming model supports this process by optimising the collaboration of teams with AI and minimising resistance to new technologies, thus fostering innovation (La Torre et al., 2023). Shifting from traditional competency models to analytical approaches allows organisations to manage human resources more effectively, develop employee competencies and build competitive advantage based on the strategic use of data (Karwehl, Kauffeld, 2021).

The third thematic cluster (18 articles) emphasises that the digitisation of HRM is not only about the implementation of new technologies, but also about changing approaches to competence management and employee development. The digitisation of HRM requires a shift from traditional competency models to HR analytics-based approaches, allowing organisations to manage human resources more effectively and develop employee competencies through data analytics (Berti et al., 2021). The COVID-19 pandemic accelerated this process, requiring investment in IT, digital skills development and overcoming employee resistance to successfully implement the transformation (Al-Alawi et al., 2023). Digital Kaizen, combining continuous improvement with technology, enables incremental improvements in HR processes, increasing efficiency and supporting business transformation (Dang-Pham et al., 2022).

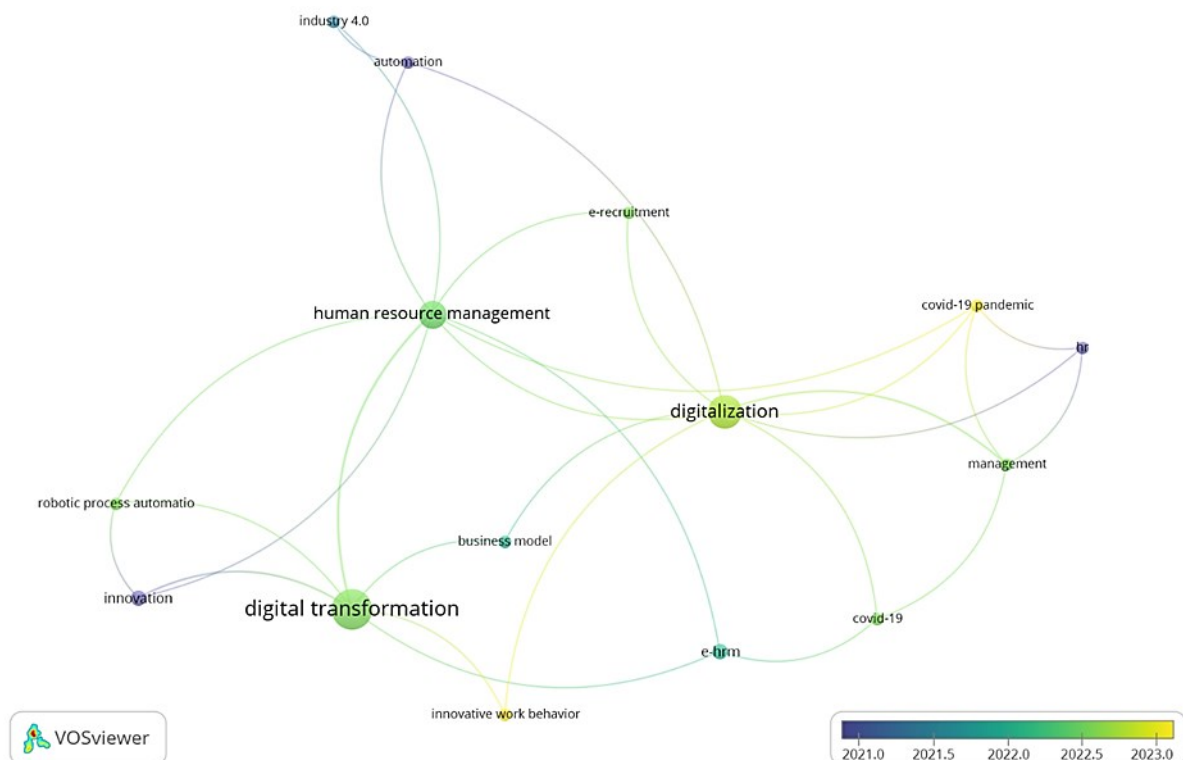


Figure 3. Author keyword co-occurrence.

Source: Author's creation based on Scopus data.

This figure presents the themes (topics) alongside their average publication year (APY), which serves as a marker for identifying trends within these topics. The chart shows a map of thematic clusters generated in VOSviewer based on a co-occurrence analysis of terms (e.g. keywords) related to the topics of digitalisation, digital transformation and HRM. The analysis of the sources shows the evolution of approaches to human resource management (HRM) in the context of digitalisation and digital transformation. Initial publications focused on theoretical aspects and first implementations of e-HRM, as well as on employee competences (Karwehl and Kauffeld, 2021). Over time, especially after 2020, the pandemic accelerated digitisation, forcing the development of e-recruitment and remote management (Vedernikov et al., 2022). In the 2022-2024 publications, an emphasis on the practical aspects of digital transformation is evident (Erro-Garcés, Aramendia-Muneta, 2023; Nematollahi et al., 2024), evaluating the effectiveness of implemented changes and developing digital competences. HRM has evolved from a support function to a strategic business partner (Karwehl, Kauffeld, 2021), crucial to achieving the organisation's goals in the digital age. Sources highlight the strong interdependencies between HRM, digitalisation and digital transformation. HR analytics, used to optimise processes and make data-driven decisions, is becoming increasingly important. Additionally, publications address new challenges such as the ethics of data use and cyber security. In the context of digital transformation, business models are changing (Mazhar, Al-Shawabkeh, 2022). The research focuses on the impact of technology on HR processes, strategic changes in organisations and the long-term implications of these changes. The chart shows that research on the digitalisation of HR processes shows an increasing trend over time, which is in line with the results analysis and indicates a similar upward trend.

6. Discussion

The evidence gap indicates that there is a lack of evidence on the impact of digital HRM on business performance, with studies overlooking implementation and the full process from rejection to technology adoption (Brommeyer et al., 2024; Jierasup, Leelasantham, 2024; Karwehl, Kauffeld, 2021; Saifudin et al., 2021). The knowledge gap, on the other hand, underscores the need for in-depth research on the impact of leaders' complementary skills, knowledge management in the context of digital transformation, HR analytics, and e-recruitment (Habachi et al., 2022). The practical knowledge conflict gap indicates that articles point out the limitations of competency models in the context of dynamic change and remote work, highlighting the lack of consensus on their impact on effectiveness in a changing environment (Habachi et al., 2022; Nicolás-Agustín et al., 2021; Zhao et al., 2024). The methodological gap in the digitization of HRM includes the lack of standardized methods

for measuring performance, assessing the impact on employee experience, analyzing complex data, and validating models under varying conditions, making it difficult to obtain reliable results (Habachi et al., 2022; Mazhar, Al-Shawabkeh, 2022). The empirical gap in the digitization of HRM refers to the paucity of studies based on real data, analyzing the impact of technology on different groups of employees and in the context of remote and hybrid models, especially in SMEs and different sectors (Ergasheva et al., 2024; Straková et al., 2022; Wodecka-Hyjek et al., 2024). The theoretical gap in the digitalization of HRM is due to the lack of consistent definitions, links to management theories, consideration of organizational context, conceptualization of employee impact, and theories that explain the dynamics of change (Ergasheva et al., 2024; Wodecka-Hyjek et al., 2024).

Future research on HR digitization should focus on several key aspects to support the development of this field. It is important to understand the impact of technologies such as artificial intelligence (AI), machine learning and process automation on recruitment, onboarding, career development, administration and performance management. It is also worth exploring how these technologies can reduce the burden on HR departments and increase their ability to accomplish strategic tasks. An important area is to analyze the use of Big Data and HR analytics in decision-making, forecasting trends, identifying talent and improving employee engagement.

Another direction of research should be the personalization of HR processes, taking into account the impact of technology on employee satisfaction and well-being, as well as risks such as job burnout and work-life imbalance. It is also important to study the impact of digitization on organizational culture, fostering organizational values and managing change in the context of digital transformation. It is also necessary to develop HR digitization performance indicators and conduct cost-benefit analyses of the implementation of new technologies, taking into account their impact on productivity, costs and the achievement of strategic organizational goals.

The ethical and social aspects of HR digitization require special attention. Research should focus on protecting employee data privacy, countering discrimination, and promoting diversity and inclusion in the workplace. It is equally important to understand the impact of digitization on the labor market, including changes in demand for competencies, automation of occupations and creation of new employment opportunities. Future research must provide solutions that promote efficiency, ethics and inclusion in human resource management, taking into account both the organization's and employees' perspectives.

In summary, future research directions should focus on advanced technologies, the employee experience, the effectiveness of digitization, as well as ethical and social aspects. Research in these areas will provide a better understanding of the potential of HR digitization and maximize the benefits for organizations and employees.

7. Conclusions

The research conducted in this study emphasizes the key connections between the digitization of HR processes and the fundamental theories and practices of management, identifying important trends, influential publications, and emerging research gaps. The analysis of the results obtained allowed the researchers to answer the research questions posed in the study. Regarding the first research question, three key thematic clusters were identified. The first is related to the strategic integration of digital technologies in human resource management. The second concerns the impact on HRM processes, while the third is related to the adaptation of competencies in response to technological changes. Regarding the second research question, numerous research gaps were identified, including the lack of evidence on the impact of HRM digitization on company business performance; the need to deepen leaders' skills in digital transformation; the standardization of methods for measuring HRM digitization; the impact of technology on various employee groups; and the lack of common definitions linking digitization with HRM. The answers to the third research question indicate that the greatest interest in the subject of HR process digitization is focused on issues such as the evolution of approaches to HRM in the context of digital transformation, its practical aspects, and the optimization of HRM based on digitization. An important issue considered in this context is also the ethics of HRM digitization and cybersecurity.

Through a comprehensive bibliometric analysis, the study not only reflects the current state of knowledge in HR digitization but also provides valuable insights for future research on modern and sustainable HR management practices. This work lays the foundation for deepening both the theoretical understanding of HR digitization and its practical applications, inspiring future innovations in the area of sustainable and effective HR process management.

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SHIFT-SHARE STUDY OF INVENTORY CHANGES IN ENTERPRISES DURING COVID-19

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Purpose: The COVID-19 pandemic significantly impacted business operations worldwide, including in Poland. Inventory management became a key area that underwent dynamic changes due to sudden supply chain disruptions, demand variability, and logistical constraints. As a result, enterprises had to adapt their warehousing strategies to minimize risks and maintain business continuity. This study analyzes changes in inventory levels in Polish enterprises from a sectoral and regional perspective (by voivodships) between 2019 and 2023, with particular attention to the impact of the pandemic on inventory levels and structures across different economic sectors.

Design/methodology/approach: The study employs the Shift-Share method to evaluate the influence of macroeconomic, industry-specific, and local factors on variations in enterprise inventories. This method allows inventory volume changes to be decomposed into components reflecting general economic trends, specific industry effects, and individual enterprise characteristics. The study analyzed inventories for three sectors: industry, trade, and construction. Each type of inventory was considered in four categories: raw materials, semi-finished products, finished products, and goods. The data were collected according to the classification of the Central Statistical Office of Poland. All data have been adjusted for inflation to ensure consistency, using 2019 as the base year. Since inflation in Poland exceeded 34% during the analyzed period, these adjustments provided accurate rates of change.

Findings: Despite significant disruptions in global supply chains, the overall inventory volume in Polish enterprises increased by 19.8% between 2019 and 2023. However, the dynamics of changes varied significantly between the periods 2019–2021 and 2021–2023. The volume of most inventories increased significantly in the first period and slightly in the second. The most significant fluctuations occurred in the industrial production of raw materials and supplies.

Originality/value: This study applies the Shift-Share method to analyze inventory changes across firms during the COVID-19 pandemic. It offers a sectoral and regional perspective, providing insight into the key factors influencing inventory fluctuations. The results are relevant for researchers interested in supply chain resilience and inventory management strategies during periods of economic uncertainty.

Keywords: Shift-share analysis, pandemic impact, inventory.

Category of the paper: Research paper, Viewpoint.

1. Introduction

The COVID-19 pandemic has had a significant impact on the functioning of businesses around the world, including Poland. Inventory management is one of the key areas that has undergone dynamic changes. As a result of sudden disruptions in supply chains, demand variability and logistical constraints, companies have had to adapt their warehouse strategies to minimize risk and maintain business continuity. The post-pandemic period (2021-2023) has brought further challenges related to rebuilding economic stability, structural changes in various sectors and regional differences in the pace of returning to pre-pandemic levels of production and distribution. The topic concerning the study of the specific logistical aspects of inventory management, taking into account the difficulties faced by enterprises during the pandemic, can be found, among others, in the works of (Pasimeni, 2021; Kott, Sukiennik, 2022; Comporek, 2024; Sobczak, Chomac-Pierzecka, 2024; Gasowska, 2024).

Regardless of the industry, Polish enterprises have faced challenges related to excessive inventory accumulation due to falling sales and shortages caused by logistics disruptions. This study focuses on analyzing the dynamics of changes in inventories of enterprises in Poland from a sectoral and regional (by province) perspective in the years 2019-2023. Particular attention is paid to the impact of the pandemic on the levels and structure of inventories in various sectors of the economy and on regional differences in inventory management. The Shift-Share method used in the study allows for identifying factors responsible for changes in inventories resulting from nationwide economic trends and those specific to individual provinces and sectors. It was introduced to the economic analysis of regions by E.S. Dunn (1960) and used in later works (Kundsen, 2000; Malik, 2011; Suchecki, 2010; Mach, 2017). Research on inventory dynamics in globalization and business environment changes using the shift-share approach is covered in the following works (Gradzewicz, Mućk, 2019; Ferrari, 2022).

This article aims to analyze the impact of the COVID-19 pandemic on changes in the structure and level of inventories in Polish enterprises. In particular, key trends in inventory changes in various sectors will be discussed, focusing on the geographical aspect in the pandemic period (2019-2021) and the post-pandemic period (2021-2023). The study's results can provide valuable guidance on the future shaping of warehouse policy in the face of potential economic crises at both the sectoral and regional levels.

2. Methods

The Shift-Share method is an analytical tool used to assess the impact of various factors on changes in inventories of industrial, commercial, and construction enterprises by decomposing these changes into components resulting from macroeconomic, industry-specific, and local influences. It allows for identifying the factors affecting inventory level changes (materials, finished goods, semi-finished products, and merchandise) by breaking down their increase or decrease into components that result from general market trends, specific industry effects, and individual characteristics of a given type of enterprise.

The analysis examined the formation of quantitative variables denoted as TX_{jir} , where j represents the industries of enterprises, i – types of inventories, r – regions (voivodship), that indicate absolute increases or the rate of change in X_{ji} . The diagnostic variables describing the categories include variable X_{1ir} – inventories of industrial enterprises by types; variable X_{2ir} – inventories of trade enterprises by types; and variable X_{3ir} – inventories of enterprises in the construction sector by types. Each variable representing the value of inventories has four dimensions: inventories of materials, semi-finished products and work-in-progress, finished goods, and merchandise. Average growth rate of variable X in the country and in a given industry:

$$TX_{j..} = \frac{\sum_r \sum_i (X_{jri}^* - X_{jri})}{\sum_r \sum_i X_{jri}}, \quad (1)$$

X_{jri}^* is the observation of the analyzed variable in the r -th region and i -th cross-sectional group, to the industry; in SSA analyses we use aggregate measures (Sucheckı, 2010, p. 164).

Statistical data were collected across multiple dimensions for each variable, developing a contingency table with matrix elements. The values in this table represent the total variable X for the r -th voivodeship and the j -th sector. The time range of the analyzed data covers the years 2019-2023. The shifts were analyzed over three-time intervals: 2019-2021, 2021-2023, and 2019-2023. The data were collected using the local GUS database.

The selection of the three industries for analysis, quantitatively defined as variables X_1 , X_2 , and X_3 , was dictated not only by the availability of data but also by the fact that these three sectors account for approximately 90% of the inventories of all enterprises in the country, allowing for an aggregated assessment of dynamics at the macro level.

To minimize the impact of regional size, weighted variables were applied in the calculations and analysis. During this process, we calculated the individual rate of change for each variable examined and three aggregate indicators: the average rate of change for the r -th region, the j -th sector, and the country as a whole. Furthermore, the values obtained from the statistical data bank were adjusted for inflation using the inflation index, with all calculations based on prices modified to reflect the 2019 level. Since inflation in Poland exceeded 34% from 2019 to 2023, this approach allowed us to achieve more accurate rates of change. Although the inflation index

has certain limitations and may not reflect specific price changes for raw materials, supplies or products in specific industries, the value of an enterprise's inventories may change under other factors. For accurate adjustment, it is necessary to have access to detailed macroeconomic data and consider the inflation dynamics at the industry and regional levels.

The outcome of the Shift-Share analysis is the calculation of structural-geographical equality. This relationship describes the geographical differentiation of the excess of the average regional inventory growth rate over the national average and is represented as a component of two effects: structural and geographical. Suchecki (2010) describes the detailed calculation method in section 6.1 on the Classical Variable Distribution Method (SSA). Determining and analyzing the dynamics of inventory changes will allow us to present the studied area of working capital management in a structural-spatial dimension while highlighting the strengths and weaknesses of the analyzed regions.

In assessing the dynamics of inventory changes in enterprises, the average values of financial variables were examined across three categories: industrial enterprise inventories, wholesale and retail trade enterprise inventories, and construction industry enterprise inventories. The specificity of economic activity for each group of enterprises with inventories is reflected in the results of the analysis. The data used for calculations are accurate and were collected over five years, with two-year intervals, and presented for each of 16 voivodeships. The conducted study will enable the assessment of changes in the inventory structure of enterprises in individual voivodeships, which will also allow for evaluating the regional structure and dynamics of enterprise inventories during the studied period.

Conducting the study by the outlined assumptions will allow for answering the following research hypotheses:

- on a national scale, during the COVID-19 pandemic (2019-2023), enterprises experienced disruptions in global supply chains and reduced inventory value,
- by examining the structural effect of changes, it is possible to identify industries and types of inventories whose dynamics have a decisive impact on the level of enterprise stock,
- changes in the structure (structural effect) and competitiveness zone (geographical effect) influence the increase or decrease in inventories in individual voivodeships (total effect).

3. Results

In studying the dynamics and structure of enterprise inventories, data on enterprise inventories for three industries available in the Financial Results of Enterprises category, according to the PKD 2007 sections, were collected and analyzed. Additionally, data on

inventories across all business sectors were reviewed collectively. The analysis of manufacturing enterprise inventories, where balance sheet categories present inventories, is provided in subsection 3.1. Similarly, the analysis results for wholesale and retail trade enterprises are presented in 3.2, and for the construction industry in 3.3. Each of the three data categories underwent a general and detailed analysis, including a structural (sectoral) breakdown and a share change analysis.

The starting point for the conducted analysis was the determination of inventory value (in millions of zlotys) for the years 2019-2023. The data were adjusted for inflation. We calculated the dynamics and structure of inventories based on the balance sheet classification, which includes materials, finished goods, semi-finished products, and merchandise, across three primary industries. Table 1 presents the industry's average growth/decline rates of enterprise inventory value.

Table 1.

Average growth rate in the country by industries

Rate of change by industries	2019-2021	2021-2023	2019-2023
Total	20,2%	-0,4%	19,8%
Industrial enterprises	28,6%	-2,3%	25,7%
Wholesale and retail trade	12,8%	4,1%	17,4%
Construction industry enterprises	4,9%	2,1%	7,7%

Source: own study based on data from the Central Statistical Office.

It is worth noting that despite significant changes in international supply chains during and immediately after the pandemic, the overall inventory volume did not decrease; instead, an increase of 19.8% was observed. However, there is a notable difference between 2019-2021 and 2021-2023 dynamics. Among the industries, the most significant fluctuations occurred in industrial production, where a 2.3% decline was followed by growth of 28.6% in the first period in the second. This sector accounts for more than half of the total inventory volume, so such fluctuations indicate a precarious supply chain situation.

Table 2 presents the analysis of the situation by structural components of inventories. The overall trend is similar and confirms the previous conclusions. The most significant materials category for industrial production experienced the most extraordinary fluctuations. A 7.8% decline followed a growth of 37.9% in the first and second sub-periods.

Table 2.

Average growth rate in the country by type of inventories

Rate of change by inventories	2019-2021	2021-2023	2019-2023
Materials	37,9%	-7,4%	27,7%
Semi-finished products	20,2%	-1,0%	19,0%
Finished products	12,7%	4,6%	18,0%
Goods	10,1%	4,8%	15,4%

Source: own study based on data from the Central Statistical Office.

3.1. Industrial enterprises

In the study of changes occurring in the inventories of industrial enterprises, a general analysis of the examined category was conducted (by calculating the dynamics of changes), and its structural components were analyzed (using shift-share analysis) in the form of materials, finished goods, semi-finished products, and merchandise.

The interpretation of the obtained results examines how the analyzed variable influences inventory situations across various industries. First, we determined the inventory change rates at the national level. These calculated rates of change were weighted based on the inventory components, as shown in Table 1. We analyzed three distinct periods: the first two comprise data ranges in two-year intervals (2019-2021 and 2021-2023), while the third period encompasses the entire analysis timeframe from 2019 to 2023.

Throughout the study period, the volume of inventories in manufacturing enterprises increased by 25.7%. In the first sub-period (2019-2021), inventories grew by 28.5%, while in the second sub-period (2021-2023), there was a decrease of 2.3%.

Table 3 illustrates the dynamics of structural factors and provides a detailed analysis of the changes. The structural change coefficient was calculated for the three components mentioned earlier.

Table 3.

Sectoral (structural) factor of changes in industrial enterprises

Rate of change by inventories	2019-2021	2021-2023	2019-2023
Materials	37,2%	-9,5%	24,2%
Semi-finished products	26,0%	2,3%	28,9%
Finished products	20,3%	7,1%	28,4%
Goods	16,1%	7,3%	24,5%

Source: own study based on data from the Central Statistical Office.

When analyzing the structural changes in the inventories of manufacturing enterprises, the most significant fluctuations—both in growth and decline—were observed in the materials category, which is a fundamental component of manufacturing. During the pandemic, the volume of materials in these enterprises increased dramatically by 37.2%. However, in the post-pandemic period, it experienced a decrease of 9.5%.

For other inventory categories, growth was noted across all analyzed periods. Nonetheless, the growth rates during the second post-pandemic period were relatively moderate, averaging around 5%, compared to the pandemic period, when growth rates reached up to 20% on average.

In the third stage of the study, the structural-geographical equality was calculated to represent the total effects of changes that occurred during the analyzed periods. This equality was calculated based on equation (1) presented in Section 2 using the methodology described in Suchecki (2010) – see Table 4.

Table 4.*Structural-geographic equality (total effect) in industrial enterprises*

Rate of change by voivodship	2019-2021	2021-2023	2019-2023
Dolnośląskie	13,8%	1,5%	15,5%
Kujawsko-pomorskie	-22,8%	-5,8%	-28,5%
Lubelskie	30,8%	0,6%	33,9%
Lubuskie	30,7%	-10,4%	13,7%
Łódzkie	0,6%	26,4%	41,0%
Małopolskie	13,6%	-10,1%	-1,9%
Mazowieckie	-1,5%	10,8%	12,3%
Opolskie	23,8%	-13,7%	3,9%
Podkarpackie	-2,0%	16,0%	18,0%
Podlaskie	8,6%	8,0%	21,8%
Pomorskie	-20,4%	7,4%	-16,3%
Śląskie	-7,3%	-5,6%	-14,2%
Świętokrzyskie	-11,5%	-6,8%	-18,6%
Warmińsko-mazurskie	17,3%	-16,9%	-7,9%
Wielkopolskie	-3,1%	-11,2%	-17,1%
Zachodniopomorskie	26,5%	-18,1%	-0,8%

Source: own study based on data from the Central Statistical Office.

The columns in Table 4 present the percentage changes in the total effects achieved for the analyzed regions. Over the entire study period, the highest inventory growth rate among industrial enterprises was observed in Łódź Voivodeship, which exceeded the national average by 41%.

Conversely, the lowest inventory growth rate, specifically a decline of 28.5%, was recorded in Kujawsko-Pomorskie Voivodeship and in the Świętokrzyskie, Śląskie and Wielkopolskie Voivodeships. Moreover, the growth/decline trends in the sub-periods within these voivodeships were opposite to the national trends.

Additional calculations were made to analyze the structural and geographical effects of the changes, as detailed in Table 5. The total effect for Łódź Voivodeship increased by 41%. This increase was only slightly influenced by changes in the structure of inventory components, with the structural effect rising by just 0.6%. Instead, it was predominantly driven by internal changes unique to the region, as the geographical (local) effect accounted for 40.4% of the total change.

Table 5.*Shift-Share Analysis results 2019-2023 in industrial enterprises*

Rate of change by voivodship	Total	Structural	Geographic
Dolnośląskie	15,5%	0,4%	15,1%
Kujawsko-pomorskie	-28,5%	0,8%	-29,3%
Lubelskie	33,9%	0,8%	33,1%
Lubuskie	13,7%	0,6%	13,2%
Łódzkie	41,0%	0,6%	40,4%
Małopolskie	-1,9%	0,7%	-2,6%
Mazowieckie	12,3%	0,5%	11,8%
Opolskie	3,9%	0,3%	3,6%
Podkarpackie	18,0%	0,9%	17,0%
Podlaskie	21,8%	0,9%	20,9%
Pomorskie	-16,3%	0,3%	-16,7%

Śląskie	-14,2%	0,4%	-14,6%
Świętokrzyskie	-18,6%	1,1%	-19,7%
Warmińsko-mazurskie	-7,9%	0,7%	-8,6%
Wielkopolskie	-17,1%	0,5%	-17,6%
Zachodniopomorskie	-0,8%	0,6%	-1,4%

Source: own study based on data from the Central Statistical Office.

3.2. Retail trade

The analysis for the wholesale and retail trade enterprises was conducted based on the same principles as for industrial enterprises. Sector-weighted growth rates were calculated for three periods. Over the entire analysis period (2019-2023), the inventories of trade enterprises increased by 17.4%. The growth trend in 2019-2021 was three times higher, reaching 12.8%, whereas in 2021-2023, it amounted to 4.1% (Table 1).

The structural change coefficient was calculated for the four inventory components of trade enterprises as part of the detailed analysis of structural (sectoral) changes (see Table 6).

Table 6.
Sectoral (structural) factor of changes in retail trade

Rate of change by inventories	2019-2021	2021-2023	2019-2023
Materials	84,5%	-40,4%	10,0%
Semi-finished products	27,6%	-6,5%	19,3%
Finished products	9,0%	10,2%	17,9%
Goods	10,7%	6,4%	17,8%

Source: own study based on data from the Central Statistical Office.

During the analysis of changes in inventory volumes at trade enterprises, it was observed that from 2019 to 2021, there was a significant increase in the materials category. However, this increase was later followed by a substantial decline in the subsequent period. As a result, the overall growth for the entire analyzed period remained moderate. This indicates that such fluctuations during the pandemic were very significant for retail enterprises.

In the next stage of the study, the total impact of inventory changes across the examined periods was calculated using structural-geographical equality, as presented in Table 7.

Table 7.
Structural-geographic equality (total effect) in retail trade

Rate of change by voivodship	2019-2021	2021-2023	2019-2023
Dolnośląskie	8,8%	-16,8%	-11,2%
Kujawsko-pomorskie	7,4%	-21,2%	-18,1%
Lubelskie	18,2%	-8,4%	8,0%
Lubuskie	35,8%	-4,2%	31,1%
Łódzkie	-14,0%	-7,5%	-21,9%
Małopolskie	-4,2%	2,5%	-1,7%
Mazowieckie	-5,4%	4,1%	-1,2%
Opolskie	-15,5%	12,1%	-4,4%
Podkarpackie	-1,2%	-8,1%	-10,2%
Podlaskie	-4,4%	-2,1%	-6,8%
Pomorskie	9,2%	-28,2%	-24,8%
Śląskie	11,4%	14,1%	29,2%

Cont. table 7.

Świętokrzyskie	-2,2%	-10,9%	-14,3%
Warmińsko-mazurskie	-7,0%	11,6%	5,0%
Wielkopolskie	1,1%	12,4%	15,3%
Zachodniopomorskie	-0,9%	10,3%	10,6%

Source: own study based on data from the Central Statistical Office.

The most considerable inventory growth among trade enterprises occurred throughout the study period in Lubuskie Voivodeship, reaching 35.8% in the first sub-period. Conversely, the most significant decline was recorded in Pomorskie Voivodeship, with a 28.2% decrease in the second analyzed sub-period.

Notably, the general trend of significant inventory increases during the pandemic, followed by a slight rise in the subsequent period, was not confirmed in any single voivodeship. Instead, each region exhibited different trends, resulting in the observed overall effect.

In an attempt to conduct a more detailed analysis of the changes recorded in trade enterprises within the achieved total effect, structural and geographical effects were additionally calculated – see Table 8.

The increase in the total effect for Lubuskie Voivodeship was primarily driven by the local factor (+30.8%) and, to a lesser extent, by the structural factor (+0.3%).

Table 8.

Shift-Share Analysis results 2019-2023 in retail trade

Rate of change by voivodship	Total	Structural	Geographic
Dolnośląskie	-11,2%	0,3%	-11,5%
Kujawsko-pomorskie	-18,1%	0,2%	-18,3%
Lubelskie	8,0%	0,3%	7,7%
Lubuskie	31,1%	0,3%	30,8%
Łódzkie	-21,9%	0,2%	-22,1%
Małopolskie	-1,7%	0,1%	-1,8%
Mazowieckie	-1,2%	0,3%	-1,4%
Opolskie	-4,4%	0,2%	-4,6%
Podkarpackie	-10,2%	0,0%	-10,3%
Podlaskie	-6,8%	0,3%	-7,1%
Pomorskie	-24,8%	0,2%	-25,0%
Śląskie	29,2%	0,0%	29,3%
Świętokrzyskie	-14,3%	0,2%	-14,5%
Warmińsko-mazurskie	5,0%	0,2%	4,8%
Wielkopolskie	15,3%	0,3%	15,0%
Zachodniopomorskie	10,6%	-0,1%	10,7%

Source: own study based on data from the Central Statistical Office.

3.3. Construction industry enterprises

The analysis of inventory changes for construction industry enterprises showed a similar trend – an overall increase throughout the entire study period, with more significant growth in the first sub-period (2019-2021) and half the growth in the second sub-period (2021-2023). Compared to other industries, the construction sector did not exhibit significant fluctuations in inventory accumulation overall.

Table 9 presents a detailed analysis of structural changes, including the coefficient of changes in inventory components for construction industry enterprises.

Table 9.

Sectoral (structural) factor of changes in construction industry enterprises

Rate of change by inventories	2019-2021	2021-2023	2019-2023
Materials	15,7%	-4,4%	10,6%
Semi-finished products	-2,8%	1,4%	-1,4%
Finished products	30,1%	10,7%	47,3%
Goods	19,6%	12,5%	34,6%

Source: own study based on data from the Central Statistical Office.

Overall, the situation across the inventory components aligns with the general trend. However, in the semi-finished products and work-in-progress category, a notable increase was observed in the second sub-period, while a decrease occurred in the first sub-period.

In the finished goods category, inventory accumulation in the first sub-period was three times higher than in the second, reaching 30.1% and 10.7%, respectively. As for merchandise, the trend was 19.6% in the first sub-period compared to 12.5% in the second. These observed trends can be attributed to the nature of the production process in this industry.

Table 10 presents the calculation of structural-geographical equality for voivodeships, where the total effect of inventory changes over the analyzed periods was computed.

Table 10.

Structural-geographic equality (total effect) in construction industry enterprises

Rate of change by voivodship	2019-2021	2021-2023	2019-2023
Dolnośląskie	-10,3%	253%	228,6%
Kujawsko-pomorskie	1,6%	-12%	-12,9%
Lubelskie	31,8%	31%	72,9%
Lubuskie	-14,8%	-34%	-53,4%
Łódzkie	76,4%	17%	121,1%
Małopolskie	10,4%	5%	21,8%
Mazowieckie	1,5%	-5%	-4,1%
Opolskie	57,4%	-47%	-15,1%
Podkarpackie	9,4%	-5%	1,4%
Podlaskie	30,0%	9%	42,9%
Pomorskie	-6,8%	-20%	-28,0%
Śląskie	-10,1%	-6%	-16,7%
Świętokrzyskie	37,1%	-17%	11,1%
Warmińsko-mazurskie	-9,2%	-10%	-19,9%
Wielkopolskie	5,2%	-3%	1,3%
Zachodniopomorskie	-59,2%	32%	-46,0%

Source: own study based on data from the Central Statistical Office.

The increase in the total effect for Dolnośląskie Voivodeship was primarily driven by the local factor (+223.2%) and, to a lesser extent, by the structural factor (+5.3%).

Throughout the study period, the most extensive inventory growth in the construction sector occurred in Dolnośląskie Voivodeship, reaching 253% in the second sub-period for the semi-finished products and work-in-progress category.

This anomalous increase may result from specific production processes in this industry compared to other categories and voivodeships. It significantly contributed to the atypical fluctuations in inventories' structural dynamics.

Overall, the construction sector exhibited substantial variability in inventory dynamics across regions, with a standard deviation of approximately 70%.

Furthermore, the calculations for structural and geographical effects have been conducted and are presented in Table 11. The increase in the total effect for Dolnośląskie Voivodeship was primarily driven by the local factor, which accounted for a rise of 223.2%, and to a lesser extent by the structural factor, contributing an increase of 5.3%.

Table 11.

Shift-Share Analysis results 2019-2023 in construction industry enterprises

Rate of change by voivodship	Total	Structural	Geographic
Dolnośląskie	228,6%	5,3%	223,2%
Kujawsko-pomorskie	-12,9%	7,3%	-20,2%
Lubelskie	72,9%	12,4%	60,5%
Lubuskie	-53,4%	5,7%	-59,0%
Łódzkie	121,1%	4,8%	116,3%
Małopolskie	21,8%	3,3%	18,5%
Mazowieckie	-4,1%	-1,5%	-2,5%
Opolskie	-15,1%	-1,0%	-14,1%
Podkarpackie	1,4%	4,6%	-3,3%
Podlaskie	42,9%	3,3%	39,6%
Pomorskie	-28,0%	3,8%	-31,8%
Śląskie	-16,7%	-5,8%	-10,9%
Świętokrzyskie	11,1%	4,6%	6,5%
Warmińsko-mazurskie	-19,9%	4,1%	-23,9%
Wielkopolskie	1,3%	2,6%	-1,3%
Zachodniopomorskie	-46,0%	1,5%	-47,5%

Source: own study based on data from the Central Statistical Office.

4. Discussion

The study demonstrated the dynamics of changes and structural-geographical shifts in enterprises' current material assets during the COVID-19 pandemic and immediately after its conclusion. Calculations were performed for enterprises in three industry types according to the balance sheet classification of inventories. The data used for calculations were indexed to the 2019 level to ensure comparability, considering changes in the Consumer Price Index (CPI).

Across all analyzed industries, enterprises generally exhibited a stimulating effect on inventory changes throughout the study period. The growth rate in the first sub-period (2019-2021) was strictly positive and averaged around 20%. However, in the second sub-period (2021-2023), the growth rate was nearly absent, yet no negative trend was observed either.

A key aspect of analyzing the results was associating them with the regional characteristics of enterprises. As a summary of the study, Figure 1 presents the inventory dynamics by voivodeships, comparing 2023 to 2019, accumulated to 100%.

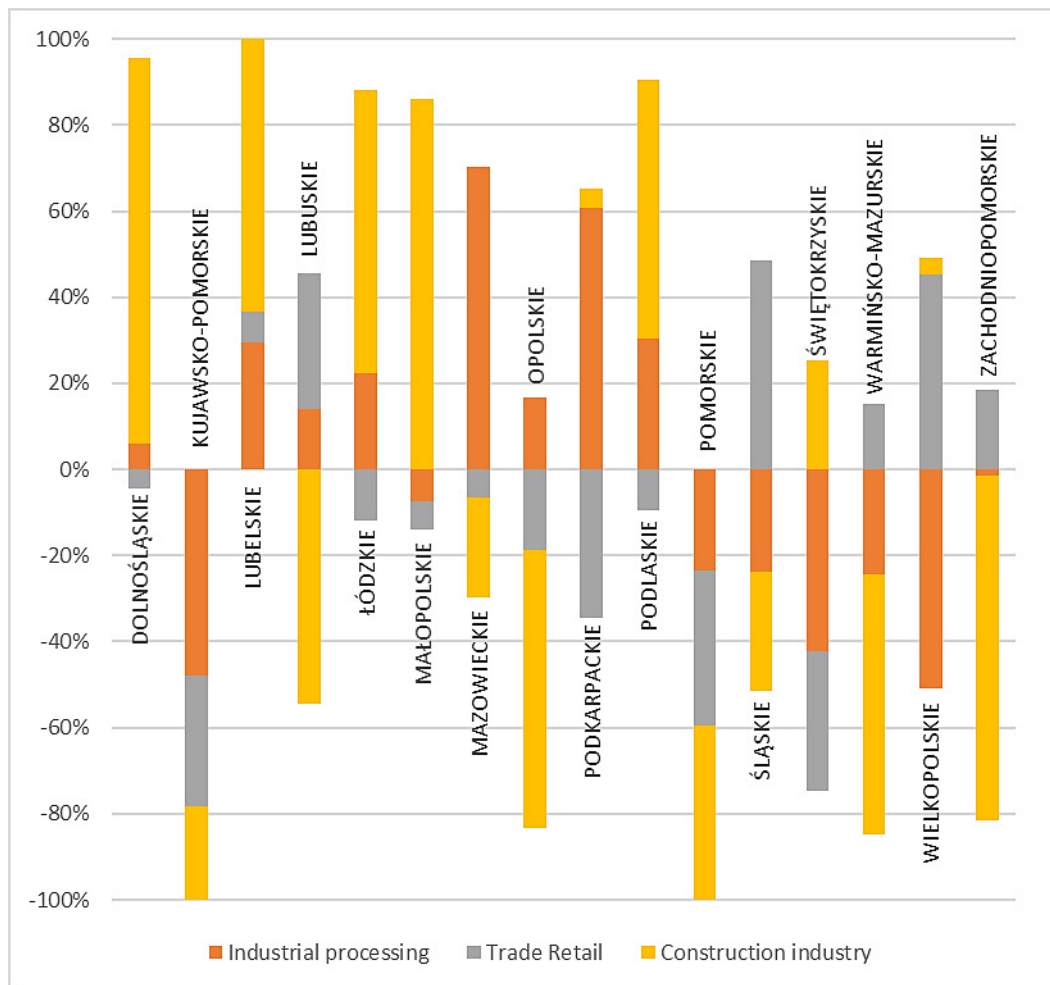


Figure 1. Inventory dynamics by voivodeships (2019-2023), accumulated to 100%.

Source: own study based on data from the Central Statistical Office.

Figure 1 shows that only in Lubelskie Voivodeship were the dynamics strictly positive across all three analyzed industries. In contrast, in Kujawsko-Pomorskie and Pomorskie Voivodeships, the trend was strictly negative. In all other voivodeships, positive and negative trends were observed, leading to an average gradual overall accumulation of inventories.

Another interesting aspect is the variability of inventory dynamics by industry across voivodeships, which can also be observed in Figure 1. For industrial enterprises, the standard deviation was 19%; for trade enterprises, it was 16%, whereas for construction enterprises, it reached 68%. These results indicate the specific nature of the production process in the construction sector and significant regional differences. Overall, the geographical effect had the greatest impact on inventory dynamics, in contrast to the structural effect, across all voivodeships.

The study conducted allowed for specific quantitative estimates of inventory dynamics at the industry and voivodeship levels. These estimates allow for further research not only to analyze but also to forecast the situation with the accumulation of inventories, which in turn allows for the prediction of the dynamics of transportation and storage prices.

The study confirmed the hypothesis that, on a national scale, enterprises experienced disruptions in global supply chains and a decrease in inventory costs during the COVID-19 pandemic (2019-2023). This is evident from the differing dynamics observed in the two sub-periods of the study: the first (2019-2021) and the second (2021-2023).

Regarding the second hypothesis about the structural effects of these changes, the production sector and raw material inventories were identified as significantly influencing inventory levels within enterprises. Additionally, local geographical factors also play a crucial role in the dynamics of inventories.

Further research is needed into the extent of inflation's impact on inventories' value. The indexation carried out has certain limitations and risks associated with the methodological component—methods of inventory valuation in accounting and adjustments based on industry price indices, which can complement inflation indexation for a more accurate analysis.

5. Summary

On a national scale, during the COVID-19 pandemic (2019-2023), enterprises experienced disruptions in global supply chains and a shift in inventory value. However, it cannot be conclusively stated that in the post-pandemic period, enterprises fully transitioned from the Just-in-Time (JIT) strategy to the Just-in-Case (JIC) strategy.

With the end of the pandemic, enterprises have begun abandoning risk-reduction strategies focused on avoiding supply shortages and ensuring supply chain stability, as these are more costly. Instead, businesses are gradually returning to strategies that minimize inventory levels and optimize supply chains, ensuring that goods and raw materials arrive just in time for their use, thereby reducing storage costs.

By analyzing the structural effect of changes, the industrial sector and raw materials and material inventories were identified as key factors influencing inventory levels in enterprises. During the study period, inventory fluctuations in the industrial sector reached 30%, while for raw materials and supplies, they reached 45%. In contrast, other analyzed categories did not exceed a 20% change.

The Shift-Share Analysis (SSA) revealed changes in the total effects across different industrial sectors and further divided these changes into structural and geographical impacts. The increase or decrease in inventories in specific voivodeships (total effect) was influenced by both structural changes (structural effect) and changes in the competitiveness zone

(geographical effect). In most cases, the geographical (local) effect was more significant and had a noticeable impact across all enterprise sectors.

The study covers the years 2019–2023, which allows us to assess the short-term effect of the pandemic, which is its weakness. There is no long-term analysis that would take into account enterprises' resilience after the pandemic. Also, the inflation adjustment is based on the average level of inflation, but individual industries may have experienced different inflation levels.

The study showed that enterprises tried to adapt to disruptions in supply chains, but due to uncertainty, not all were able to avoid overstocking. In the short term, an increase in inventories was characteristic of all sectors, but in the post-pandemic period, there was a return to optimising warehouse inventories.

The study also showed different industry scenarios:

- industry experienced the most significant fluctuations due to changes in demand for raw materials,
- the trade sector had more stable growth but with significant changes in 2021-2023,
- the construction sector showed the minor changes, indicating longer adaptation cycles.

The data obtained can help optimise procurement policies and identify practical approaches to inventory management in times of crisis. The study's results can also be useful for shaping economic policy, and data on regional differences can help better target state support and subsidies. The study provides a valuable analysis of the impact of COVID-19 on inventory management in Polish enterprises. However, it has certain limitations due to the methodology and time range.

Businesses, government agencies, and academics can use the lessons learned to develop inventory management strategies during times of instability.

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THE RELATIONSHIP BETWEEN RISK AND THE COST OF EQUITY IN THE CONTEXT OF SENSITIVITY OF BETA COEFFICIENT – COMPARATIVE STUDY FOR THE LARGEST COMPANIES LISTED ON WARSAW AND FRANKFURT STOCK EXCHANGE

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Purpose: The main objective of the article is to examine the stability of the beta parameter for the largest companies listed on the Warsaw and Frankfurt Stock Exchanges.

Design/methodology/approach: The study is a comparative analysis. The hypothesis is subjected to statistical verification, stating that beta parameters are stable. The estimation of beta parameters is carried out using the least squares method and a simple rate of return in the period 2005-2021, while the verification of the stability hypothesis is carried out based on Jarque-Bera test, Breusch-Pagan test, and t-Student test.

Findings: The presented research results indicate that for companies listed on the WSE, along with the extension of the period of measuring the frequency of rates of return, the beta parameter is characterized by a lower level of sensitivity. This is probably due to the greater amplitude of fluctuations in the rate of return with increasing the frequency of measurement.

Practical implications: In the company's finances, the beta parameter plays a key role in measuring investment risk. Since its introduction, it has been subjected to numerous empirical studies and analyses in both developing and highly developed markets. A positive phenomenon is the insensitivity of the beta parameter to the change in the rate of return of the stock market index for the monthly measurement of the rate of return in the case of companies with the largest capitalization on the Polish stock market.

Originality/value: In Poland, research is carried out on the properties of the beta parameter, however, there is no research on its comparability to the economies of countries where the capital market is highly developed.

Keywords: beta stability, correlation, coefficients, rate of return, interval, risk.

Category of the paper: Research paper.

JEL Classification Codes: G10, G15, C58.

Introduction

The source of the word "risk" comes from Italian *risicare*, which in translation into English means: to dare. The Greek variation of the word, *rhize*, it means circumnavigating the cape, that is, an act of courage. In turn, the Latin word *risicum* means the probability of success or failure (Dębski, 2018, p. 57).

Before moving on to the essence and significance of investment risk, the author of the research decided to present the historical outline of the risk phenomenon. This will allow for a better understanding the concept of risk, which is interpreted differently in different fields of science. According to some authors, it is almost impossible to create a single universal definition (Karmańska, 2014, p. 44).

Risk is related to fundamental aspects of mathematics, psychology, statistics, and history. Risk research began in the renaissance. The mathematical core of the risk concept was the question of the French mathematician Pascal, about the division of the pool in an unfinished game of chance, when one of the players is one move ahead of the rival. This is how the concept of probability was introduced into modern risk theory. The emergence of new ideas in the field of risk control techniques somehow stimulated the pace of development of society (Bernstein, 1997, pp. 87-122).

In the eighteenth century, Bernoulli noted that the repetition of events is established by certain regularities occurring in nature. At that time, the law of large numbers began to be applied, which, according to Bernoulli's law, states that: "With a probability arbitrarily close to 1, it can be expected that with a sufficiently large number of attempts, the frequency of a given random event will be little different from the probability of its occurrence" (Dekking et al., 2005, p. 41). A few years later, the concept of normal distribution, the concept of standard deviation, was introduced, which became the basis of the law of averages used in quantitative risk study techniques. One hundred years later, Bayes perfected his research in the field of statistics. Bayes' theorem tells us how we should assess the probability of an event occurring and how to modify it, depending on the actual course of events. In the nineteenth century. Galton described the law of regression relative to the mean, and in the twentieth century. Markowitz explained why putting all the eggs in one basket is excessively risky (Bernstein, 1997, p. 187).

In the literature of the risk subject, we can find numerous attempts to distinguish between risk and uncertainty and to determine the relationship that occurs between them. Uncertainty in the information aspect concerns the discrepancy between the information necessary to solve the task and the information possessed. It is a situation that somehow forces you to decide without full knowledge of the reality in which it will be implemented. In the financial research, we can notice a similar understanding of the concept of risk. It is believed that there is a situation in which at least one of the factors explaining it is not known, but the probability of its occurrence

is known. In the analysis of equity market risk, we can determine the following relationship between risk and uncertainty:

- the risk relates to recurring events, while the uncertainty of a specific phenomenon is used when it is not possible to apply probability calculus,
- the difference between risk and uncertainty relates to the state of knowledge (Nahotko, 2001, pp. 13-22).

One of the first economic concepts of risk was proposed by A. Willett. Based on philosophical determinism, which denies the randomness of the processes of the external world, he decided that one should speak of an illusion of randomness or impression – which results from the imperfection of knowledge about the laws governing reality (Willet, 1901, p. 11).

The second significant concept of risk was measurable and non-measurable uncertainty, proposed by F.H. Knight (1921, p. 56). According to the presented argumentation, we deal with risk when we can determine the future states of the world and their probability distribution. Causal concepts of risk mean that an event can be mapped to a probability distribution. In this sense, risk is the possibility of states other than expected, which can be predicted and described using probability calculus (Bieda, 2013, pp. 367-378).

The definitions of risk presented above indicate that investing, and thus the rate of return on investment required by the investor, is one of the forms of activity on the financial market, which is burdened with a high level of uncertainty. This type of risk is defined as investment risk, manifested in the cost of capital reflected in the expected rate of return required by the market. In economic theory, it is assumed that risk can be reduced by acquiring new information. In other words, it requires knowing as many future states as possible and the probabilities of their occurrence (Francis, 2000, p. 100).

Another concept of risk that should be analyzed from the point of view of classical or neoclassical economic theory is the behavioral concept of risk (Solek, 2010, pp. 21-34). It is based on the following assumptions (Simon, 1995, p. 99-118):

- entities act in a rational manner,
- access to information is full and unrestricted,
- entities maximize profit or expected utility,
- entities act in their own interest and have consistent preferences.

From a practical point of view, it seems that the assumption about the rationality of economic participants of the market who have full information has nothing to do with reality. There are many examples of investor behavior that are irrational. An example would be equity risk premium, in other words the average observed rates of return on shares are higher than the rates of return on treasury debt securities, even if differences in the level of risk are considered (Mehr, 2003, pp. 54-69).

The relationship between the level of risk and the cost of capital is reflected in the risk-free rate of return and the risk premium. As the market assigns a greater degree of risk to a given investment, the required rate of return increases, which in turn reduces the current value of the investment. This bonus is due to uncertainty about the expected returns (Pratt et al., 2000, pp. 121-140). According to the author of the research, the market hates uncertainty in terms of expected cash flows, and thus demands a high price to accept this uncertainty.

The subject of this article is to estimate the investment risk and present the possibilities of its comprehensive analysis, while the author of subjected research would like to mainly refer to the systematic risk of shares. The primary measure of market risk of a stock is the beta coefficient. It is a parameter representing the market factor in the single-indicator Sharpe model, which is most often a specific stock index. The main objective of the article is to examine the stability of the beta parameter for the largest companies listed on the Warsaw and Frankfurt Stock Exchanges.

Literature review

Since the introduction of the single-indicator Sharpe model into the literature, empirical research began in countries with a developed capital market, the aim of which was to understand the statistical properties of share returns through appropriate estimation of the Sharpe model, especially assuming that the distributions of rates of return or the stochastic structure of the model are not met. These studies boiled down to trying to answer the following questions:

- Which stock index to choose?
- What should be the length of the analysis?
- What should be the interval of measuring the rate of return? (Dębski et al., 2018, pp. 270- 286).

The most general market portfolio was proposed by R. Roll (1977, pp. 129-176), who proposed that portfolio should contain all the assets available on the market. As T. Miziołek (2013, pp. 33-39) rightly pointed out, such index does not exist in practice, because it is not known what its structure would be. In empirical research, various indices are used, both profitable, i.e., covering changes in the prices of all companies listed on a given stock market along with the income of financial instruments listed on them, as well as price indices, covering only changes in the prices of shares of companies included in the portfolio of a given index. In general, it can be concluded that the choice of index depends on the purpose of the study. Examples of stock market indices used in empirical research are the indices of the New York and London Stock Exchanges as well as the indices of other European stock exchanges (Tarczyński et al., 2014, pp. 122-139).

A very important issue when estimating the beta parameter is to define the length of the estimation test. According to the author of the research, the issue of the sample length should be considered in two aspects:

1. Comparability of financial markets.
2. Comparability of data. Here it is necessary to answer the question whether the observations from the beginning and from the end of the sample are comparable.

There are a lot of empirical studies around the world of finance literature in which 10-year and longer research trials were used (Tarczyński et al., 2014, p. 88). T. Lin, Y.H. Chen and C.G. Boot (1992, pp. 517-541) in a study of the spot rates of five currencies: the British pound, the German mark, the Japanese yen, the Canadian dollar and the Swiss franc found that the beta of the term premium was considered purely random for all the cases examined. No relationship was found between the length of the time horizon and the number of cases supporting the randomness hypothesis. A. Odabasi (2003, pp. 15-32) analyzed the stability of the beta coefficient during the period 1992-1999 on the Istanbul Stock Exchange. The sample was divided according to research periods from quarters to four years. The results of the study showed that the beta coefficients estimated for the two-year period were the most stable. On the other hand, research conducted by D. Witkowska (2008, pp. 143-154) for companies listed on the Warsaw Stock Exchange based on samples of various lengths did not allow to answer the question whether the selection of an appropriate estimation sample should be based on a large number of data that contain averaged information from all observations, which may lead to wrong investment decisions. In turn, Y. Ye (2017, pp. 177-187) based on the analysis of the stability of the beta parameter on the stock exchange in China states that with the increase in the statistical sample time, the beta becomes less stable.

Another problem to solve is to determine the time interval of measurement of the rate of return on shares. In empirical research, very different intervals are used. In their work, S. Wright, R. Mason, and E. Miles used quarterly measurements of the rate of return (2003).

In turn, J. Brzeszczyński, J. Gajdka and T. Schabek (2011, pp. 28-49) used periods of 1, 5, 10 and 21 days. P. Daves, M. Ehrhardt, and R. Kunkle (2000, pp. 7-13) suggest that the daily rate of return should be used to estimate the beta parameter of an action, as the accuracy of the beta estimation increases. C.F. Mwachunga (2013) in his research conducted on a sample of companies listed on the Nairobi Stock Exchange states that the rates of return on shares were positive and increased as the daily to annual time interval increased, which shows that the average rate of return over a longer period is more appropriate. On the other hand, C.H.S. Fun (2006), based on the analysis of 40 companies (a portfolio of companies selected using the perfect analysis tool) in the period 2000-2006, conclude that daily rates of return give the most precise results in the context of the smallest estimated beta error. Other results of studies on the impact of the rate of return on risk measurement intervals are presented by M. Momcilovic, S. Begovic, S. Tomasevic (2014, pp. 168-171). These authors surveyed 12 companies listed on the Belgrade Stock Exchange between January 2011 and December 2013. Based on the

conducted research, they conclude that there are no significant differences in the beta coefficient values between the daily, weekly and monthly rates of return.

Studies on the impact of the frequency of measuring the rate of return on shares on the beta parameter were also conducted in Poland. Extensive research in this area was carried out by

E. Feder-Sempach (2011, pp. 156-211). The results of the research on the example of companies from the WIG 20 index did not allow to give a clear answer at what interval should be carried out when analyzing the Polish market. The author points out that the choice of the time interval should be economically justified e.g., by the phase of the business cycle in the domestic economy or the phase of development of the capital market. Another important study is an article written by W. Dębski, E. Feder-Sempach and B. Świdorski (2014, pp. 270-286), whose authors conducted an empirical analysis of the 33 largest entities listed on the Warsaw Stock Exchange in the period 2005-2012. Studies show a greater convergence between beta parameter estimates on daily and weekly data than on monthly data.

Research sample and study methodology

The analysis of the invariance of the beta parameter, also known as the sensitivity analysis, was carried out for companies listed on WIG 20 and DAX in the period 2005-2021 (based on the list of entities listed on WIG 20 and DAX at the end of September 2022). The conducted research is based on a simple rate of return on the shares of a given company measured with a daily, weekly, and monthly frequency – the verification concerns the impact of the change in the model specification on the beta parameter:

$$R_t = (P_t - P_{t-1})/P_{t-1} \quad (1)$$

where:

R_t – simple rate of return,

P_t – share price in the period t (Dębski et al., 2018, p. 43).

The primary explanatory variable in the estimated Sharpe model is the rate of return on the relevant stock index. For companies listed on the Warsaw Stock Exchange, it is the rate of return from the WIG 20 index, in the case of the German Stock Exchange in Frankfurt it is the DAX index. In the conducted research, the author changed the specification of the model, consisting in changing the rate of return from the WIG 20 index to the rate of return from the WIG index, and change the rate of return from the DAX index to Prime All Share. The sensitivity analysis of the beta parameter concerns the impact of the change in the rate of return from the stock exchange index to which a given company is included in the rate of return from the basic index of the Warsaw Stock Exchange (WIG) and the Frankfurt Stock Exchange (Prime All Share).

Empirical verification of the sensitivity of the beta parameter was carried out using the following statistical parameters:

- Parameter α and the statistical value of p-value,
- Parameter β and the statistical value of p-value,
- Jarque-Ber test statistics (J-B) and p-value statistic,
- Breusch-Pagan statistics (B-P) and p-value statistic,
- t-Student test in the form of p-value.

The results of the statistical survey based on the statistical values/models refer to:

- Significance of the estimated structural parameters of the model (parameter α and β),
- Verification of the hypothesis on the normality of the distribution of model residues (J-B test):

$$JB = \frac{n}{6} \left\{ \frac{1}{n} * \frac{\sum_{t=1}^n (R_t - \bar{R})^3}{\left\{ \frac{1}{n} * \sum_{t=1}^n (R_t - \bar{R})^2 \right\}^{3/2}} \right\}^2 + \frac{n}{24} * \left\{ \frac{\sum_{t=1}^n (R_t - \bar{R})^4}{\left\{ \frac{1}{n} * \sum_{t=1}^n (R_t - \bar{R})^2 \right\}^2} - 3 \right\}^2 \quad (2)$$

where:

n – sample size;

R_t – a sequence of ascendingly ordered observations,

\bar{R} – arithmetic mean from R_t ,

- Verification of the hypothesis of heteroskedasticity of the random component (B-P test).
- Hypothesis about the equality of parameters of the regression model as a test t-student which test the statistical invariability of the beta parameter in the estimated model, in which the obtained assessment of this parameter for the explanatory variable in the form of the rate of return from the WIG 20 and DAX indexes, respectively, was compared to the assessment obtained from the model in which the explanatory variable is the rate of return from the WIG index and Prime All Share. This verification was carried out for the daily, weekly, and monthly frequency of measurement of the rate of return. The verification of the hypothesis is performed based on the student's t-test, for which statistic has $n-2$ degrees of freedom:

a) Daily interval: $H_0: \beta_{D,WIG} = \beta_{D,WIG20}$, for $\beta_{D,WIG} = const$, $H_0: \beta_{D, Prime All Share} = \beta_{D, DAX}$, for $\beta_{D, Prime all share} = const$,

b) Weekly interval: $H_0: \beta_{W,WIG} = \beta_{W,WIG20}$, for $\beta_{W,WIG} = const$, $H_0: \beta_{W, Prime All Share} = \beta_{W,DAX}$, for $\beta_{W, Prime all share} = const$,

c) Monthly interval: $H_0: \beta_{M,WIG} = \beta_{M,WIG20}$, for $\beta_{M,WIG} = const$, $H_0: \beta_{M, Prime All Share} = \beta_{M, DAX}$, for $\beta_{M, Prime all share} = const$.

Empirical Results

The obtained results for companies listed on WIG 20 (presented in Tables 1-3) indicate that for all frequencies of measurement of the rate of return, the significance of estimating the parameters of α and β does not change, because in almost all cases the assessment of the beta parameter is important (with a significance level of 0.05), except for the companies: Pepco Group NV (weekly and monthly frequency) and Allegro.eu SA (monthly frequency). In turn, the evaluation of the parameter α is irrelevant for the significance level of 0.05 except in the case of the following companies: CCC SA, CD Projekt SA, Dino Polska SA, LPP SA (daily, weekly, and monthly interval). In general, the beta parameter rating retains its value, i.e., it is greater than 1 and is less than 1.

In principle, similar conclusions in the analysis of α and β parameters can be drawn for companies listed on the DAX index. The data were presented in tables 4-6. The evaluation of the beta parameter is basically important for most companies (except Fresenius Medical Care AG & Co KGaA, HelloFresh SE, Daimler Truck Holding AG). α is irrelevant except in 8 cases (Adidas AG, Linde Plc, Vonovia SE, Sartorius AG, Hannover Ruck SE, Merck KGAA, Symrise AG). The analysis for the DAX index was carried out at a significance level of 0.05.

Verification of the hypothesis about the normality of the distribution of the residues of the random component of the model indicates that for daily, weekly and monthly data for all companies listed on the DAX based on the Jarque-Ber test and the significance level of 0.05 there are no grounds for rejecting the null hypothesis, which means that the distribution of residues is a normal distributed. Based on data from the WSE, in the context of the verification of the hypothesis on the normality of the distribution of residuals, indicates that there are no grounds for rejecting the zero hypothesis for almost all companies listed on WIG 20, regardless of the frequency of measurement of rates of return, except for Allegro.eu SA (weekly frequency) and Cyfrowy Polsat SA (monthly frequency).

In terms of heteroskedasticity of the random component of the estimated model, the obtained statistics of the Breusch-Pagan test indicate that this phenomenon occurs in the case of the studied companies on WIG 20. For daily data at a significance level of 0.05, the statistics indicate that in 12 cases (companies) the random component is homoskedastic. For weekly and monthly data, there are no grounds for rejecting the null hypothesis about the equality of variance of the random component for 3 and 1 companies, respectively, the random component is characterized by the lack of such equality, i.e., heteroskedasticism occurs. A similar trend is presented by the results of the Breusch-Pagan statistics for companies listed on the Frankfurt Stock Exchange. That is, as the period for measuring the frequency of data increases, the phenomenon of homogeneous is more visible: for daily data for 25 companies, weekly for 27 and 36 for monthly data.

The last point of the study was a statistical analysis of the invariance/sensitivity of the beta parameter to the change of the explanatory variable from WIG 20 to WIG and DAX to Prime All Share. The results of the test indicate that:

- for daily data in the case of the WIG 20 index at the significance level of 0.05, the zero hypothesis for 17 companies and 38 companies listed on the DAX should be rejected;
- for weekly data in the case of the WIG 20 index at the materiality level of 0.05, the zero hypothesis for 6 companies and 35 companies listed on the DAX should be rejected;
- for monthly data in the case of the WIG 20 index at the significance level of 0.05, the zero hypothesis should not be rejected for all 20 companies, whilst it should be rejected for 35 companies listed on the DAX.

The presented research results indicate that for companies listed on the WSE, along with the extension of the period of measuring the frequency of rates of return, the beta parameter is characterized by a lower level of sensitivity. This is probably due to the greater amplitude of fluctuations in the rate of return with increasing the frequency of measurement. According to the author of the work, a positive phenomenon is the insensitivity of the beta parameter to the change in the rate of return of the stock market index for the monthly measurement of the rate of return in the case of companies with the largest capitalization on the Polish stock market.

Summing up the conducted studies of the sensitivity of the beta parameter to the change in the specificity of the market variable in the single-indicator Sharpe model, and in the scope of the stochastic structure for companies from the WSE and the Frankfurt Stock Exchange, it should be stated that they brought interesting results from a substantive point of view. Overall, the research led to the conclusion that the change in the benchmark of the market variable in the estimated model from the rate of return did not bring significant changes. These changes are caused by a change in the frequency of measurement of the rate of return. This does not mean that some changes do not occur in the values of beta evaluations or in the values of the coefficient of determination as well as in the range of stochastic structure of the estimated model.

Conclusion

The obtained results provide valuable insights into the behavior of companies listed on the WIG 20 and DAX indices. This research offers a comprehensive analysis of the α and β parameters across various measurement frequencies and indices, revealing critical patterns and implications.

The significance of the β parameter, observed across most cases, reaffirms its importance as a measure of systematic risk. Notably, exceptions like Pepco Group NV and Allegro.eu SA on the WIG 20 index and Fresenius Medical Care AG & Co KGaA and Daimler Truck Holding

AG on the DAX highlight the need for further investigation into company-specific or sector-specific influences. Similarly, the insignificance of the α parameter in most instances suggests a predominant influence of market-wide factors rather than firm-specific characteristics on returns. These findings align with studies by Sharpe (1964, pp. 425-442), Fama and French (1992, pp. 427-465), and more recent analyses by Bekaert et al. (2019, pp. 215-260) and Asness et al. (2020, pp. 27-69), reinforcing the robustness of β as a key risk indicator.

A critical evaluation of the research indicates certain limitations and weaknesses. For example, while the findings provide valuable insights into parameter stability, the model's assumptions of homoskedasticity and normality of residuals may not hold universally, as evidenced by the Breusch-Pagan test results for heteroskedasticity in several cases. Additionally, the study's reliance on specific indices such as WIG 20 and DAX may limit the generalizability of the results to other markets or sectors. Future research could address these limitations by incorporating alternative econometric models that account for heteroskedasticity and expanding the analysis to a broader set of indices. Moreover, the sensitivity of β to changes in the benchmark index, observed particularly for daily and weekly data, suggests potential structural differences in market dynamics that warrant deeper exploration.

The results also underscore the importance of understanding the stochastic structure of financial data. The Jarque-Bera test confirmed the normality of residuals in most cases, adding credibility to the model's validity. However, exceptions such as Allegro.eu SA and Cyfrowy Polsat SA suggest that deviations from normality can occur due to unique firm-specific factors or market anomalies. Such findings align with more recent empirical studies (e.g., Harvey et al., 2018, pp. 1-34), which advocate for robustness checks in financial modeling.

This research contributes to the understanding of systematic risk by demonstrating that the β parameter retains stability across different frequencies of return measurements, particularly for companies with larger capitalizations. The results also provide evidence that longer measurement periods reduce sensitivity, likely due to the smoothing effect of aggregated data. These findings are consistent with studies by Banz (1981, pp. 3-18) and Roll (1988, pp. 541-566) and further supported by recent advancements in high-frequency data analysis (e.g., Hansen, Lunde, 2022, pp. 469-495).

The study's implications extend beyond academic interest. For practitioners, the stability of the β parameter across various measurement frequencies underscores its utility in risk assessment and portfolio management. Furthermore, the identified exceptions to α and β significance highlight potential areas for targeted risk mitigation strategies. For policymakers, the observed differences in market characteristics between the WSE and Frankfurt Stock Exchange may inform regulatory approaches to enhance market efficiency and stability. For instance, the heteroskedasticity trends observed in daily data indicate potential inefficiencies in short-term trading, which could be addressed through improved market regulations.

The broader importance of this research lies in its potential applications. The findings can inform investment strategies, particularly in emerging markets like Poland, where the behavior of financial parameters may differ from developed markets. Additionally, the evidence of reduced sensitivity of β with longer measurement periods provides a basis for further exploration of data aggregation effects in financial modeling. The results also highlight the role of market structure and its influence on parameter stability, offering new directions for cross-market comparative studies.

In conclusion, this study advances the understanding of market risk parameters by evaluating their behavior under varying conditions and benchmarks. While certain limitations exist, the research highlights the robustness of the β parameter as a risk measure and its relevance to both academic and practical applications. By incorporating robust statistical tests and addressing potential weaknesses, the study provides a solid foundation for future research and practical decision-making in financial markets.

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Appendix

Table 1.

Estimation results for companies from the WiG20 index, daily frequency

Entity	alpha	alpha – p-value	beta	beta p-value	J-B test	J-B test p value	B-P test	B-P test p-value	t test (p- value)
Asseco Poland SA	0.00	0.16	0.57	0.00	0.01	0.99	0.41	0.82	0.00
Allegro.eu SA	0.00	0.22	0.62	0.00	0.36	0.84	1.20	0.55	0.80
CCC SA	0.00	0.04	0.66	0.00	0.40	0.82	7.39	0.02	0.00
CD Projekt SA	0.00	0.02	0.86	0.00	0.51	0.77	0.32	0.85	0.00
Cyfrowy Polsat SA	0.00	0.13	0.49	0.00	0.44	0.80	0.30	0.86	0.00
Dino Polska SA	0.00	0.00	0.60	0.00	0.06	0.97	12.05	0.00	0.09
Jastrzębska Spółka Węglowa SA	0.00	0.91	1.31	0.00	2.01	0.37	3.86	0.15	0.00
KGHM Polska Miedź SA	0.00	0.07	1.33	0.00	0.41	0.81	0.46	0.79	0.00
LPP SA	0.00	0.00	0.61	0.00	0.71	0.70	6.20	0.05	0.00
Lotos SA	0.00	0.29	0.93	0.00	1.03	0.60	12.64	0.00	0.00
mBank SA	0.00	0.11	1.14	0.00	0.73	0.69	27.34	0.00	0.00
Orange Polska SA	0.00	0.74	0.64	0.00	0.28	0.87	0.15	0.93	0.00
Pepco Group NV	0.00	0.86	0.32	0.01	0.41	0.82	1.36	0.51	0.56
Bank Polska Kasa Opieki SA	0.00	0.84	1.19	0.00	0.10	0.95	0.03	0.99	0.00
PGE Polska Grupa Energetyczna SA	0.00	0.56	1.00	0.00	0.80	0.67	12.56	0.00	0.00
Polskie Górnictwo Naftowe i Gazownictwo SA	0.00	0.33	0.72	0.00	1.63	0.44	0.73	0.69	0.00
Polski Koncern Naftowy ORLEN SA	0.00	0.29	1.08	0.00	0.17	0.92	1.16	0.56	0.00
Powszechna Kasa Oszczędności Bank Polski SA	0.00	0.39	1.13	0.00	0.04	0.98	6.47	0.04	0.00
Powszechny Zakład Ubezpieczeń SA	0.00	0.55	0.90	0.00	0.08	0.96	0.18	0.91	0.03
Santander Bank Polska SA	0.00	0.11	1.07	0.00	0.46	0.80	32.95	0.00	0.00

Source: own elaboration.

Table 2.*Estimation results for companies from the WiG20 index, weekly frequency*

Entity	alpha	alpha – p-value	beta	beta p-value	J-B test	J-B test p-value	B-P test	B-P test p-value	t test (p-value)
Asseco Poland SA	0.00	0.15	0.51	0.00	0.08	0.96	4.89	0.09	0.08
Allegro.eu SA	-0.01	0.10	0.74	0.01	6.28	0.04	0.04	0.98	0.99
CCC SA	0.00	0.03	0.83	0.00	0.02	0.99	0.01	1.00	0.01
CD Projekt SA	0.01	0.02	0.83	0.00	0.27	0.87	0.00	1.00	0.12
Cyfrowy Polsat SA	0.00	0.09	0.56	0.00	0.01	1.00	0.61	0.74	0.08
Dino Polska SA	0.01	0.00	0.62	0.00	0.37	0.83	4.08	0.13	0.44
Jastrzębska Spółka Węglowa SA	0.00	0.95	1.30	0.00	1.23	0.54	2.15	0.34	0.20
KGHM Polska Miedź SA	0.00	0.06	1.44	0.00	0.02	0.99	0.70	0.70	0.06
LPP SA	0.00	0.00	0.67	0.00	0.16	0.92	13.86	0.00	0.03
Lotos SA	0.00	0.28	0.94	0.00	0.43	0.81	4.86	0.09	0.12
mBank SA	0.00	0.09	1.28	0.00	0.01	0.99	7.11	0.03	0.01
Orange Polska SA	0.00	0.75	0.67	0.00	0.09	0.96	0.04	0.98	0.26
Pepco Group NV	0.00	0.79	0.17	0.67	0.05	0.98	4.20	0.12	0.97
Bank Polska Kasa Opieki SA	0.00	0.91	1.11	0.00	0.08	0.96	7.21	0.03	0.01
PGE Polska Grupa Energetyczna SA	0.00	0.63	1.10	0.00	0.22	0.89	3.34	0.19	0.16
Polskie Górnictwo Naftowe i Gazownictwo SA	0.00	0.34	0.70	0.00	0.24	0.89	3.28	0.19	0.20
Polski Koncern Naftowy ORLEN SA	0.00	0.29	1.10	0.00	0.02	0.99	0.38	0.83	0.10
Powszechna Kasa Oszczędności Bank Polski SA	0.00	0.40	1.08	0.00	0.00	1.00	1.87	0.39	0.01
Powszechny Zakład Ubezpieczeń SA	0.00	0.55	0.95	0.00	0.08	0.96	1.52	0.47	0.44
Santander Bank Polska SA	0.00	0.09	1.10	0.00	0.01	0.99	4.41	0.11	0.02

Source: own elaboration.

Table 3.*Estimation results for companies from the WiG20 index, monthly frequency*

Entity	alpha	alpha – p-value	beta	beta p-value	J-B test	J-B test p-value	B-P test	B-P test p-value	t test (p- value)
Asseco Poland SA	0.01	0.14	0.62	0.00	0.63	0.73	5.21	0.07	0.35
Allegro.eu SA	-0.06	0.08	0.46	0.28	0.00	1.00	0.00	1.00	0.96
CCC SA	0.02	0.04	1.18	0.00	0.10	0.95	0.54	0.76	0.44
CD Projekt SA	0.02	0.02	0.76	0.00	0.50	0.78	0.07	0.97	0.56
Cyfrowy Polsat SA	0.01	0.11	0.39	0.00	15.47	0.00	0.66	0.72	0.67
Dino Polska SA	0.04	0.00	0.49	0.01	5.00	0.08	5.42	0.07	0.84
Jastrzębska Spółka Węglowa SA	0.01	0.69	1.41	0.00	1.95	0.38	0.06	0.97	0.58
KGHM Polska Miedź SA	-0.13	0.07	1.32	0.00	0.44	0.80	0.19	0.91	0.70
LPP SA	0.02	0.00	0.97	0.00	0.33	0.85	0.81	0.67	0.49
Lotos SA	0.01	0.27	1.18	0.00	0.10	0.95	0.71	0.70	0.98
mBank SA	0.01	0.05	1.44	0.00	0.00	1.00	0.66	0.72	0.39
Orange Polska SA	0.00	0.67	0.52	0.00	0.11	0.95	0.33	0.85	0.92
Pepco Group NV	-0.01	0.76	0.27	0.74	1.29	0.52	0.09	0.95	0.95
Bank Polska Kasa Opieki SA	0.00	0.79	1.19	0.00	0.09	0.96	4.73	0.09	0.68
PGE Polska Grupa Energetyczna SA	0.00	0.53	1.15	0.00	0.18	0.91	0.22	0.89	0.68
Polskie Górnictwo Naftowe i Gazownictwo SA	0.00	0.44	0.66	0.00	0.56	0.76	1.76	0.42	0.85
Polski Koncern Naftowy ORLEN SA	0.00	0.33	1.14	0.00	0.52	0.77	4.30	0.12	0.92
Powszechna Kasa Oszczędności Bank Polski SA	0.00	0.30	1.16	0.00	0.01	1.00	0.21	0.90	0.63
Powszechny Zakład Ubezpieczeń SA	0.00	0.53	1.14	0.00	0.07	0.96	1.21	0.55	0.95
Santander Bank Polska SA	0.01	0.09	1.22	0.00	0.38	0.83	7.14	0.03	0.56

Source: own elaboration.

Table 4.*Estimation results for companies from the DAX index, daily frequency¹*

Entity	alpha	alpha – p-value	beta	beta p-value	J-B test	J-B test p-value	B-P test	B-P test p-value	t test (p-value)
Covestro AG	0.00	0.30	1.07	0.00	1.28	0.53	0.06	0.97	0.00
Adidas AG	0.00	0.04	0.85	0.00	0.08	0.96	13.83	0.00	0.00
Allianz SE	0.00	0.52	0.95	0.00	0.19	0.91	0.15	0.93	0.00
Basf SE	0.00	0.47	1.10	0.00	0.13	0.94	1.01	0.60	0.00
Bayer AG	0.00	0.48	1.05	0.00	0.45	0.80	0.01	0.99	0.00
Beiersdorf AG	0.00	0.51	0.52	0.00	0.00	1.00	0.35	0.84	0.00
Bayerische Motoren Werke AG	0.00	0.49	1.13	0.00	0.27	0.88	44.93	0.00	0.00
Continental AG	0.00	0.83	1.16	0.00	0.21	0.90	10.46	0.01	0.00
Deutsche Boerse AG	0.00	0.39	0.90	0.00	0.18	0.91	13.18	0.00	0.00
Deutsche Bank AG	0.00	0.07	1.44	0.00	0.51	0.77	91.02	0.00	0.00
Deutsche Post AG	0.00	0.21	0.93	0.00	0.00	1.00	52.14	0.00	0.00
Deutsche Telekom AG	0.00	0.45	0.73	0.00	0.23	0.89	7.01	0.03	0.00
E. On SE	0.00	0.48	0.87	0.00	0.17	0.92	14.07	0.00	0.00
Fresenius Medical Care AG & Co KGaA	0.00	0.30	0.41	0.00	0.32	0.85	3.58	0.17	0.00
Fresenius SE & Co KGaA	0.00	0.38	0.70	0.00	0.38	0.83	1.10	0.58	0.00
HeidelbergCement AG	0.00	0.54	1.11	0.00	0.20	0.91	1.80	0.41	0.00
Henkel AG & Co KGAA	0.00	0.48	0.65	0.00	0.02	0.99	12.70	0.00	0.00
Infineon Technologies AG	0.00	0.22	1.22	0.00	0.14	0.93	3.96	0.14	0.00
Linde Plc	0.00	0.09	0.96	0.00	0.02	0.99	11.82	0.00	0.00
Merck KGAA	0.00	0.04	0.60	0.00	0.48	0.79	1.70	0.43	0.00
MTU Aero Engines AG	0.00	0.14	0.97	0.00	0.15	0.93	46.24	0.00	0.00
Muenchener Rueckversicherungs-Gesellschaft AG	0.00	0.25	0.86	0.00	0.21	0.90	61.79	0.00	0.00
RWE AG	0.00	0.65	0.86	0.00	0.00	1.00	0.94	0.63	0.00
Sap SE	0.00	0.22	0.77	0.00	0.28	0.87	0.04	0.98	0.00
Siemens AG	0.00	0.38	1.09	0.00	0.07	0.97	2.80	0.25	0.00
Vonovia SE	0.00	0.07	0.52	0.00	0.08	0.96	0.61	0.74	0.00
Volkswagen AG	0.00	0.24	1.08	0.00	0.20	0.91	1.00	0.61	0.00
Airbus SE	0.00	0.23	1.06	0.00	0.08	0.96	1.95	0.38	0.00
Brenntag SE	0.00	0.10	0.78	0.00	0.23	0.89	0.04	0.98	0.00
Daimler Truck Holding AG	0.46	0.46	1.28	0.07	0.05	0.97	0.18	0.91	0.01
HelloFresh SE	0.00	0.03	0.36	0.00	0.89	0.64	1.12	0.57	0.00
Hannover Ruck SE	0.00	0.04	0.86	0.00	0.00	1.00	1.21	0.55	0.00
Porsche Automobil Holding SE	0.00	0.98	1.27	0.00	0.26	0.88	0.14	0.93	0.00
Puma SE	0.00	0.85	0.77	0.00	0.11	0.95	1.55	0.46	0.00
Qiagen NV	0.00	0.13	0.47	0.00	0.11	0.95	0.10	0.95	0.00
Siemens Healthineers AG	0.00	0.09	0.54	0.00	0.00	1.00	11.42	0.00	0.00
Sartorius AG	0.00	0.00	0.52	0.00	0.71	0.70	1.67	0.43	0.00
Symrise AG	0.00	0.04	0.66	0.00	0.76	0.68	75.80	0.00	0.00
Zalando SE	0.00	0.20	0.76	0.00	0.42	0.81	0.16	0.92	1.00

Source: own elaboration.

¹ The Mercedes-Benz Group AG was not included in the research, because the DAX began in 2022, which was outside the period covered by the study.

Table 5.*Estimation results for companies from the DAX index, weekly frequency²*

Entity	alpha	alpha – p-value	beta	beta p-value	J-B test	J-B test p-value	B-P test	B-P test p-value	t test (p-value)
Covestro AG	0.00	0.27	0.97	0.00	0.89	0.65	0.79	0.67	0.00
Adidas AG	0.00	0.04	0.88	0.00	0.18	0.91	0.84	0.66	0.00
Allianz SE	0.00	0.14	0.94	0.00	0.05	0.97	0.88	0.64	0.00
Basf SE	0.00	0.50	1.15	0.00	0.05	0.97	15.04	0.00	0.00
Bayer AG	0.00	0.59	0.99	0.00	0.74	0.69	0.00	1.00	0.00
Beiersdorf AG	0.00	0.50	0.51	0.00	0.67	0.72	0.26	0.88	0.00
Bayerische Motoren Werke AG	0.00	0.51	1.12	0.00	0.15	0.93	2.32	0.31	0.00
Continental AG	0.00	0.84	1.19	0.00	0.00	1.00	0.30	0.86	0.00
Deutsche Boerse AG	0.00	0.37	0.86	0.00	0.01	1.00	0.02	0.99	0.00
Deutsche Bank AG	0.00	0.09	1.42	0.00	0.14	0.93	25.89	0.00	0.00
Deutsche Post AG	0.00	0.21	0.92	0.00	0.02	0.99	22.60	0.00	0.00
Deutsche Telekom AG	0.00	0.48	0.70	0.00	0.00	1.00	0.15	0.93	0.00
E. On SE	0.00	0.48	0.92	0.00	0.39	0.82	0.95	0.62	0.00
Fresenius Medical Care AG & Co KGaA	0.00	0.45	0.29	0.33	0.11	0.95	7.74	0.02	0.80
Fresenius SE & Co KGaA	0.46	0.49	0.79	0.04	0.46	0.79	1.15	0.56	0.73
HeidelbergCement AG	0.00	0.51	1.10	0.00	0.10	0.95	9.91	0.01	0.00
Henkel AG & Co KGAA	0.00	0.53	0.70	0.00	1.20	0.55	0.30	0.86	0.00
Infineon Technologies AG	0.00	0.24	1.37	0.00	0.00	1.00	1.24	0.54	0.00
Linde Plc	0.00	0.03	0.90	0.00	0.07	0.97	2.91	0.23	0.00
Merck KGAA	0.00	0.05	0.63	0.00	0.89	0.64	0.34	0.84	0.00
MTU Aero Engines AG	0.00	0.14	1.01	0.00	0.03	0.98	6.35	0.04	0.00
Muenchener Rueckversicherungs- Gesellschaft AG	0.00	0.24	0.86	0.00	0.11	0.94	2.17	0.34	0.00
RWE AG	0.00	0.68	0.86	0.00	0.76	0.68	0.51	0.78	0.00
Sap SE	0.00	0.24	0.80	0.00	0.51	0.78	11.10	0.00	0.00
Siemens AG	0.00	0.36	1.08	0.00	0.27	0.87	0.33	0.85	0.00
Vonovia SE	0.00	0.06	0.54	0.00	0.57	0.75	0.54	0.76	0.00
Volkswagen AG	0.00	0.28	1.12	0.00	0.23	0.89	0.98	0.61	0.00
Airbus SE	0.00	0.23	1.07	0.00	0.11	0.95	4.48	0.11	0.00
Brenntag SE	0.00	0.09	0.74	0.00	0.80	0.67	1.36	0.51	0.00
HelloFresh SE	0.01	0.04	0.35	0.05	0.82	0.66	3.60	0.17	0.14
Hannover Ruck SE	0.00	0.03	0.81	0.00	0.22	0.90	17.45	0.00	0.00
Porsche Automobil Holding SE	0.00	0.93	1.41	0.00	0.10	0.95	10.80	0.00	0.00
Puma SE	0.00	0.86	0.76	0.00	0.12	0.94	0.71	0.70	0.00
Qiagen NV	0.00	0.14	0.47	0.00	0.22	0.89	0.32	0.85	0.00
Siemens Healthineers AG	0.00	0.09	0.45	0.00	0.23	0.89	0.00	1.00	0.00
Sartorius AG	0.01	0.00	0.48	0.00	0.02	0.99	12.23	0.00	0.00
Symrise AG	0.00	0.03	0.59	0.00	0.19	0.91	7.87	0.02	0.00
Zalando SE	0.00	0.19	0.87	0.00	0.45	0.80	0.00	1.00	0.00

Source: own elaboration.

² The Mercedes-Benz Group AG was not included in the research, because the DAX began in 2022, which was outside the period covered by the study. Daimler Truck Holding AG was not included in the conducted research due to the too short period of listing on the DAX index in 2021 (beginning of trading on December 19, 2021).

Table 6.*Estimation results for companies from the DAX index, monthly frequency*

Entity	alpha	alpha – p-value	beta	beta p- value	J-B test	J-B test p-value	B-P test	B-P test p-value	t test (p-value)
Covestro AG	0.00	0.27	0.97	0.00	0.89	0.65	0.79	0.67	0.00
Adidas AG	0.00	0.04	0.88	0.00	0.18	0.91	0.84	0.66	0.00
Allianz SE	0.00	0.14	0.94	0.00	0.05	0.97	0.88	0.64	0.00
Basf SE	0.00	0.50	1.15	0.00	0.05	0.97	15.04	0.00	0.00
Bayer AG	0.00	0.59	0.99	0.00	0.74	0.69	0.00	1.00	0.00
Beiersdorf AG	0.00	0.50	0.51	0.00	0.67	0.72	0.26	0.88	0.00
Bayerische Motoren Werke AG	0.00	0.51	1.12	0.00	0.15	0.93	2.32	0.31	0.00
Continental AG	0.00	0.84	1.19	0.00	0.00	1.00	0.30	0.86	0.00
Deutsche Boerse AG	0.00	0.37	0.86	0.00	0.01	1.00	0.02	0.99	0.00
Deutsche Bank AG	0.00	0.09	1.42	0.00	0.14	0.93	25.89	0.00	0.00
Deutsche Post AG	0.00	0.21	0.92	0.00	0.02	0.99	22.60	0.00	0.00
Deutsche Telekom AG	0.00	0.48	0.70	0.00	0.00	1.00	0.15	0.93	0.00
E. On SE	0.00	0.48	0.92	0.00	0.39	0.82	0.95	0.62	0.00
Fresenius Medical Care AG & Co KGaA	0.00	0.45	0.29	0.33	0.11	0.95	7.74	0.02	0.80
Fresenius SE & Co KGaA	0.46	0.49	0.79	0.04	0.46	0.79	1.15	0.56	0.73
HeidelbergCement AG	0.00	0.51	1.10	0.00	0.10	0.95	9.91	0.01	0.00
Henkel AG & Co KGAA	0.00	0.53	0.70	0.00	1.20	0.55	0.30	0.86	0.00
Infineon Technologies AG	0.00	0.24	1.37	0.00	0.00	1.00	1.24	0.54	0.00
Linde Plc	0.00	0.03	0.90	0.00	0.07	0.97	2.91	0.23	0.00
Merck KGAA	0.00	0.05	0.63	0.00	0.89	0.64	0.34	0.84	0.00
MTU Aero Engines AG	0.00	0.14	1.01	0.00	0.03	0.98	6.35	0.04	0.00
Muenchener Rueckversicherungs- Gesellschaft AG	0.00	0.24	0.86	0.00	0.11	0.94	2.17	0.34	0.00
RWE AG	0.00	0.68	0.86	0.00	0.76	0.68	0.51	0.78	0.00
Sap SE	0.00	0.24	0.80	0.00	0.51	0.78	11.10	0.00	0.00
Siemens AG	0.00	0.36	1.08	0.00	0.27	0.87	0.33	0.85	0.00
Vonovia SE	0.00	0.06	0.54	0.00	0.57	0.75	0.54	0.76	0.00
Volkswagen AG	0.00	0.28	1.12	0.00	0.23	0.89	0.98	0.61	0.00
Airbus SE	0.00	0.23	1.07	0.00	0.11	0.95	4.48	0.11	0.00
Brenntag SE	0.00	0.09	0.74	0.00	0.80	0.67	1.36	0.51	0.00
HelloFresh SE	0.01	0.04	0.35	0.05	0.82	0.66	3.60	0.17	0.14
Hannover Ruck SE	0.00	0.03	0.81	0.00	0.22	0.90	17.45	0.00	0.00
Porsche Automobil Holding SE	0.00	0.93	1.41	0.00	0.10	0.95	10.80	0.00	0.00
Puma SE	0.00	0.86	0.76	0.00	0.12	0.94	0.71	0.70	0.00
Qiagen NV	0.00	0.14	0.47	0.00	0.22	0.89	0.32	0.85	0.00
Siemens Healthineers AG	0.00	0.09	0.45	0.00	0.23	0.89	0.00	1.00	0.00
Sartorius AG	0.01	0.00	0.48	0.00	0.02	0.99	12.23	0.00	0.00
Symrise AG	0.00	0.03	0.59	0.00	0.19	0.91	7.87	0.02	0.00
Zalando SE	0.00	0.19	0.87	0.00	0.45	0.80	0.00	1.00	0.00

Source: own elaboration.

ARTIFICIAL INTELLIGENCE IN EVERYDAY LIFE – PRACTICAL APPLICATIONS

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Purpose: Analysis of practical applications of artificial intelligence in the modern world and their impact on people's everyday functioning.

Design/methodology/approach: In order to implement the assumptions of the paper, an approach based on literature analysis and survey research was used. The main research methods include: Literature studies - analysis of existing scientific publications, industry reports and articles on practical applications of AI in everyday life. Thanks to this, the main areas in which AI is used were identified, and the key benefits and challenges related to its use were identified. Survey - conducting research among respondents to collect data on the level of awareness and experiences related to AI in everyday life. The survey allows to assess the extent to which users use technologies based on AI and what their attitudes are towards them. The theoretical scope includes the definition of artificial intelligence, its key technologies and a review of literature on its applications. The thematic scope of the work focuses on practical aspects of the use of AI in various areas of life. The approach combines the analysis of existing knowledge with empirical research, which allows for a more complete picture of the impact of artificial intelligence on everyday life.

Findings: During the work, it was found that artificial intelligence is playing an increasingly important role in everyday life, and its practical applications cover a wide range of fields. Based on the analysis of the literature and the survey results, it was found that AI is widely used and there are many benefits resulting from its use. However, despite many advantages, users also see potential risks. The analyses also show that many people use AI solutions.

Research limitations/implications: Despite the cognitive value of the article and the research conducted, there are some limitations that may affect their results and interpretation. The survey was conducted on a specific group of respondents, which may not fully reflect the global approach to AI. The results may be conditioned by the cultural context, level of technological knowledge or age group of participants. The study focuses on selected aspects of the practical use of AI. AI is a technology that is developing rapidly, which means that the conclusions formulated in the article may require updating over time due to the emergence of new trends, tools and legal regulations. Although the article addresses issues related to privacy and ethics, it does not constitute a complete analysis of these issues. Future research could more thoroughly examine the impact of AI on user rights, legal regulations and ethical challenges related to process automation. Suggestions for future research include: expanding the study to a larger

and more diverse group of respondents, which would allow for more representative results; analyzing the long-term impact of AI on everyday life, taking into account forecasts and future technology trends; more closely examining the ethical and legal issues related to the development of AI; and comparing the perception of AI across different social and professional groups to determine what factors influence the level of acceptance of this technology.

Practical implications: The research results and literature analysis indicate that artificial intelligence has a significant impact on everyday life, which carries significant consequences for business, economy and social practice. The main practical implications include optimization of business processes, personalization of services and products, increasing accessibility and convenience, changes in the labor market, impact on economies and trade.

Social implications: Research on artificial intelligence and its practical applications in everyday life has a wide impact on society, shaping both social attitudes and approaches to technology. Key social consequences resulting from the analysis of AI include: changes in social attitudes towards technology, impact on employment and the labor market, social and ethical responsibility, impact on public policy and regulations, quality of life and social well-being

Originality/value: The article makes a significant contribution to understanding the practical applications of AI in everyday life, highlighting both the benefits and challenges of its implementation. It highlights both the benefits and potential risks of the growing role of AI.

Keywords: Artificial intelligence, everyday life, AI applications, automation, personalization, technologies.

Category of the paper: Research paper.

1. Introduction

Currently, artificial intelligence is gaining huge popularity as a research direction and the subject of numerous publications. Information about it can be found both in specialist journals and increasingly in popular science materials. The growing interest in artificial intelligence leads to the emergence of a group of enthusiasts who often dream of how technologies based on it will soon change our lives.

In the world of science, the period of uncritical fascination with the potential of artificial intelligence seems to be over. Over the years, this field has experienced many ups and downs. Today, the influence of artificial intelligence can be seen almost everywhere. It is worth remembering, however, that artificial intelligence methods support people, but their knowledge and experience remain irreplaceable.

2. History and current level of development of artificial intelligence

Artificial intelligence (AI) is a field of computer science that focuses on creating computer programs that can perform tasks that require human intelligence. These tasks include pattern recognition, natural language understanding, decision-making, learning, planning, and many others. The main goal of AI is to create systems that are capable of thinking and making decisions in a way that resembles humans (Żybula, 2024, p. 7).

The history of artificial intelligence is a process of moving from theoretical concepts to advanced technological solutions that have significantly influenced the shape of the modern world and our lifestyle. The development of AI has significant consequences, affecting various areas of social and economic life and everyday experiences. It enables the creation of innovative technologies and tools that change the way we work and our daily activities. Artificial intelligence enables innovative solutions in areas such as medicine, transport, education, industry and agriculture, as well as in many other areas, transforming the way entire industries and societies function.

The current state of AI shows significant advances in technology, especially in the area of generative models such as those developed by OpenAI. AI has reached a level where it can perform tasks on par with humans in many domains, such as generating text, images, and interacting with robots. For example, language models such as GPT-4 have achieved 86% accuracy in multi-task tests, which is significantly higher than the results of non-experts (around 34.5%) (Measuring trends in AI, 2024).

In terms of practical applications, AI is being implemented in various sectors, including education, finance, and healthcare, where algorithms make critical decisions. The challenges associated with responsible use of AI technologies are also significant, leading to increased interest in issues such as privacy, security, and model transparency (Measuring trends in AI, 2024).

In summary, AI shows great potential to transform various aspects of everyday life and business, but also poses significant challenges that must be addressed appropriately. For more details, it is worth reading the full reports available from sources such as McKinsey, AI Index or Our World in Data.

Artificial intelligence is being defined as a field of knowledge that includes, among others, neural networks, robotics and the creation of models of intelligent behavior and computer programs simulating these behaviors, including machine learning, deep learning and reinforced learning (Czym jest sztuczna inteligencja, 2024).

With the development of artificial intelligence, new concepts and techniques have emerged that have significantly expanded its scope and capabilities. The most important of them include: machine learning (ML), deep learning (DL) and artificial neural networks. These terms refer to advanced methods of data analysis and decision-making that have become the foundation of

modern AI solutions. For example, deep learning, which is based on multi-layer neural networks, allows systems to recognize patterns in data such as images or sounds. An example of a practical application is the voice or image recognition algorithm used by platforms such as Facebook. Thanks to the use of DL, these systems are able to understand and interpret data at a level close to human perception, which makes them key in the development of technologies such as autonomous vehicles, voice assistants (e.g. Alexa, Siri) or recommendation systems in e-commerce.

Modern artificial intelligence technologies enable the automation of processes that would have required human involvement just a few years ago, making them a central element of digital transformation in many sectors of the economy (Haenlein, Kaplan, 2019, pp. 5-14).

Table 1.

Artificial Intelligence Tools and Their Practical Application

Tools	Application	Examples
Voice recognition	Voice analysis and solution delivery.	Siri as a personal assistant to get things done.
Text recognition	Analysis of the source text and its basis the result is provided.	Shaping, tomorrow.com – analysis and selection of valuable online content.
Image recognition	Image analysis and comparison with available material to deliver the desired result.	Microsoft and Tate Museum connect current events with museum collections.
Decision making	Based on the information provided, the AI presents available solutions.	IBM Elements – an educational version of Watson that recommends student development paths.
Autonomous robots and vehicles	Carrying out defined tasks by robots or vehicles.	Amazon KIVA - a system that automates order picking in warehouses.

Source: Jarek, Mazurek, Hałas-Dej, 2019, pp. 191-206.

Table 1 explains the use of AI tools and presents examples of their applications. AI technologies encompass a wide range of tools and methods that are used to create systems that can process data, learn, make decisions, and solve problems.

In summary, artificial intelligence is a breakthrough in internet communication and the economy in general. Described as the leading technology of the new digital era, AI is compared to the role of steam and electricity, which started the industrial era (Sztuczna inteligencja..., 2024).

3. Application of artificial intelligence systems with examples of their practical applications

The future of artificial intelligence is very promising for every industry. Currently, it is not just a concept, but a real support for modern companies. AI uses a number of technologies (Jak wykorzystać sztuczną inteligencję..., 2023). Semantic AI helps machines understand the

nuances of human language and can make interactions with technology smoother and more intuitive.

For several years now, there has been an increase in the number of programs and solutions based on artificial intelligence. Companies are seeing the benefits of AI resulting from, among other things, speed and continuity of operation and minimizing the risk of irregularities. Systems based on artificial intelligence learn from their mistakes, so they do not make the same mistake twice. The potential of this technology is seen not only by entrepreneurs, but also by government and non-governmental organizations. The European Union has increased the amount of grants for researchers and scientists working on solutions related to AI by 70% (Zastosowania sztucznej inteligencji, 2021).

Artificial intelligence is playing an increasingly important role in shaping modern marketing strategies. Thanks to advanced algorithms and the ability to analyze huge data sets in real time, AI allows companies to better understand customer needs, precisely target advertising campaigns and optimize sales processes. Table 2 presents examples of the use of artificial intelligence technology.

Table 2.

Examples of the use of artificial intelligence technologies

Artificial Intelligence Tool	Marketing Application Examples
Voice processing technologies	Place orders by voice via your device or the Amazon Alexa app. Virtual assistants supporting task completion (Siri, Google Home, Cortana).
Text processing technologies	Alpine.AI – a virtual assistant as a guide through the shopping center. ING Bank Śląski – an assistant in the banking application serving customers and navigating to branches, Naver – GPS suggesting interesting places along the route, Touchpoint – analysis of customer feedback to eliminate irritating situations, IntelligentX Brew – a chatbot that collects data to create new beer recipes, Toyota, Saatchi & Saatchi – AI creating an advertising campaign for the Toyota Mirai, TVN – a chatbot promoting “Millionaire” on Facebook in the style of the program.
Image recognition and processing technology	Shiseido – skin condition analysis and cream selection based on photo and weather conditions, eBay – photo as a tool for searching for identical or similar items, Amazon – an unattended store with automatic payment that analyzes selected products, FashionAI – electronic mirrors in clothing stores that match the collection to the customer, eBay – selecting the best gift based on facial recognition and emotion analysis, BBVA – client identification before video consultation by comparing a photo, Adobe Sensei – automatically crop images according to brand requirements, Everypixel – an image search engine that rates the attractiveness of photographs.
Decision making	Spotify, Emirates – matching travel destinations based on music style and user preferences, Iperfume.pl, Kontigo.pl – dynamic price adjustment to the user based on purchase history, ING Bank Śląski – matching advertisements to the user based on their internet history. Amazon, Netflix – new product recommendations based on user behavior, Jaguar I-PACE – analysis of driving style and efficiency of using an electric car, Start Today, StretchSense – ZozoSuit helps you order clothes that fit your body perfectly, Albert AI, Harley Davidson – a marketing campaign management platform that creates strategy recommendations.
Autonomous robots and vehicles	Ford & Alibaba, Amazon Go, Zaitt Brasil – unmanned stores, Schnuck – a robot that checks shelf stock and reports shortages or irregularities, Moby Mart – an autonomous replenishment store being tested in Shanghai.

Source: Jarek, Mazurek, Hałas-Dej, 2019, pp. 191-206.

Artificial intelligence offers a number of benefits for companies that want to revolutionize their strategies. The key advantages of its use are primarily (AI w marketingu..., 2024):

1. Personalization of customer communication and shopping experiences

The effects of these actions are:

- increased customer engagement,
- greater likelihood of purchase,
- better adaptation of the product to customer needs.

2. Automation and optimization of advertising campaigns

The effects of these actions are:

- reducing campaign costs,
- increasing return on investment (ROI),
- better use of your advertising budget.

3. Better understanding and segmenting your audience

The effects of these actions are:

- accurate recipient profiles,
- accurate campaign targeting,
- better adjustment of the offer to the customer's needs.

4. Predicting trends and consumer behavior

The effects of these actions are:

- the ability to respond to trends earlier,
- developing more relevant marketing strategies,
- increasing competitive advantage.

It should also be noted that artificial intelligence has an impact on the consumer. The Internet has introduced many beneficial solutions from the consumer's point of view, including: automatic recommendations, product matching (Grewal et al., 2017, pp. 1-6), shorter shopping times (Moncrief, 2017, pp. 201-279), and personalization of service (Jordan, Mitchell, 2015, pp. 255-260). Artificial intelligence goes a step further, opening up new perspectives in almost every aspect of marketing activities. An analysis of examples of its applications shows a wide range of benefits that AI brings to consumers, as presented in Table 3.

Table 3.

The benefits of AI for consumers

Benefits for the consumer	Areas
More convenience and speed of purchase	<ul style="list-style-type: none"> - Streamlining the purchasing process and increasing convenience by shortening selected processes (payment, logging in). - 24/7 customer service. - Product experience when shopping online. - New sales channels emerging thanks to unmanned stores.
New experiences in contact with the brand	<ul style="list-style-type: none"> - Hyper-personalization on a mass scale. - Democratization of consulting, previously reserved for brands from the premium segment (the so-called democratization of consulting). - AI as a way to provide after-sales service and create additional value beyond the basic product.

Cont. table 3.

A new dimension of relationships consumer with the brand	<ul style="list-style-type: none"> - Creating solutions that go beyond the category or manufacturer's domain. - Delivering exceptional brand experiences. - Minimizing regret after making a purchase that does not meet expectations, thanks to the possibility of virtual product testing. - Brands provide additional impressions by building a zone of positive surprises. - The process of learning categories is eliminated and the possibility of creating benchmarking against other users increases motivation to change consumer behavior. - Introducing new products or modifying existing ones thanks to collected and analyzed information left on the Internet.
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Source: Jarek, Mazurek, Hałas-Dej, 2019, pp. 191-206.

Artificial intelligence systems play a key role in enabling better understanding of user intent and tailoring content to their needs. With advanced technologies such as natural language processing, companies are able to analyze huge amounts of data and transform it into valuable insights.

4. Legal and ethical dilemmas of using artificial intelligence in practice

The outlook for AI usage today and in the future is quite positive. Its impact is visible not only in the personal sector, but also in business functionality and the way companies interact with their customers and employees. The basis of the AI discourse in the business sphere is the extent to which companies can rely on AI as the main decision-maker and whether some judgments should be made exclusively by human employees (Haenlein, Kaplan, 2019, pp. 5-14). This issue is addressed by (Arrieta et al., 2020, pp. 82-115) recalling the principles that should be followed when implementing AI in the enterprise:

- Fair AI – AI results should not discriminate against any individuals or groups (based on religion, race, disability, etc.). This should be done at a fundamental level, at the level of making improvements to how AI perceives these groups.
- Transparent and explainable AI – Users should be aware and informed if they are interacting with AI and what data is being collected and used; in this case, personalized user accounts should be taken into account when generating results.
- Human-centric AI – Work performed by AI should benefit people and society as a whole, in line with the United Nations Sustainable Development Goals.
- Privacy and security by design – privacy and security of personal data should always be maintained; this is considered to be one of the biggest obstacles we face when using intelligent IT systems.
- All third parties should always be treated with the same standards.

Although the growth that AI is undergoing is enormous, its intelligence level is still far from the brainpower of humans. This includes skills such as language acquisition, creativity, visual identification, and intuition. In addition, humans naturally acquire primitive abilities to

understand space, numbers, time, where AI requires appropriate coding and mechanical implementation to acquire this knowledge (Hagendorff, Wezel, 2017, pp. 355-365). This position of AI is perceived positively by some researchers, but they are hesitant that their great expectations will not be fulfilled in the next 20 years of AI evolution. This is due to the fact that AI development is mainly based on Deep Learning and imitation of the learning process of young children, as opposed to specific guidelines of specially designed programs, logic, and decision trees (Makridakis, 2017, pp. 46-60).

Many scientists and politicians draw attention to the potential threats associated with artificial intelligence. They point to possible violations of freedom and human rights (Sypniewska, Gołębiowski, 2023, pp. 249).

Artificial intelligence is revolutionizing many fields. It offers virtually unlimited possibilities for increasing business efficiency. Artificial intelligence ethics is a set of principles and values that are the basis for designing and using modern technology systems. It aims to ensure that artificial intelligence is created and used in a way that is: ethical, transparent, responsible, and brings social benefits (Sztuczna inteligencja bez tajemnic..., 2024).

When implementing AI solutions, one should be aware of the applicable legal regulations related to the use of artificial intelligence. The most important of them are: copyright law, personal data protection law, laws regarding liability for the functioning of artificial intelligence used by companies. Work is currently underway on new regulations that are to facilitate the pursuit of claims for damages caused by AI systems. The key issue here is the issue of civil liability - whether the manufacturer, user or the system itself is responsible for the actions of AI.

The expected legal regulations may introduce solutions such as: mandatory insurance for AI producers or special compensation funds. Therefore, it is important for entrepreneurs to closely follow these changes and prepare for new requirements and obligations (Sztuczna inteligencja regulacje prawne, 2025).

In summary, the use of AI requires balancing innovation with legal and ethical responsibility. Companies must take steps to ensure compliance with regulations, transparency of algorithms, and protection of consumer interests. Legal regulations and ethical guidelines will play a key role in the sustainable development of this area.

5. Practical approach to AI – own research results

The aim of the survey was to collect opinions from respondents on the role of artificial intelligence in personal life. The study involved 92 respondents who had the opportunity to respond in a Google form. The study involved 71% of women, 27% of men, and 2.2% of people who declared another gender. In terms of age, the group of 18-25 years old made up 85% of

participants, 10% were aged 26-35, and 3.3% were aged 46-55. On the other hand, people from the age groups 36-45 and 66 and over made up only 1%.

Figure 1 presents respondents' answers regarding their first association with the concept of artificial intelligence.

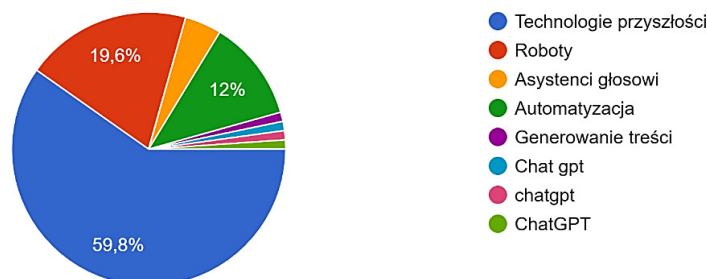


Figure 1. Respondents' answers regarding their first association with artificial intelligence.

Source: own study.

The distribution of answers clearly shows that respondents consider artificial intelligence as the technology of the future (59.8%), which may also suggest that they perceive it as something that is related to future technologies or modern solutions that can change human life. 19.6% identify artificial intelligence with robots and their work in factories. 12% of people associate AI with voice assistants such as Siri, Alexa or Google Assistant, which help manage everyday tasks and provide necessary information. Less numerous but significant associations included categories such as automation (12%) and content generation (1.1%), which shows that respondents also perceive AI in the context of its ability to automate tasks and generate various forms of content. Respondents, having the opportunity to provide their own answer to this question, answered that they associate artificial intelligence with "ChatGPT".

Figure 2 presents responses regarding the use of artificial intelligence in everyday life. The largest share, 44.6%, fell on the category of transport (e.g. maps, navigation), but equally frequent were responses related to online shopping (29.3%) and various applications related to health issues (6.5%). In their responses, respondents also indicated issues such as (1.1%): generating texts or sounds, assistance with learning, smart household appliances, or obtaining information.

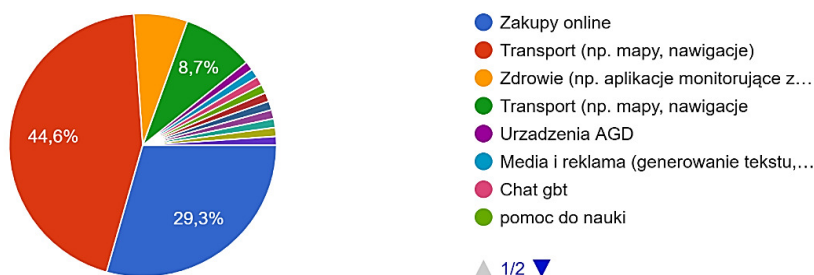


Figure 2. Application of artificial intelligence in everyday life areas.

Source: own study.

In the next question (figure 3), respondents assessed the impact of artificial intelligence on the efficiency of work performed. The responses show that a large proportion of people have a very positive (17.4%) and positive (42.4%) assessment of artificial intelligence. Their responses may suggest that they probably notice significant benefits resulting from its use in everyday life, such as time savings, increased efficiency or better organization of tasks. 34.8% assessed the impact of AI neutrally, which may indicate that they do not notice significant changes in their work, and 5.4% of respondents expressed negative and very negative opinions.

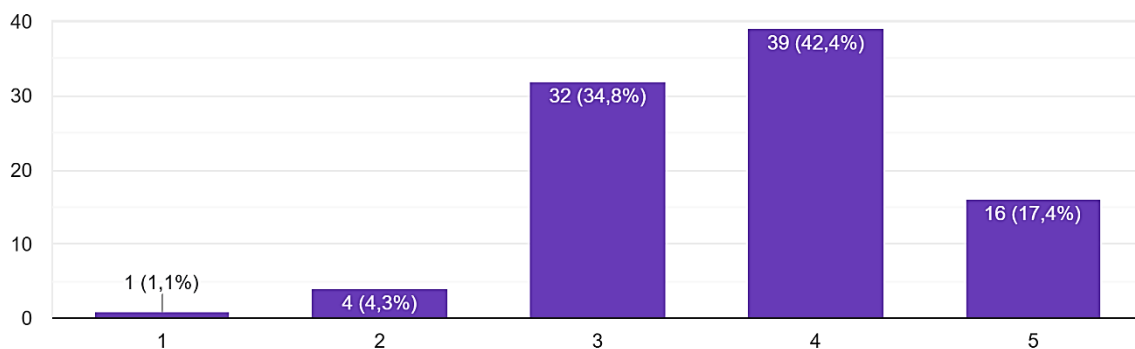


Figure 3. The impact of artificial intelligence on work efficiency.

Source: own study.

Figure 4 shows the respondents' position on replacing human work with artificial intelligence. For example:

- 46.7% of respondents are in favor of replacing human work with artificial intelligence, but they have some concerns.
- 29.3% are against it because they believe it could lead to social problems.
- 15.2% of people is in favor, considering it as technological progress.
- 5.4% has no opinion on this matter.
- 3.3% of people are strongly against it.

These results show that most respondents have some concerns about AI replacing human labor, even though they consider it a technological advance. A significant portion of respondents also fear potential social problems that may result from this process.

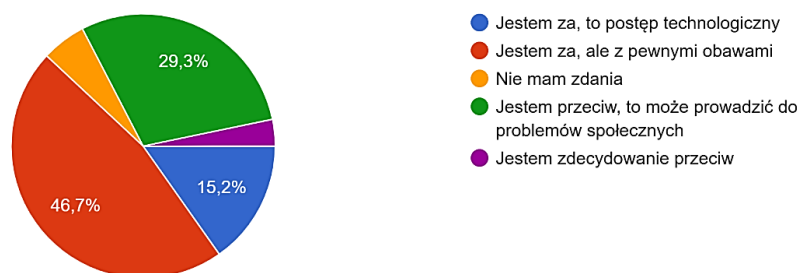


Figure 4. Position on replacing human work with artificial intelligence.

Source: own study.

Figure 5 presents the concerns of respondents related to the development of artificial intelligence in the future. 73.9% of people expressed concerns related to the replacement of jobs by artificial intelligence, 60.9% fear loss of privacy, and 48.9% worry about addiction to technology. Meanwhile, 47.8% of people are concerned about both the takeover of control by artificial intelligence and social manipulation. The fewest people, 27.2%, fear the use of artificial intelligence for military and armament purposes.

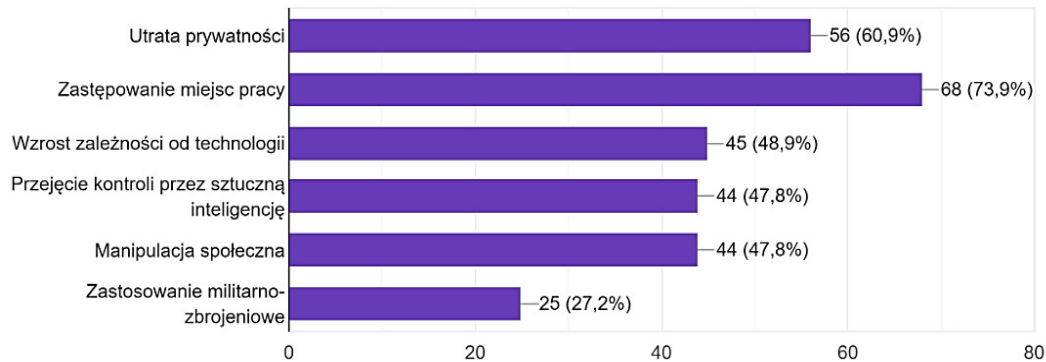


Figure 5. Respondents' concerns about the development of artificial intelligence.

Source: own study.

The survey results indicate the main concerns of the public related to the development of AI, especially in the context of the impact on the job market and privacy. It can be concluded that further research and action are needed to understand and mitigate these concerns.

6. Summary

The use of artificial intelligence is a breakthrough in many areas of life and business. AI enables more precise prediction of needs, personalization of experiences and automation of processes, which leads to increased efficiency of operations and better understanding of users or customers. Tools based on artificial intelligence, such as chatbots, predictive analytics or recommendation systems, are used in areas such as customer service, logistics, education or healthcare, allowing for more effective management of resources and building lasting relationships with recipients. At the same time, the development of AI is associated with legal and ethical challenges, such as protection of personal data, transparency of algorithms or potential risk of manipulation. Maintaining a balance between innovation and social responsibility, by complying with regulations and building user trust, is becoming crucial.

In summary, artificial intelligence is revolutionizing many areas of human activity, transforming them into more dynamic, precise and effective processes. However, its full use requires a conscious approach that takes into account both technological potential and ethical and social issues.

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OUTLOOK FOR THE DEVELOPMENT OF MODULAR CONSTRUCTION IN POLAND – A CASE STUDY

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Purpose: The paper analyses the residential construction sector in Poland, with a particular focus on single-family housing in Poland regarding the modular and prefabricated house market. The analysis covered the share of the modular and prefabricated house market, construction costs, prefabricate production processes, construction site work, production waste management issues.

Design/methodology/approach: The subject of observation and evaluation of the cost level were industry reports, technology block diagrams and price calculations using information provided by the business entity under review. The presentation and detailed analysis of the available data took the form of tables and bar charts, supported with descriptive explanations. The source of information for this study was literature on the subject, statistical data and numerous studies by the Statistics Poland (GUS) and Eurostat, reports in the industry section, an interview with the owner of a construction company, analysis of financial documents provided by the business entity examined, as well as the authors' own observations. The company's characteristics, revenues, costs and sales market were examined. In addition, the machinery and production technology of the examined company were analysed.

Findings: The case study is a plant producing houses using prefabricated modules, on whose example the production process of prefabricates and their use in the construction of a residential building was analysed. Examination of the production process enabled detection of the problem of production waste management. The paper presents an overview of the characteristics of the production facility with particular focus on the technological processes. Issues related to the cost of building prefabricated houses were also analysed.

Research limitations/implications: The analysis is limited to statistical data and to data provided by one prefabricated house production facility.

Keywords: cost, production, modular houses, prefabricated houses, wood waste.

Category of the paper: research paper.

1. Introduction

Building a house is an important stage in a person's life (Yifei et al., 2023). Many people feel the need for more privacy, which is not offered by living in a multi-family building, and therefore choose to build a detached house (Lihtmaa et al., 2024; Daly et al., 2025). This results in a continuously increasing number of newly constructed dwellings of this type being put into use (Douhard et al., 2024; Ziari et al., 2025). The number of detached houses constructed in Poland is increasing year by year (Trojanek et al., 2023; Karpinska et al., 2020). In 2014, 69260 single-family buildings were completed, followed by 106261 in 2021, 109308 in 2022 and 96170 single-family buildings in 2023 (GUS, 2020, 2021, 2022, 2023). The number of new buildings put into use has regularly increased over these years despite the COVID-19 pandemic, skyrocketing prices of building plots, building materials and building services (Rynekpiertwotny.pl, 2024). Ensuring energy security for new construction projects not only at the in-use stage, but also at the construction stage, is vital. Modern energy systems are used for this purpose (Mikielewicz et al., 2019; Kosowski et al., 2009; Tucki et al., 2020; Kosowski et al., 2019).

Building a house using the conventional technology is very energy- and material-intensive, which undoubtedly affects the investment costs and the environment (Chardon et al., 2016; Tucki et al., 2021). The energy needed to build a house and the energy used to produce building materials emits harmful substances into the atmosphere (Xiaocun et al., 2021; Bansal et al., 2014). The use of raw materials to produce building materials is increasingly exploiting the Earth's natural resources (López-Sosa et al., 2025; Ghafoor et al., 2024). They are manufactured using non-renewable energy sources, which contributes to the depletion of the Earth's resources. In addition, the issue of exhaust emissions must be taken into account (Tucki et al., 2019; Tucki et al., 2029). One should emphasise that building a house is an expensive endeavour (Kb.pl, 2025; Rynekpiertwotny.pl, 2024). The demand for traditional building materials is very high, which translates into high and still rising prices. In the case of single-family houses built in the traditional technology, the average cost of building a single-family house in 2025 for a 100 sqm builder's finish single-storey house is PLN 429,000 net (an increase of 3.13% compared to 2024). In the case of a 140 sqm house, the average construction cost in January 2025 was PLN 551,000 net (an increase of 5.57% compared to 2024). In the case of a 200 sqm house, the average construction cost in January 2025 was PLN 619,000 net (an increase of 5.99% compared to 2024) (kb.pl, 2025).

An alternative to building houses using the conventional construction technology is the production of prefabricated or modular houses (Su et al., 2024; Chen et al., 2024).

When talking about prefabricated houses, people often confuse them with modular homes (Tavares et al., 2019; Al-Sammar et al., 2024). Both techniques use prefabricated components, but they represent two different trends in the building industry. Prefabricated construction is

based on the erection of buildings using prefabricated components of various designs. Prefabricated elements do not form modules that the entire building is divided into, but are, for example, ready-made wall or ceiling elements. This technique is more of a competitor to traditional construction, as most of the work is done at the construction site anyway and the building is permanently connected to the ground.

Prefabricated houses arrive in the form of walls and ceilings, and once installed, the entire connection and finishing process is left to the investor. Modular houses are delivered as finished interiors and, after assembly, only the connection points need to be closed and the building is ready for use. The assembly time at the construction site is usually a few days for both technologies. However, the difference is in the finishing of the building – in prefabricated construction, the entire finishing stage takes place at the construction site and takes much longer.

Prefabricated houses are made of ready-made wooden structures. They are produced in a production hall under controlled conditions over a period of approximately 12 days. Finished prefabricated elements are transported to the construction site, where they are assembled on a previously prepared foundation slab. This significantly reduces the construction time of a house, as the work to create the building shell at the construction site takes about 2-3 days. In contrast, the building shell in the brick construction technology can be completed no earlier than within 2 months.

Modular houses are made of prefabricated elements that are connected together in the factory to form entire building sections, which are then transported and assembled at their final location. Modular houses are also largely made of prefabricated elements, but they are characterised by repeatability of the basic modular unit. The main idea at the design stage is to use modules of similar dimensions. They may differ in terms of details or functions, but they ultimately form one building. This allows for a significant reduction in the time needed for planning and execution. The modules are designed for transport and can be almost completely finished at the factory (including installations and interior finishing). Unlike a prefabricated house, modular houses do not have to be permanently attached to the ground, so it is possible to dismantle the modular building and transport it to another location. Finished modules are usually transported to their destination on a truck trailer, which means that their dimensions (especially the width and height) depend on the size of the vehicles that transport them.

The most commonly used solutions in modular construction are undoubtedly steel containers and wooden frame structures. Prefabricated elements made of expanded clay concrete, reinforced concrete elements, reinforced PVC or cement-bonded particle boards are less popular (Saad et al., 2025).

2. Single-family residential construction in Poland

The number of new residential buildings in Poland is increasing every year. The vast majority of these are single-family homes. The number of new residential buildings completed in individual years, broken down into single-family and multi-family buildings, is presented below (Fig. 1).

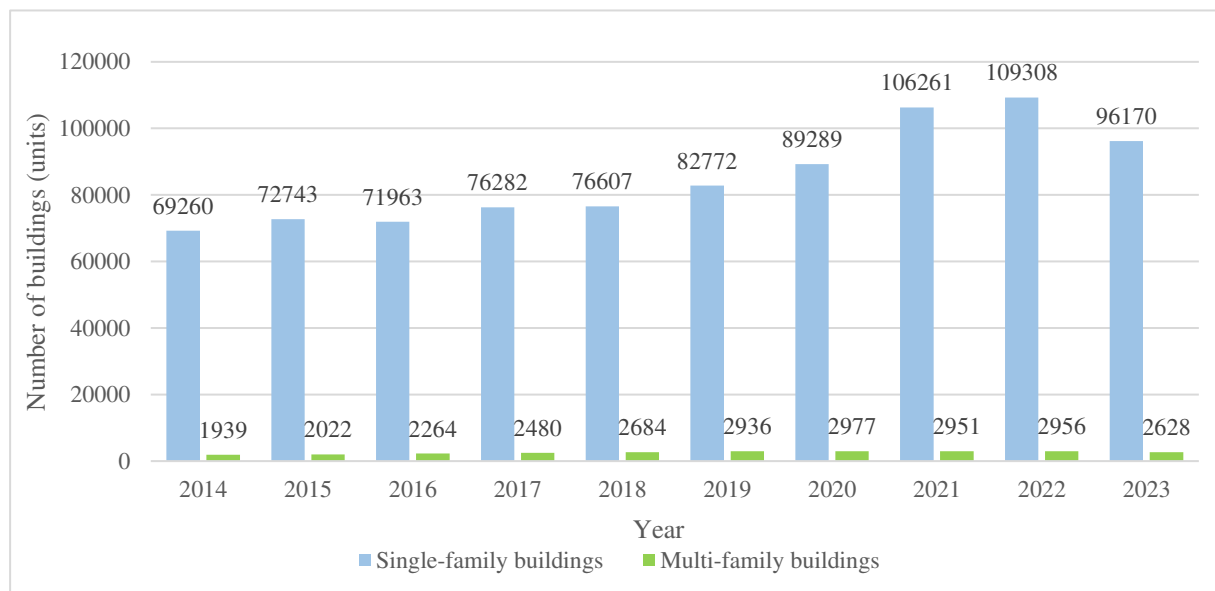


Figure 1. New residential buildings put into use by type of building.

Source: Authors own study based on statistical data (GUS, 2020, 2021, 2022, 2023).

Table 1 presents information on the number of residential units put into use, average usable area and average duration of the construction process in 2020-2023.

Table 1.

New residential buildings put into use in 2020-2023

	Type of building							
	Single-family				Multi-family			
Year	2020	2021	2022	2023	2020	2021	2022	2023
Number of residential units	97245	115457	119575	105566	120536	115709	115545	112678
Average usable area of residential units in sqm	132.3	133.3	131.4	130.7	53.3	52.6	52.1	51.8
Average duration of the construction process in months	46.9	48.5	50.0	51.3	23.6	23.9	24.3	25.0

Source: Authors own study based on statistical data (GUS, 2020, 2021, 2022, 2023).

Contemporary construction utilises many different construction technologies. The number of new residential buildings put into use, broken down into different construction technologies, is shown in Figure 2. The breakdown includes the improved traditional technology, wooden structures and others, including the large panel, monolithic and large block technologies.

In Poland, wooden-framed buildings still make up a small fraction of residential construction. According to data from Statistics Poland (GUS), 1160 such buildings were put into use in 2021 (an increase of 28.2% y/y), which accounted for 1.1% of all residential buildings.

Classification of the construction method as a specific technology is based on the predominant type of structure used in the construction of the building. However, this does not exclude the use of other technologies to a lesser extent. The improved traditional technology is by far the most common in the residential construction sector.

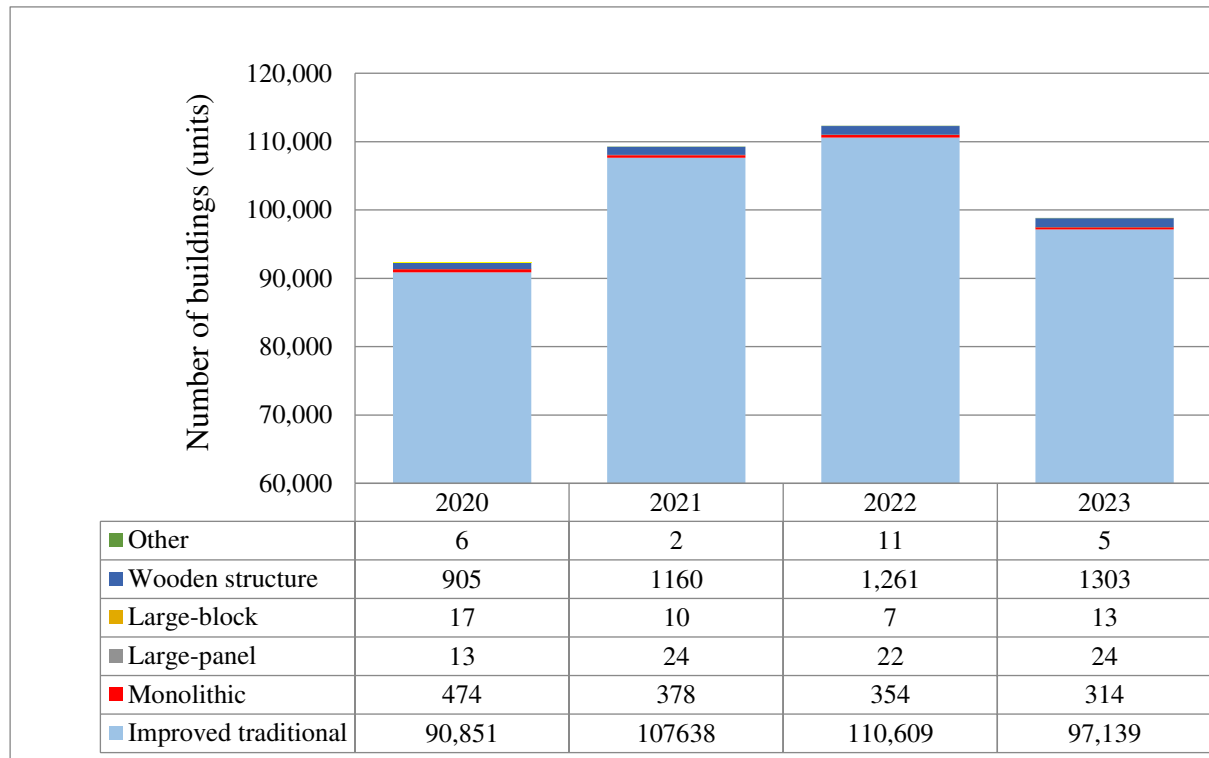


Figure 2. New single-family residential buildings put into use by erection technology.

Source: Authors own study based on statistical data (GUS, 2020, 2021, 2022, 2023).

Both traditional and concrete-based construction require construction breaks because they involve a lot of wet work, such as concreting, bricklaying and plastering. If these are not observed, moisture can build up in the building, which can result in the growth of mould and mildew. Technological breaks are not only required for masonry work, but also for interior and exterior finishing work. One such example would be the construction of stairs.

Figure 3 shows the average construction time in months by the construction technology used (2020-2023).

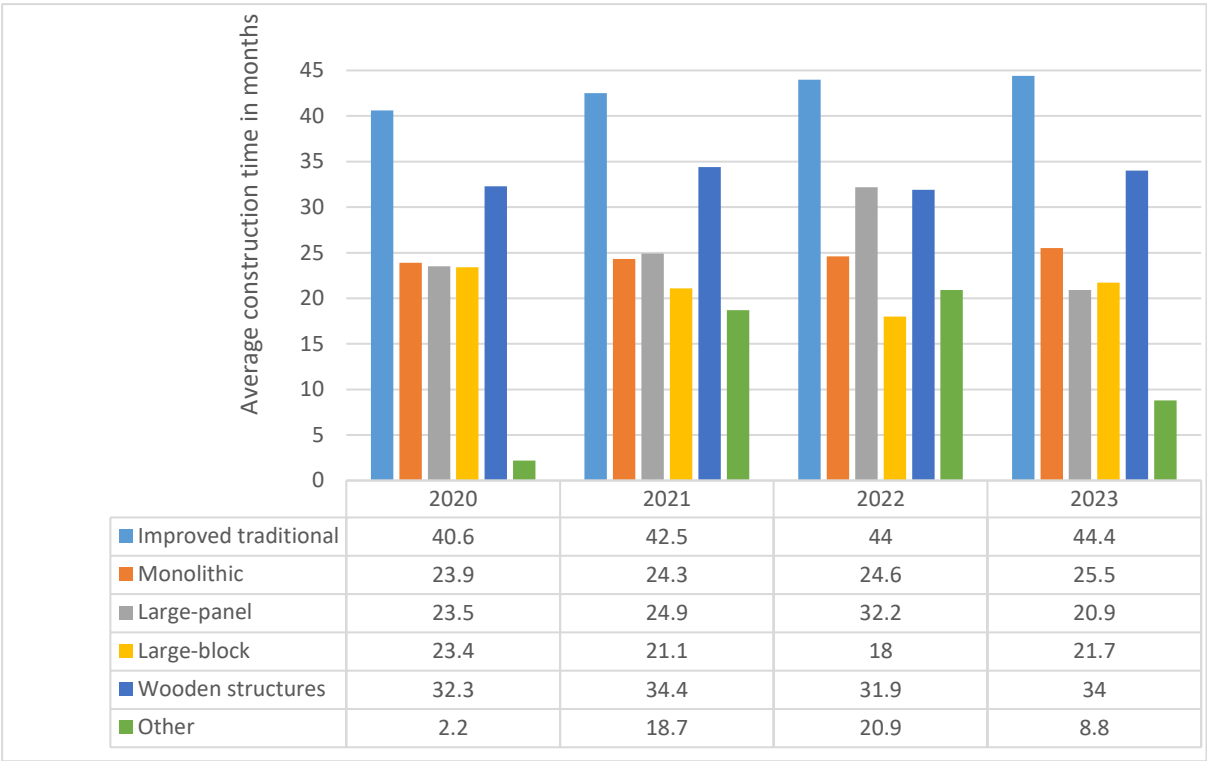


Figure 3. Average construction time in months by construction technology.

Source: Authors own study based on statistical data (GUS, 2020, 2021, 2022, 2023).

The chart below shows the number of newly constructed single-family residential buildings in a particular calendar year, built with the use of the wooden structure technology (Fig. 4). The chart also shows a rising trend line over the period analysed. This proves the growing popularity of building with this technology and determines the direction of development of the single-family construction sector.

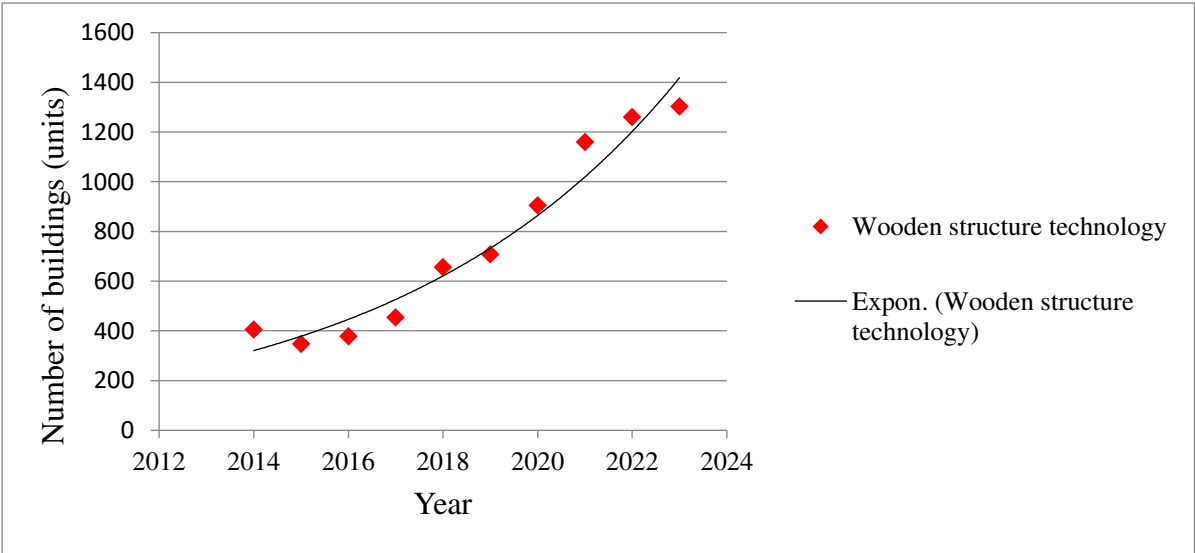


Figure 4. New single-family residential buildings erected in the wooden structure technology.

Source: Authors own study based on statistical data (GUS, 2020, 2021, 2022, 2023).

According to the report “Modular Construction in Poland 2024-2029” by the research company Spectis, total revenue of the 100 largest manufacturers of prefabricated buildings made of wood, steel, concrete and expanded clay concrete amounted to around PLN 10bn in 2022, of which 47% was generated by sales in the modular building segment (Fig. 5) (Forum-holzbau.pl, 2023). Nominal change (% , y/y) is shown in the figure.

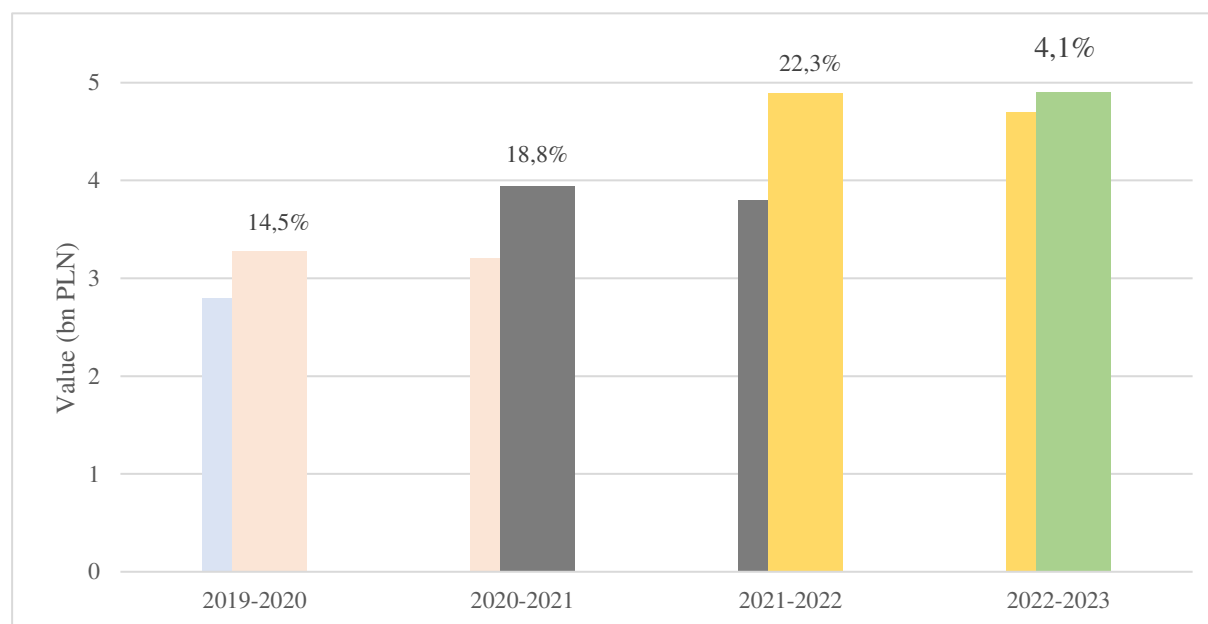


Figure 5. Modular construction market in Poland.

Source: Authors own study based on statistical data (Forum-holzbau.pl, 2023).

The demand for construction timber is increasing, while its harvesting has been limited in recent years. As a result, there are more and more shortages of this raw material (Forest Europe, 2020).

The production technology of prefabricated houses is based on the manufacturing of finished elements, i.e. main walls with window carpentry, load-bearing walls, ceilings, roof trusses, in dry conditions in a production hall. The main raw material used is renewable construction timber, boards or wood panels, the production of which generates significantly lower CO₂ emissions than the production of common building materials. The timber used is dry (its moisture content does not exceed 15%), which means that there is no possibility of its volume changing. Figure 6 shows the annual volume of timber harvested, excluding firewood. An increasing trend in the exploitation of timber resources can be observed until 2018, when the amount of raw material obtained was the highest, reaching over 44,590,000 m³. According to Eurostat, in recent years Poland has consistently ranked fifth in terms of annual timber harvesting.

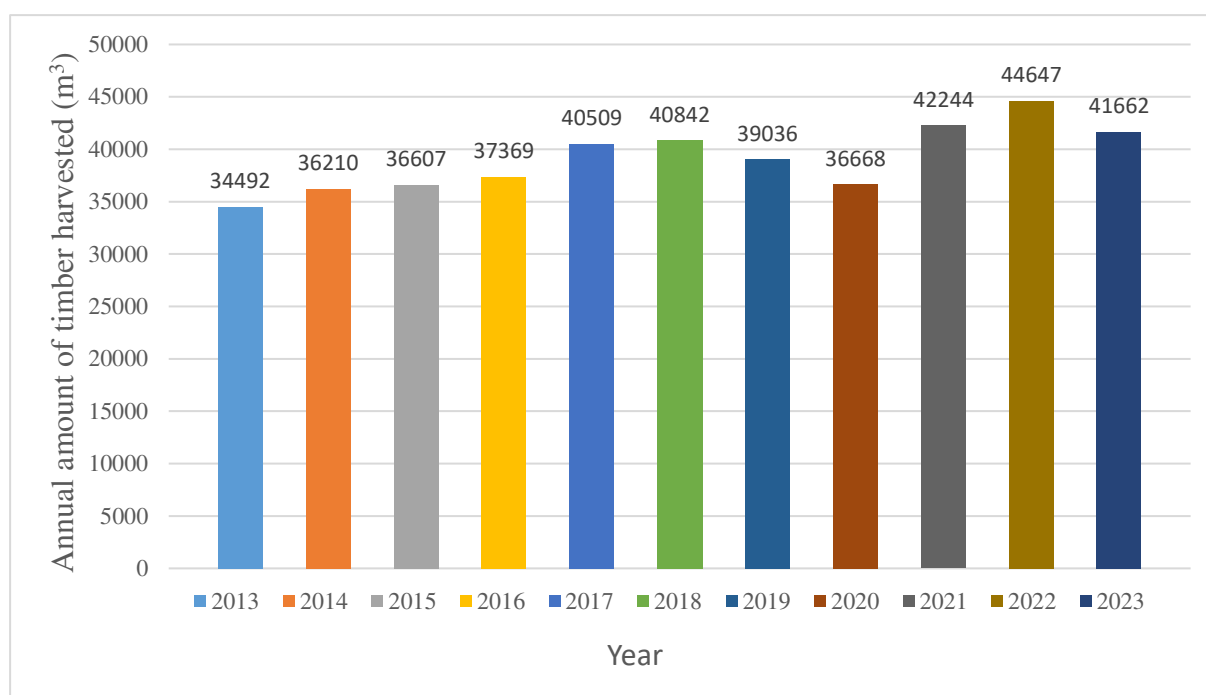


Figure 6. Annual amount of timber harvested in Poland in thousand m³.

Source: Authors own study based on statistical data (Eurostat, 2025).

3. Case study

The case study was produced based on data obtained from a company that designs and produces prefabricated residential buildings, technical specifications from a manufacturer of machinery used at the production plant, and on the basis of our own observations.

Implementation of a detached house design begins with a surveyor marking out the site where the house is to be built according to the coordinates specified in the design. Then, almost simultaneously, work begins at the construction site and at the production hall. The first task at the construction site is to install the power, water and sewage connections. Then, the access road and the area where the building is to be erected are hardened. After that, a foundation slab is created, which will form the basis of the building. The process of manufacturing the modules that will make up the building starts at the production hall. The structure consists of external walls, internal walls, ceiling modules and roof panels. The operations are performed using specialised CNC machines that ensure accurate material processing. Thanks to automation of the production line, serial production is possible.

The production of prefabricated elements takes place in controlled conditions on the production floor. The diagram shows particular stages of the production process using the example of construction of an exterior wall (Fig. 7).

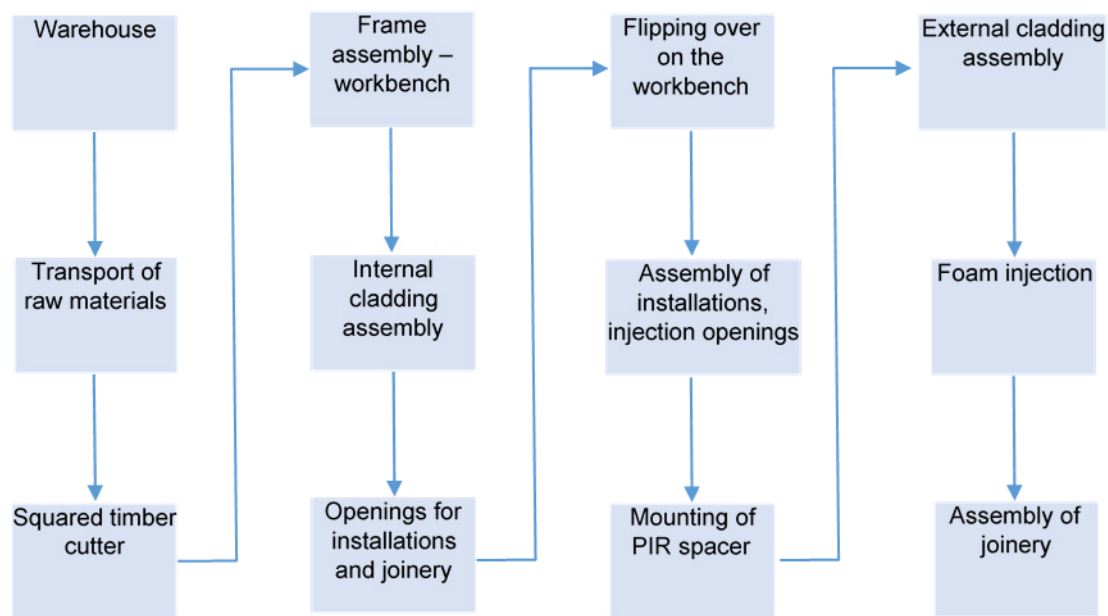


Figure 7. Diagram of the prefabricate production process for a residential building external wall.

Source: Authors own study based on data obtained from the production plant.

The production process commences with the machines being set up according to the design. Then the materials are transported from the warehouse to the production hall and arranged in such a way that the material to be used is as close as possible to the workstation where it will be processed. The first processing step is carried out at carpentry centre No. 1 and includes cutting the squared timber and making the designed notches and rabbets. Then, the processed elements are transferred to workbench No. 1 and assembled into a frame, which constitutes the skeleton of the partition. The individual elements are attached using pneumatic nail guns (Fig. 8a). Next, the inner sheathing is installed at carpentry centre No. 2 (Fig. 8b). After installation of the sheathing, holes are made for different installations (Fig. 8c) and the places for the window and door joinery are cut out. Next, the wall is flipped over its long side onto workbench No. 2, where the plumbing (Fig. 8d) and electrical installations are installed. Injection holes are also made. Then a hard PIR foam spacer is mounted on the wall skeleton, on which the external cladding is mounted using carpentry centre No. 2. Then, foam is injected into the interior of the wall, which is placed in a press to prevent excessive expansion of the insulator (Fig. 8e). The production process of the prefabricated wall is completed by installation of window and door joinery (Fig. 8f).

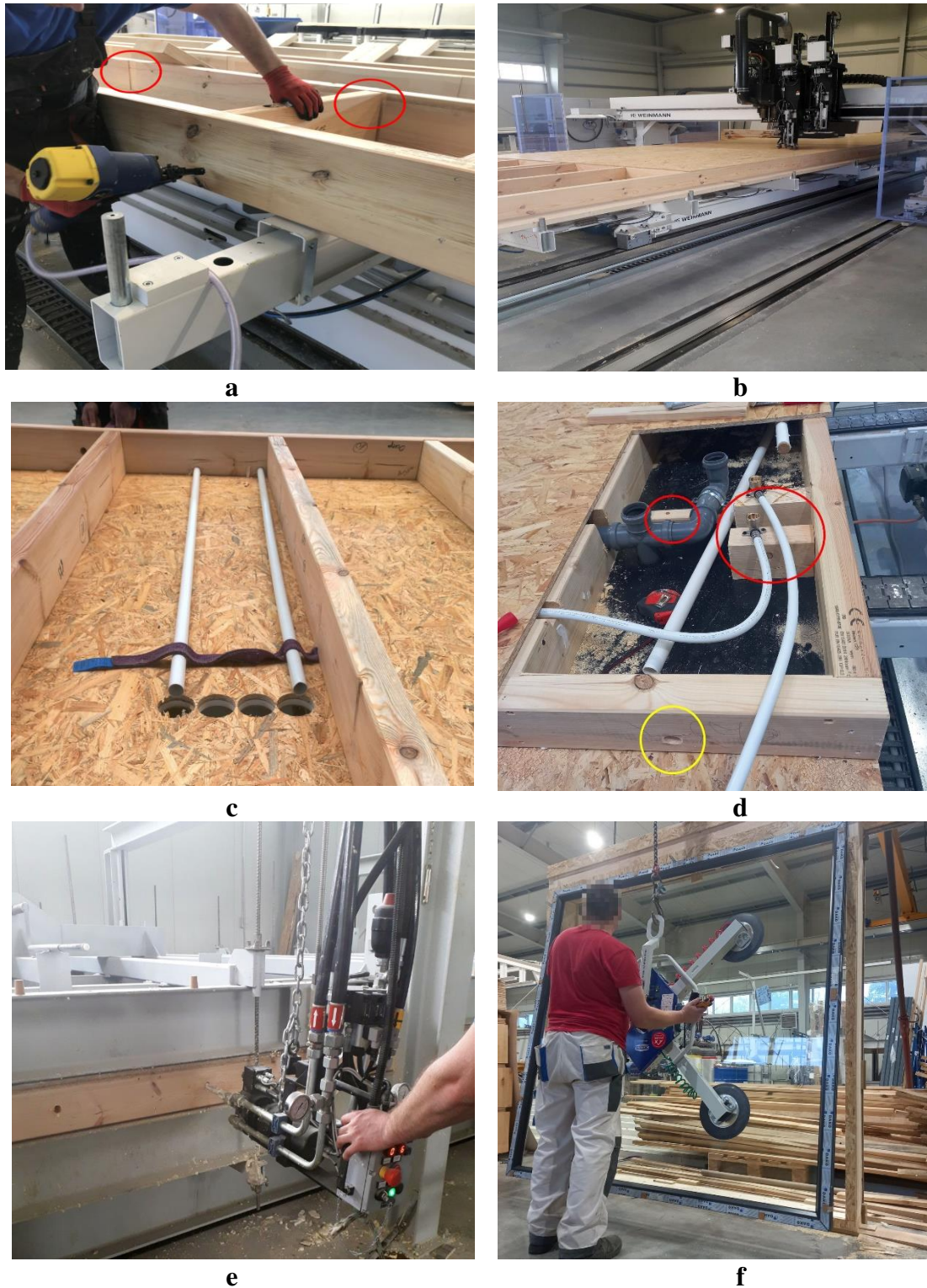


Figure 8. Production of prefabricates: a – construction of the wall frame using a pneumatic nail gun; b – automatic attachment of panels using carpentry centre No. 2; c – installation of electrical wiring piping; d – installation of water and sewage systems; e – process of polyurethane foam injection; f – Installation of the window in the external wall.

Source: Authors own study based on data obtained from the production plant.

Works at the construction site start at the same time as the production process. The diagram below illustrates the individual stages of building construction (Fig. 9).

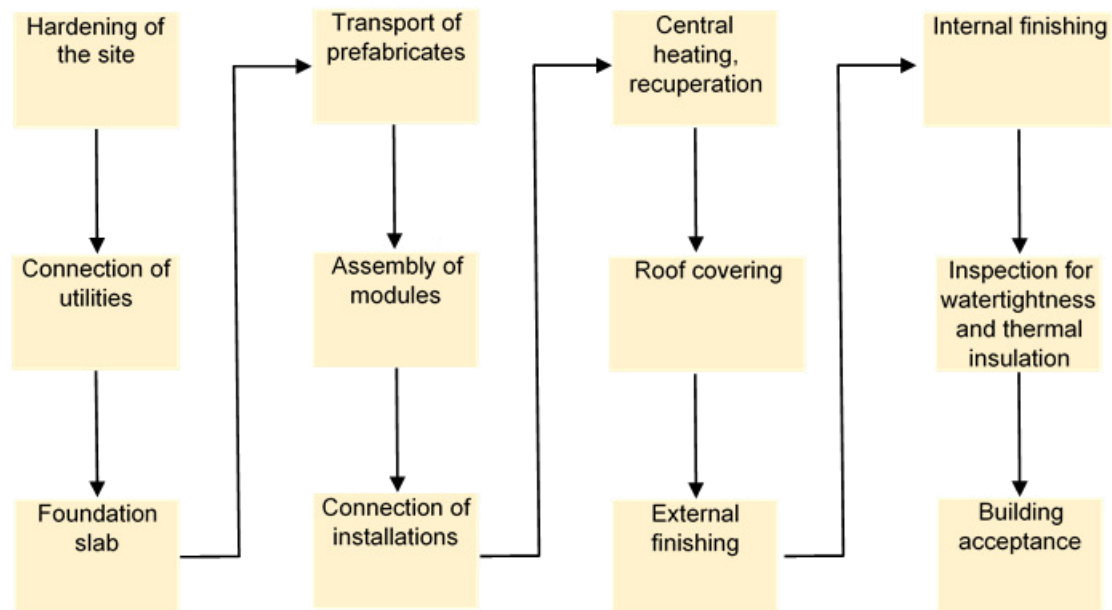


Figure 9. Diagram of works as the construction site.

Source: Authors own study based on data obtained from the production plant.

The first step is installing the necessary utilities at the construction site. Then, the area is prepared and the foundation slab is laid (Fig. 10a). The next step involves transporting prefabricated parts to the construction site (Fig. 10b). The walls are attached to the foundation using a crane (Fig. 10c), and the floor and roof are attached to them (Fig. 10d). In the next step, all installations are connected. In addition, a central heating system with a heat pump and a mechanical air recirculation system – recuperator – are connected. At the same time, the workers install the roofing. The next stage involves interior finishing work – installing the suspended ceiling, preparing the walls for painting and painting them, installing sockets and switches (Fig. 10e). At the same time, finishing work is being carried out on the outside of the building – completing the façade, laying the foundation perimeter around the building and preparing the entrance with paving blocks (Fig. 10f). The final stage is inspection of the building for watertightness and thermal insulation. Once the test is positive, building acceptance is carried out, after which the building achieves the builder's finish status.

The analysis revealed the problem of production waste management. Based on the above, assessment of the production of prefabricated wooden houses was carried out and ways of managing production wood waste were suggested.

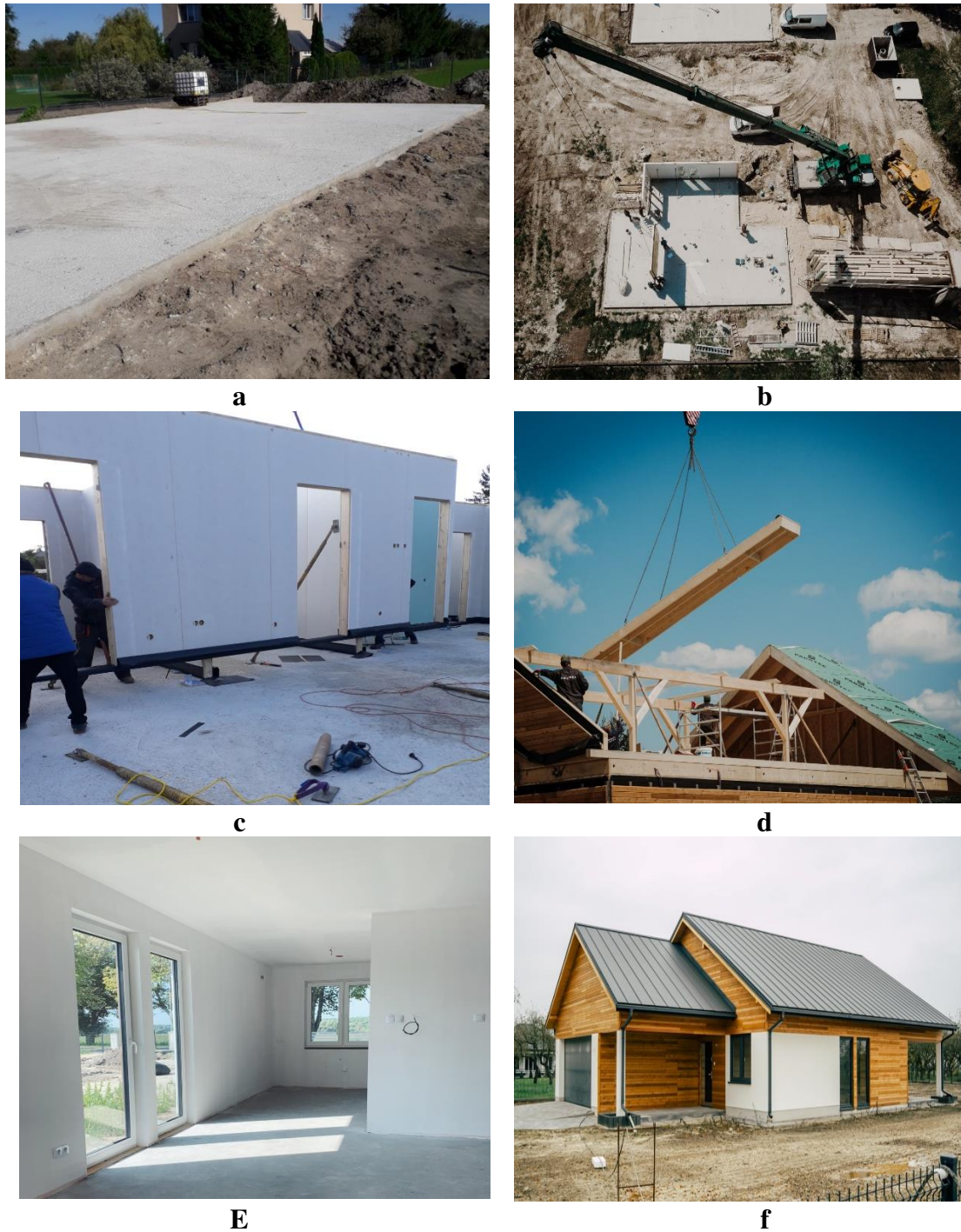


Figure 10. Production of prefabricates: a – finished foundation slab; b – process of module placement; c – installation of a prefabricated module; d – installation of a roof panel; e – view from the interior of a finished house; f – finished building constructed in the wooden modular structure technology.

Source: Authors own study based on data obtained from the production plant.

Analysis of the prefabrication process revealed a problem with production waste management. Specifically, wood waste that could be recycled or used as fuel is disposed of together with other waste. This is handled by a third party company. This solution is uneconomical and not environmentally friendly; a different way of dealing with this type of waste should be considered.

3.1. Production waste management

Waste generated during the production of prefabricated elements at the analysed company can be divided into two groups. The former includes natural wood waste that can be safely recycled and waste that contains harmful substances such as adhesives or resins, or is artificial in itself, such as electrical cable sheaths or water and sewage pipes. Wood waste includes sawdust from sawing wood, shavings from drilling holes, pieces of wood of various sizes that are too short as well pieces of wood from notching and rebating. Waste that can be classified in the second group includes pieces of OSB board containing adhesives, cut off residues of dried PUR foam, short sections of water and sewage pipes, electrical cable sheaths, pieces of roofing membrane and wind insulation foil, residues of rigid polyurethane foam, and pieces of plasterboard.

The company does not currently process any waste. The waste is not stored or sorted. It is removed from the production hall by a conveyor belt that collects sawdust and shavings from the carpentry centre, a sawdust extractor that collects sawdust from various stations and transports it to one place, and a container into which pieces of construction wood, OSB and plasterboard, foam residues, pieces of foil and other kinds of production waste are thrown (Fig. 11). All waste is then placed in one container, which is periodically taken away from the plant.

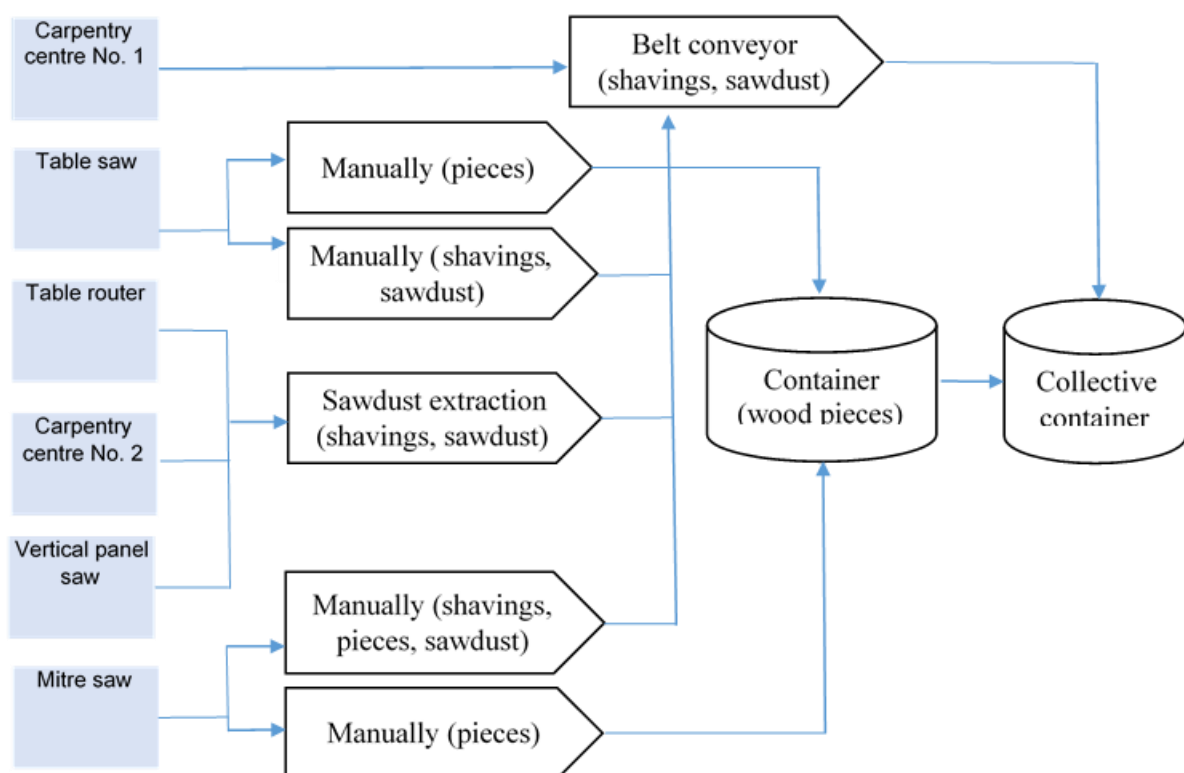


Figure 11. Current waste management system of the production plant.

Source: Authors own study based on data obtained from the production plant.

The company outsources its waste management to a third party, which collects unsorted waste in return for payment. This solution is not environmentally friendly and generates costs that could be minimised. The sorting of waste alone would reduce disposal costs. The production hall is equipped with a central heating system. The heat is generated by a solid fuel boiler, which the company keeps stocked with fuel. By choosing to sell the waste, the company could use the funds from the sale to purchase fuel. By choosing to recycle production waste, the company can become self-sufficient in terms of heating by using the fuel it produces itself. This eliminates the middlemen who add a significant mark-up to the price of the final fuel. This waste management solution can bring measurable benefits.

The production of prefabricated houses generates clean wood waste in the form of sawdust, shavings and solid wood pieces. The production of a 140 sqm house takes on average 12 days, assuming a daily working time of 10 hours and no interruptions due to breakdowns or unavailability of materials. Therefore, an average of two houses can be produced in a month at the company under review. Due to the fact that the line is highly automated, production does not generate a large amount of wood waste.

Companies buy specific types of wood waste. Most of them are interested in purchasing shavings, sawmill residues or ready pellets. Only a small group of companies is interested in production waste. In addition, they are reluctant to work with companies that generate small amounts of waste. One can conclude that sale is not an appropriate way to manage the waste of a company conducting this type of activity.

In order to save money, the company may consider purchasing a wood pellet production line. Wood used to make the prefabricated elements is coniferous wood with a high lignin content, which acts as a binder during pellet production. The wood used has the desired production parameters, with a moisture content of no more than 15%. As a result, the product manufactured could be high in calories and of a good quality, which is crucial for an efficient combustion process. Pellets are a biofuel that releases much less carbon dioxide during combustion than other solid fuels. In addition, the structure and good quality of the granules guarantee a fairly low ash production.

Selection of the above waste management method is justified by the nature of the company's production and the economic aspect of modernisation. Considering that the production hall is heated by a solid fuel boiler, it is possible to replace it with biofuel in the form of wood pellets. Thanks to this waste management model, the heating costs of the facility, which are currently constantly increasing, will decrease significantly. The method of heating with this biofuel is also characterised by lower exhaust emissions, meeting the required European standards, which has a positive impact on the environment.

3.2. Financial potential of the sector of prefabricated buildings

Prefabricated buildings are used to construct other structures. They can be made of various materials, including wood, steel and concrete. According to the Observatory of Economic Complexity (OEC), in 2022, prefabricated buildings ranked as the 326th most traded product in the world, with a total turnover of USD 12.2bn. In 2021-2022, exports of prefabricated buildings increased by 13.1%, from USD 10.8bn to USD 12.2bn. The trade in prefabricated buildings accounts for 0.052% of total global trade. In 2022, the largest exporters of prefabricated buildings were China (USD 2.73bn), the Czech Republic (USD 635m), Estonia (USD 601m), the United States (USD 566m) and the Netherlands (USD 542m). In 2022, the largest importers of prefabricated buildings were Germany (USD 1.54bn), the United States (USD 816m), France (USD 605m), Hong Kong (USD 554m) and the United Kingdom (USD 547m).

After Estonia and Lithuania, Poland is the third largest exporter of prefabricated wooden houses in the EU. The export value reached EUR 115.1 m in 2021, recording a high growth rate (+52.7% y/y). The largest recipients of prefabricated wooden houses from Poland are Germany, the UK and Norway.

According to data from Statistics Poland (GUS), there are about 580 companies actively building in the wooden technology (including about 30-40 manufacturers of modular houses) and about 260 companies building log houses in Poland. Polish companies are also active on foreign markets – according to the report “Wooden construction as a stimulator of housing development in Poland” (Wood Technology Institute, Poznań, 2020), Polish companies build about 4,000 houses outside Poland, mainly in prefabricated frame technology.

The prices of modular houses vary from PLN 1000 per sqm up to as much as PLN 7000 per sqm and they depend on many factors, including the finishing state, type of building materials or topography of the plot where the finished house will be built. This results in a wide range of prices per square metre.

4. Summary and discussion

Construction is a rapidly developing branch of the heavy industry. Considering the aforementioned materials and processes, one can conclude that the construction industry has undergone a radical transformation over the past decades. Nowadays, the industry is shifting away from monolithic and large-panel technologies.

Due to the growing population and increasing housing shortage, more and more residential buildings are being constructed every year. Currently, the improved traditional technology which, despite constant modernisation, still consumes huge amounts of energy and materials is

the prevailing building erection method. In the era of high prices of construction materials and services and fast pace of life, there is a growing interest in technologies that prioritise production speed and economical use of materials. In response to market needs, buildings are erected using prefabricated modules based on a wooden frame. A building erected in this technology is ready for use approximately three months after launching the investment.

The production plant under review designs and produces prefabricated wooden houses. The construction of such a building is based on modules with a wooden frame, such as the external and internal walls, ceilings and roof panels.

Compared to the traditional bricklaying method, buildings constructed using this technology are built very quickly. The production time for prefabricated parts is around 12 days, the house is completed in a maximum of 3 days, and it takes around 3 months to complete the builder's finish condition.

The paper discusses the possibility of managing production waste. The modernisation involves recycling and reusing production waste in the form of uncontaminated wood: sawdust, shavings and pieces of squared timber. Currently, the company outsources waste management to a third party, incurring significant costs that will increase over time due to stricter waste disposal regulations and the degree of pollution of the planet. The modernisation would involve addition of a wood pellet production line. This form of recycling was chosen because of favourable conditions in terms of properties of the waste. Namely, the waste comes from the processing of KVH wood, which is coniferous. Softwood contains a lot of lignin, which is necessary in the pelletisation process because it acts as a kind of binder. According to the literature, good quality pellets should have a maximum moisture content of 15%. The wood mentioned above has the same characteristic and, therefore, offers great potential for the production of solid, concentrated biofuels. The company uses pellets to heat the production hall. It obtains this fuel on the market, where prices are constantly rising due to high demand and high logistics costs. In fact, pellet production is not that expensive.

Building with wood could become part of Poland's housing policy. Although it currently represents a small segment of the housing market, the share of wooden houses is likely to increase within a few years. The key limitation to the development of wooden construction in Poland is still low public awareness of the advantages of such structures.

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DIGITAL SKILLS IN SELECTED EUROPEAN UNION COUNTRIES IN THE CONTEXT OF DIGITAL EXCLUSION

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Purpose: The purpose of this paper is to analyse the key factors of the digital exclusion in selected European Union countries. Specifically, it examines the economic, social, and demographic determinants that shape digital accessibility and digital literacy in these nations.

Design/Methodology/Approach: This study analyses the factors associated with the level of digital skills, as measured by the DSI indicator, which is considered a key representation of digital exclusion. The analysis covers the 27 European Union countries from 2014 to 2023, enabling the identification of trends and changes over the examined period. Furthermore, correlations between the DSI levels and selected factors are investigated to determine the primary determinants of digital exclusion.

Findings: Significant variation in digital skill levels and the factors influencing them was observed across European Union countries. Strong correlations were identified between digital skills, GDP, and the level of education (both formal and informal). Additionally, the average age of the population was found to be a negative factor, which, in the context of aging societies, may play a crucial role in shaping future policies aimed at promoting digital inclusion for this demographic group.

Research Limitations/Implications: The conducted study provides a starting point for further analysis using a cross-sectional and temporal approach, focusing on digital exclusion in Europe.

Practical Implications: The results of the study have facilitated the identification of socio-economic factors associated with digital exclusion in European Union countries. These findings highlight key areas that require targeted action by policy-makers, particularly in addressing social inequalities and the digital marginalization of certain demographic groups.

Social Implications: The studies highlight the need for comprehensive education to develop key digital skills, enabling individuals to engage effectively and safely with the digital transformation of society and to prevent digital exclusion. They also indicate that, despite significant advancements in the availability of Internet technology over the years, digital exclusion remains unresolved, pointing to various underlying determinants of this issue.

Originality/Value: The paper identifies the factors associated with digital exclusion and provides recommendations for actions aimed at reducing digital inequality.

Keywords: sustainability, digital exclusion, digital transformation.

Category of the paper: Research paper.

1. Introduction

The dynamic development of information, communication, and digital technologies has driven the socio-economic transformation of the world, known as the digital transformation, and has contributed to the emergence of the so-called 'digital society.' This transformation affects all areas of life, and its potential for change appears to be unlimited. Technologies such as artificial intelligence (AI), robotics, the Internet of Things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, and quantum information technology continue to advance (Balcewicz, 2019). Digitization has enabled the processing of and access to vast amounts of data, transforming the functioning of individuals, businesses, and institutions. While traditional technologies remain significant for knowledge, entertainment, and communication, digital media have become integral to nearly every action, purpose, and need in contemporary society (van Dijk, 2020). It is estimated that in 2023, 5.3 billion people worldwide used the Internet, accounting for approximately 66% of the global population (Petrosyan, 2024). In the European Union countries, the number of Internet users reached approximately 410 million, representing 91.43% of the population (Eurostat, 2023), and four out of five residents acknowledge that digital technologies will be significant in their lives by 2030 (European Commission, 2023).

Despite its numerous benefits, digital transformation brings a range of significant cyber risks. The rapid development of technology presents countries with the dilemma of accelerating digital transformation and developing a technology-driven economy, often at the cost of losing control over the security of the solutions used (Wrzosek, 2020). These dilemmas are crucial as they can impact the cybersecurity levels of both the country and its citizens. Three out of four residents of the European Union emphasised the need to enhance cybersecurity, improve connectivity, and strengthen data protection (European Commission, 2023). This is particularly relevant in light of the growing threats, such as the protection of citizens' data and privacy, the issue of online harassment and violence, and the challenges posed by disinformation and filter bubbles (Balcewicz, 2019).

Digital transformation contributes to economic development and enhances the well-being of society. However, individuals who lack access to Internet infrastructure or technological tools, as well as those without adequate digital competencies, are unable to fully participate in the digital society. As a result, a digitally marginalized group continues to emerge (European Commission, 2022). Digital divides both reflect and exacerbate existing social, cultural, and economic inequalities (van Dijk, 2020). Disadvantaged groups include women, migrants, refugees, people with disabilities, the elderly, children, and rural and indigenous communities (Balcewicz, 2020).

This study contributes to the existing body of research on digital exclusion by offering a comprehensive, multi-year analysis of the key socio-economic and demographic determinants associated with digital skills across the European Union. A key contribution of this research is its investigation of correlations between the Digital Skills Indicator (DSI) and selected socio-economic factors, such as GDP, education levels, and demographic composition. By analysing data from 2014 to 2023, it provides a longitudinal perspective on digital inequalities. For the most recent data from 2023, Gretl software was employed to examine these correlations, ensuring a rigorous statistical approach to uncovering patterns and relationships. The findings offer valuable insights for policymakers by identifying key areas requiring targeted interventions to reduce digital inequalities. As digital accessibility and literacy become increasingly essential in modern societies, this study provides a timely and evidence-based contribution to the ongoing discourse on digital inclusion strategies in the European Union.

The structure of the article is as follows. The first part provides the introduction to the study, followed by a literature review that examines digital skills as an aspect of digital exclusion in society. This section identifies potential factors that may determine the level of digital skills. The next section outlines the data and methodology of the empirical analysis, while the fourth section presents the results of the study along with their interpretation and discussion. The paper concludes with a section on conclusions and recommendations, which summarises the key insights and offers practical suggestions.

2. Digital skills as a driver of digital exclusion - literature review

Digital transformation, while driving economic growth and innovation, requires effective management to minimize the entrenchment and worsening of existing social, economic, and cultural inequalities. The lack of access to next-generation Internet infrastructure or insufficient digital competencies leads to digital exclusion for certain segments of society. Thus, digital exclusion is not merely a technological issue, but also a social one, with significant implications for education, the labour market, and the daily functioning of societies (van Dijk, 2020).

The concept of digital exclusion has evolved and expanded alongside technological advancements. According to the definition established by the OECD in 2001 (OECD, 2001), the digital divide refers to the difference between individuals, households, businesses, and geographical regions at varying socio-economic levels in terms of both access to and the ability to utilize information and communication technologies (ICTs) for various activities and purposes.

Studies in the field of digital inclusion have identified three levels of digital exclusion, which have been defined and refined as research on the topic has progressed. Initially, the digital divide was primarily understood as a disparity in material and physical access, distinguishing between those who had access to ICTs - such as computers, home Internet connections, or telephone lines - and those who did not (NTIA, 1998). This stage is referred to as the first-level digital divide. As research advanced, the scope of analysis expanded to include a second level of digital exclusion, which pertains to differences in digital skills among users. This aspect determines individuals' ability to effectively engage with technology and acquire information (Hargittai, 2002). The most recent approach to the digital divide considers a third level of digital exclusion, which pertains to the ability to effectively utilize digital resources for both online and offline benefits (Van Deursen, Helsper, 2015). Research indicates that digital exclusion should be addressed comprehensively across all three levels (Helsper, 2021).

Batorski (2009) emphasizes that digital exclusion is a complex and multidimensional phenomenon that extends beyond a simple digital divide. It is not merely limited to differences in access, skills, or ways of using technology but, more importantly, encompasses the underlying factors that contribute to social and economic marginalisation. Digital exclusion and social exclusion are interconnected - limited access to offline resources (economic, cultural, social, and personal) restricts the use of digital technologies, while deficiencies in digital competencies and infrastructure further intensify social marginalization (Helsper, 2012). Although digital exclusion is not a direct cause of social exclusion, it can exacerbate the challenges faced by already marginalised individuals as the rest of society increasingly integrates the Internet into daily life (Bunyan, Collins, 2013).

In the European Union, the concept of "digital inclusion" is emphasised. The *European Declaration on Digital Rights and Principles for the Digital Decade* (European Commission, 2023) highlights the importance of guaranteeing equitable, inclusive, and secure access to technology for all EU residents. Five priority areas have been identified (European Commission, 2022): enhancing ICT accessibility, improving digital skills, eliminating language barriers, ensuring reliable, high-speed, and secure connectivity, and providing access to Wi-Fi in public spaces.

Stephens and Mankee-Williams (2021) emphasize the crucial role of digital skills in adapting to continuous technological transformation, facilitating the effective use of online services, and preventing digital exclusion. These skills include not only the ability to operate digital devices and navigate the Internet but also skills related to cybersecurity and protection against threats in the digital environment. The development of key competences, including digital skills, is a fundamental pillar of the European Education Area (Council of the European Commission, 2023), which aims to ensure equal access to high-quality education and training. Digital skills, alongside literacy, mathematics and language skills, are recognized as essential for lifelong learning, playing a key role in enhancing the European Union's innovation, productivity, and competitiveness (European Commission, 2019).

One of the main factors leading to digital exclusion is insufficient levels of digital competence. According to van Dijk (2005), these deficits range from basic technical skills to more advanced competencies required for analysing and evaluating information in a digital environment (van Dijk, 2005). These deficits particularly impact the elderly, individuals with lower levels of education, and those residing in rural areas, thereby limiting their ability to utilise modern technologies effectively (European Commission, 2023).

2.1. Digital Skill Levels Across European Union Countries

The assessment of digital skills across European Union countries is essential for understanding the current state of digital competencies and identifying areas where further development is needed. A couple of key frameworks and indicators have been designed to measure digital skills, each offering unique insights into the level of digital proficiency within the population. The following analysis compares these initiatives, highlighting their contributions to the evaluation of digital skills across Europe.

The OECD Skills for 2030 (OECD, 2019) initiative aims to assist countries in adapting their education systems by focusing on essential competencies, including digital skills, critical thinking, and creativity. This initiative emphasizes the importance of a shared vision for education, developed through global dialogue, and provides a framework for shaping future curricula and teaching strategies to address emerging societal challenges. In contrast, the Global Competitiveness Report Special Edition 2020 (World Economic Forum, 2020) evaluates countries' performance in their recovery efforts following the COVID-19 pandemic, focusing on various dimensions of economic competitiveness, including digital skills and innovation capacity. However, the data presented is selective, focusing on specific aspects of competitiveness, which may not fully capture the broader picture of global economic recovery.

While various frameworks provide valuable insights into digital competencies, the Digital Skills Indicator (DSI) 2.0 offers a more direct and standardized measurement of digital skills within the European context. Developed by the European Commission, the DSI 2.0 assesses individuals' proficiency in digital technologies, ensuring cross-country comparability and providing a comprehensive overview of digital skills. Aligned with the DigComp (Digital Competence Framework for Citizens), it supports the development and measurement of digital competencies across the EU, making it valuable for addressing digital skills gaps at both national and EU levels (Vuorikari et al., 2022). The DSI 2.0 measures competencies in five key areas: working with information (browsing, searching, evaluating, and managing data), communication and collaboration (effective digital interactions, including diversity and digital identity management), content creation (editing, integrating information, and respecting copyright and licences), safety (data and device protection, well-being, and environmental awareness), and problem-solving (identifying needs, innovation, and adaptation to technological changes) (Vuorikari et al., 2016). This framework is essential for assessing the knowledge (understanding of technologies), skills (the ability to use digital tools effectively),

and attitudes (openness to learning and responsibility) necessary to thrive in a digitally-driven world, enabling reliable international comparisons and supporting the development of digital competencies across Europe (Vuorikari et al., 2016).

According to Eurostat (2023), an analysis of digital skill levels across European Union countries reveals significant differences among member states, as illustrated in Figure 1. On average, 55.56% of the EU population demonstrates at least basic digital competence. The highest rates are observed in Western and Northern European countries, with the Netherlands leading at 82.70% of its population having achieved at least a basic level of digital literacy. Finland and Ireland also report high results. In contrast, the lowest values are recorded in Romania and Bulgaria, where approximately one-third of the population has attained at least basic digital competence. The gap between the Netherlands and Romania is as large as 54.97 percentage points, highlighting significant disparities in access to technology and digital education.

However, the data presented in Figure 2 suggest that Internet usage alone does not necessarily correlate with higher levels of digital competence. Brandtzaeg et al. (2011) identify five distinct groups of Internet users, ranging from those who do not use the Internet at all to advanced users. They describe a so-called "rich-get-richer" effect, wherein individuals with high digital skills more quickly acquire new abilities and derive greater benefits from the Internet. Their forecasts indicate that inequalities in Internet usage will continue to widen, highlighting the need for initiatives aimed at digital education and improving users' technological skills.

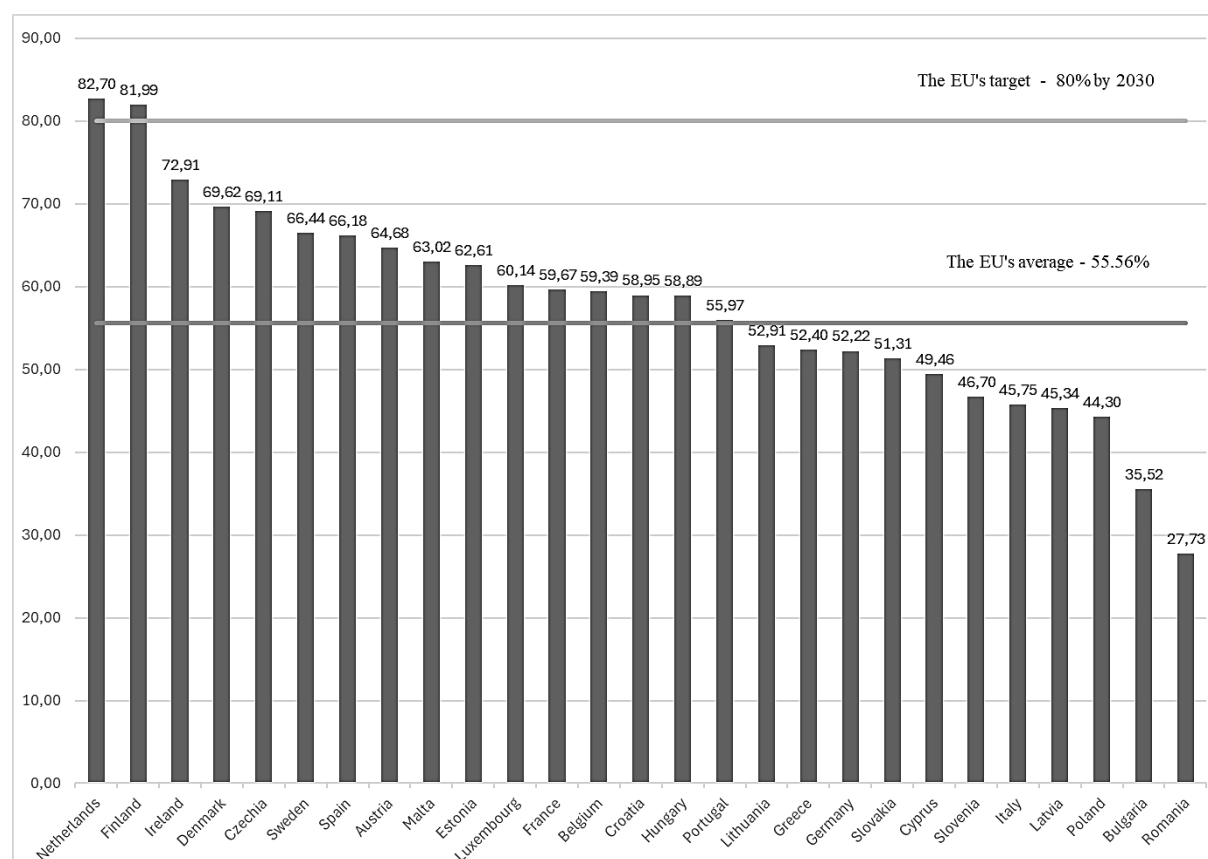


Figure 1. Percentage of people with basic and higher digital competences in Europe by country in 2023.

Source: own presentation based on data provided by Eurostat.

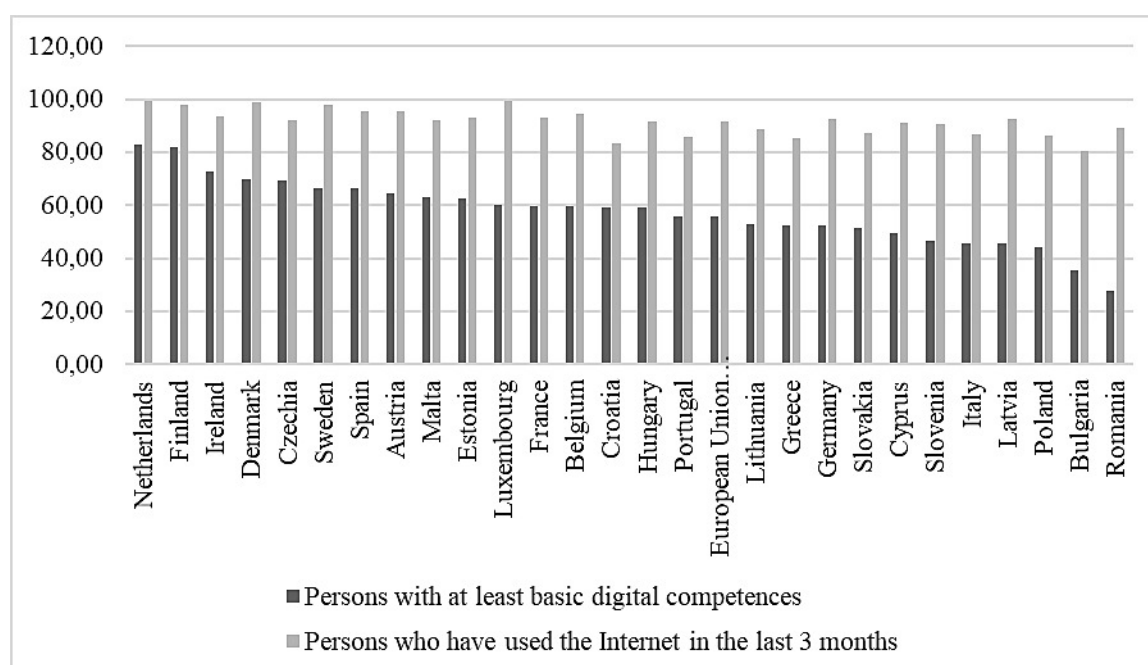


Figure 2. Comparison of the percentage of people who used the Internet in the 3 months prior to the survey with the level of digital competence by EU member state.

Source: own presentation based on data provided by Eurostat.

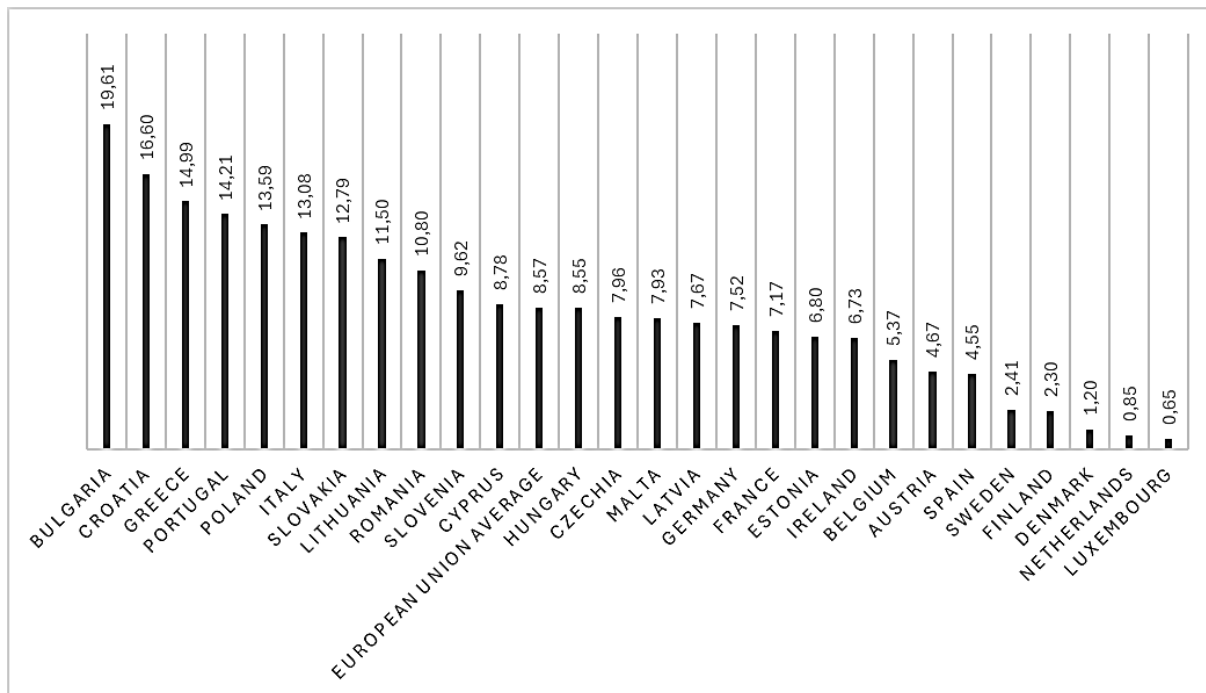


Figure 3. Percentage of people who had not used the Internet in the 3 months prior to the survey.

Source: own presentation based on data provided by Eurostat.

Despite the rapid expansion of Internet infrastructure in recent decades, millions of citizens either do not use the Internet or do so only sporadically. The reasons for this issue are complex and include both lack of access to technology and reluctance or inability to use it effectively (European Commission, 2019). According to Eurostat (2023), data illustrated in Figure 3 indicate that, on average, 8% of the population in the European Union does not use the Internet or uses it only occasionally. The highest percentage of digitally excluded individuals was recorded in Bulgaria (19.61%), which correlates with the lowest level of digital skills in the EU. The next highest percentages were found in Croatia (16.60%) and Greece (14.99%). In contrast, in Luxembourg, the Netherlands, and Denmark, this percentage does not exceed 1%.

2.2. Factors affecting digital competence levels

A low level of digital competence is associated with difficulties in effectively utilising modern technologies. Researchers have identified several contributing factors to this condition. Van Dijk (2005) categorises these factors into four dimensions: motivational, material, skills, and application. Helsper (2021) further emphasizes inequalities across economic, educational, civic, social, and cultural domains. The most commonly recognized factors include economic, educational, demographic, technological, and psychological influences.

2.2.1. Economic factors

Among the most significant economic factors contributing to digital exclusion are GDP per capita, the cost of Internet access, and the unemployment rate. The level of GDP per capita serves as a key indicator of economic development, directly influencing the advancement of digital infrastructure, education levels, and the availability of digital technologies (OECD,

2020). In countries with lower GDP, digital exclusion is more prevalent, as these technologies remain financially inaccessible to many households (Robles et al., 2021).

Szeles (2018) argues that beyond economic development, investment in research and development is crucial for enhancing digital competence. Additionally, the welfare system and the level of social policy spending play a significant role in digital inclusion, particularly for older adults and the unemployed (Alexopoulou et al., 2022). The cost of Internet access is another critical factor influencing digital exclusion, especially among low-income groups, where Internet expenses compete with essential needs such as food and housing (Van Deursen, Helsper, 2015).

The unemployment rate significantly influences digital exclusion. Unemployed individuals often have limited opportunities to invest in the development of digital skills, while a lack of Internet access further restricts their ability to search for employment and participate in online education and training. However, unemployment status can increase the likelihood of using the Internet for job searches by nearly 30 percent, highlighting the role of digital technologies in the job activation process (Vallušová et al., 2022).

2.2.2. Educational factors

Szeles (2018) argues that education plays a crucial role in preventing digital exclusion. Furthermore, studies suggest a strong link between higher education levels and greater proficiency in the critical use of technology, as well as its practical application in both professional and everyday life (European Commission, 2019). Digital technologies have transformed education, expanding opportunities for both learning and teaching. Education is fundamental to enhancing employability, fostering innovation, promoting social inclusion, and bridging the digital skills gap (European Commission, 2023). The data demonstrates that digital skills among young people are largely shaped by education, particularly through the implementation of appropriate teaching strategies (OECD, 2023).

Supporting initiatives for both formal and non-formal education will be essential in achieving the EU's 2030 target of 60% of adults participating in training annually. In 2023, 30.9% of the population had attained tertiary education, 15.37% had participated in online training, and 74.6% reported proficiency in at least one foreign language (Eurostat, 2023). In 2023, the data indicates that, on average, 69% of 15-year-old students in OECD countries possess skills related to assessing the reliability of online information, a critical component of digital competence. Witczak-Roszkowska (2022) emphasises the necessity of formulating a strategic plan for the development of digital competences at an early stage of education, which is essential for addressing existing gaps and preventing future discrepancies between labour market supply and demand. Conversely, findings by Vallušová et al. (2022) indicate that individuals with lower levels of education are less likely to use the Internet. This underscores the importance of integrating digital competencies into both formal and informal education systems, as it supports individual development across different life stages (Redecker, 2017).

2.2.3. Demographic factors

Demographic and social factors, including age, gender, education, and place of residence, play a crucial role in determining digital competence and the extent of Internet use, thereby increasing the risk of digital exclusion (Helsper, Galacz, 2009; European Commission, 2023). In particular, low socio-economic status serves as a significant barrier to accessing technology, contributing to the widening of social and economic inequalities (Helsper, 2008).

A demographic indicator that reflects the average age of a population, which in turn reflects the age structure of society, is characterised by varying needs and barriers in professional, social, and cultural life (Helsper, 2012). The level of digital competence is dependent on age. According to Eurostat (2023) the youngest group (16-24 years) demonstrates the highest level of digital skills in the European Union, with an average of 69.98% of the population, indicating broad access to technology within this group. In the 25-54 age group, this rate decreases to 64.00%, while among older individuals (55-74) drops further to only 37.05%. These trends are illustrated in Figure 4. Older age groups are less likely to use information and communication technology (ICT), due to both physical and cognitive limitations, as well as reduced adaptability to new technological solutions (Vallušová et al., 2022; Rosman et al., 2022; Szeles, 2018). The ageing population, particularly in the context of "double ageing" - with the number of people aged 65 and older projected to increase by 18% between 2020 and 2030 (European Commission, 2021) - presents a significant challenge for digital inclusion. This trend underscores the need for the development and implementation of targeted strategies to prevent the marginalization of older individuals (Adamczyk, Betlej, 2021). Figure 4 illustrates significant disparities in digital competence levels across different age groups between countries. As reported by Eurostat (2023) among older individuals, the highest levels of digital competence are reported in the Netherlands (72.23%) and Finland (62.24%), while the lowest rates are recorded in Romania (10.56%) and Bulgaria (15.31%). Poland remains one of the countries with the lowest levels of digital competence among older populations in the EU, with a digital competence rate of 18.44% in the 55-74 age group. This low rate can be attributed to differences in education levels, income, and access to digital infrastructure (Adamczyk, Betlej, 2021).

The place of residence is a significant determinant of digital competence levels. In rural areas, underdeveloped digital infrastructure, higher unemployment rates among individuals aged 15 to 29, and restricted access to public services such as education and healthcare contribute to the widening of the urban-rural digital divide (European Commission, 2021). The high costs associated with infrastructure development lead to a phenomenon known as 'profit-based discrimination,' in which rural communities are marginalised in terms of broadband Internet access (Stephens, Mankee-Williams, 2021). A similar phenomenon was observed in a study of digital exclusion in San Antonio, where limited access to technology and the high cost of infrastructure deployment constrain access in less populated and economically disadvantaged areas (Reddick et al., 2020).

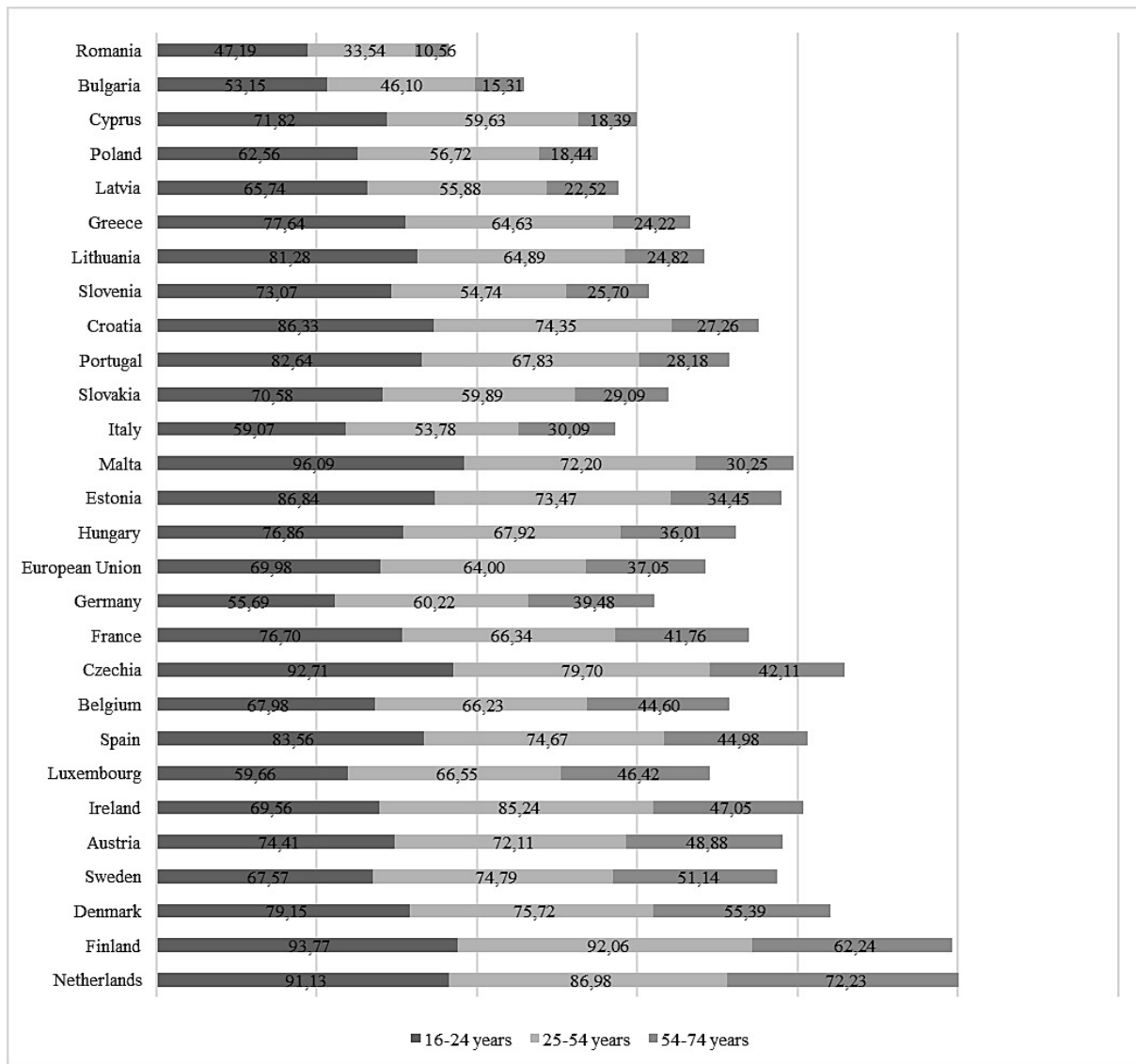


Figure 4. Percentage of individuals with basic and advanced digital competencies by age group across the analyzed countries.

Source: own presentation based on data provided by Eurostat.

The disparities in digital literacy levels based on place of residence are illustrated in Figure 5. Within the European Union, the highest percentage of individuals with basic or higher digital competencies is found in large cities (62.55%), followed by 53.25% in cities and suburbs, and 47.50% in rural areas (Eurostat, 2023). These differences are particularly pronounced in countries such as Bulgaria, Latvia, Greece, Poland, Hungary, and Portugal, where the gap between digital competence levels in large cities and rural areas exceeds 20 percentage points. In contrast, countries like Cyprus, Belgium, and Ireland exhibit minimal differences, with variations of only 1-2 percentage points.

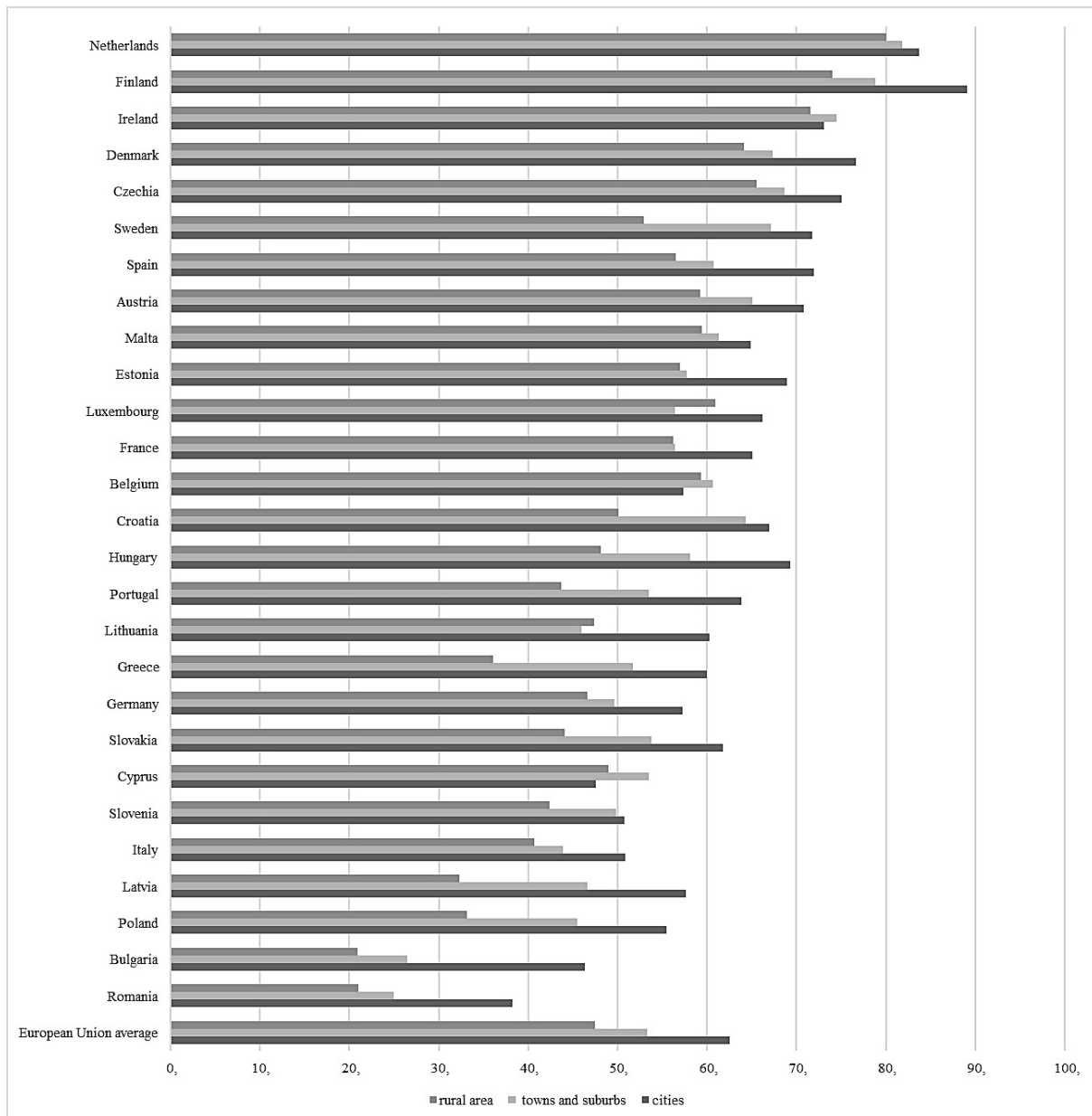


Figure 5. Percentage of people with basic and higher digital competences by big cities, cities and suburbs and rural areas within the countries analysed.

Source: own presentation based on data provided by Eurostat.

Gender is another determinant of digital skills. Although it is often assumed that males are more digitally competent, the ICILS 2013 international survey revealed that, in most European countries, 14-year-old girls scored higher in computer and information literacy (Punter et al., 2017). However, an analysis of technology use patterns shows that women are more likely to use technology for communication and social purposes, whereas men tend to engage in more advanced forms of Internet use, such as programming or data analysis (OECD, 2019). Additionally, factor analysis confirmed that the structure of digital competencies shows only small gender-based differences, with their development being closely linked to cultural background and the educational system (Aydın, 2020; Punter et al., 2017). A study conducted

in Malaysia found that gender has only a minor impact on digital literacy levels, with age and education level being the primary determinants (Rosman et al., 2022).

2.2.4. Technological factors

Technological factors play a key role in determining the level of digital competencies, with their influence closely linked to a country's economic development, the wealth of its population, and the availability of technological infrastructure. Approximately one-third of the global population, or 2.6 billion people, remained offline in 2023. While over 90% of individuals in high-income countries were using the internet in 2022, only one in four in low-income countries had access to it. Access to the internet and modern devices is crucial for acquiring digital skills, which are essential for full participation in the knowledge-based economy (World Bank, 2024). In 2019, 87% of individuals in developed countries were using the internet, whereas only 19% of people in the least developed countries had access (UN, 2020). Although 93% of the global population has access to mobile telephony or internet services, only 53.6% are actual internet users, leaving an estimated 3.6 billion people without access. This disparity not only exacerbates socio-economic inequalities but also restricts opportunities for social improvement (Reddick et al., 2020).

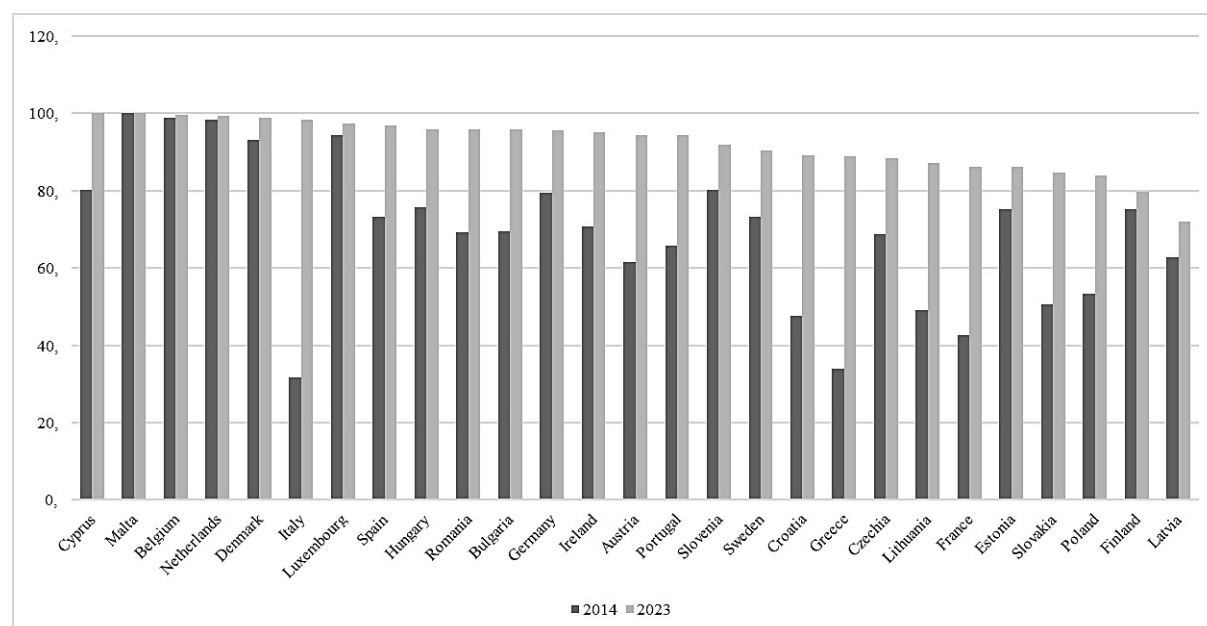


Figure 6. Percentage of households with NGA Internet access.

Source: own presentation based on data provided by Eurostat.

Figure 6 presents data on access to telecommunications infrastructure providing high-speed broadband (Next Generation Access, NGA) in EU countries. As reported by Eurostat the average percentage of households with NGA Internet access in 2023 is 92.9%, reflecting an increase of 30.2 percentage points compared to 2014. The highest levels of availability are found in Cyprus and Malta, where the rate has reached 100%. In contrast, the lowest percentages are recorded in Latvia (72%) and Finland (79.7%). The most significant increases

since 2014 were observed in Italy (an increase of 66.7 percentage points) and Greece (an increase of 54.9 percentage points).

3.2.5. Psychological factors

Psychological factors play a significant role in digital exclusion, contributing to a lack of digital engagement and, consequently, exacerbating economic and social inequalities (Helsper, 2008). Key psychological barriers include fear of technology, fear of social evaluation, and concerns about cybercrime (Tomczyk et al., 2023). A lack of self-confidence and low motivation to use digital technologies can lead to self-marginalization. Research indicates that 67.6% of households in Poland that do not use the Internet report a lack of need, while 52% identify a lack of skills as the primary barrier (Adamczyk, Betlej, 2021).

A lack of confidence in new technologies is another psychological factor contributing to digital exclusion. This is particularly pronounced among older individuals, who may fear cybercrime, loss of privacy, and difficulties in navigating complex technological interfaces (Adamczyk, Betlej, 2021). Research in Spain indicates that concerns about surveillance, personalised advertisements, and a lack of knowledge regarding personal data protection (e.g., stemming from GDPR regulations) further limit the willingness to engage with public e-services (Kaihlainen et al., 2022). Psychological barriers also include negative experiences with interactive public spaces. Individuals with lower social status and low self-esteem may avoid engaging in the digital sphere due to the potential for negative interactions, which can lead to their gradual withdrawal and further exclusion (Robles et al., 2021).

3. Data and methods of the empirical analysis

The purpose of the study was to identify factors associated with the level of digital competence across societies in the countries of the European Union, which comprised 27 member countries as of 2020. All EU countries were analysed, which vary in many respects, including geographical location and the level of economic and social development. The study explores the relationship between various economic, social, and technological indicators and the level of digital skills (DSI). Based on the research by Vuorikari et al. (2022), the DSI 2.0 indicator has demonstrated high psychometric quality, indicating its reliability and validity as a tool for measuring digital competencies. The analysis also included an empirical test of the validity of the DigComp framework, which provided the following fit indices: RMSEA (Root Mean Square Error of Approximation) = 0.033, TLI (Tucker-Lewis Index) = 0.989, CFI (Comparative Fit Index) = 0.991, and SRMR (Standardised Root Mean Square Residual) = 0.052. All of these fit indices confirm that the bi-factor model employed in the DSI 2.0 ensures an appropriate fit and serves as a robust tool for measuring digital competencies.

within the context of the DigComp framework. Although various indicators can be used to assess digital skills, the DSI 2.0 was deemed the most appropriate for this study, particularly in the context of European countries. Its selection is justified by its availability, reliability, and the possibility of cross-country comparisons within the European Union. However, DSI 2.0 presents several limitations that must be considered. A key limitation is that the data utilized in its calculation can rapidly become outdated due to the fast progression of technological advancements, which may compromise the accuracy and relevance of the results. As a quantitative measure, the DSI fails to capture qualitative dimensions, such as user satisfaction. Additionally, methodological concerns regarding the DSI are noteworthy. The indicator relies extensively on self-assessment by respondents, introducing the potential for misinterpretation of individual capabilities and variability in interpretations, which can undermine the consistency of the results.

Although various indicators can be used to assess digital skills, DSI 2.0 was deemed the most appropriate for this study, particularly in the context of European countries. Its selection is justified by its availability, reliability, and the possibility of cross-country comparisons within the European Union, despite certain limitations.

Based on the literature review, variables were selected that could potentially demonstrate a relationship with the level of digital competence in the EU countries. The characteristics of these variables are presented in Table 1. In this study, several factors potentially influencing digital competencies were not considered. These include psychological aspects, such as motivation and fear of new technologies, as well as access to educational support, including resources available within the family context. Socio-cultural factors, such as attitudes towards and acceptance of new technologies within a given society, were also excluded. The omission of these variables is due to the absence of comparable data and the challenges associated with their precise definition and measurement.

The data analysed are annual and refer to 2023. Definitions and data have been compiled from the Eurostat website. All data are expressed as a percentage of the variable's value relative to a reference value, allowing for comparisons across member countries. Data on the percentage of individuals living in predominantly rural areas for Malta were calculated using information from the National Statistics Office Malta (NSO, 2024), and for Luxembourg, the data were calculated using information from the National Institute of Statistics and Economic Studies of the Grand Duchy of Luxembourg (STATEC, 2024). The criteria for calculated included a population density of less than 300 inhabitants per km² and a population of fewer than 5000 in the area. For Cyprus, the data were sourced from the Statistical Service of Cyprus (CYSTAT, 2024).

For the analysis, the Pearson linear correlation coefficient is employed. This measure allows for an assessment of both the direction and strength of the relationships between two selected variables.

Table 1.
Characteristics of the analysed variables

Variable abbreviation	Variable characteristics
DSI	Digital Skills Index (DSI), is the percentage of individuals with basic or higher general digital skills (where all five component indicators are at the basic level or higher) relative to the total population, as defined by DigComp, an indicator developed for the 16-74 age group.
PKB	The GDP per capita indicator, expressed in purchasing power standards (PPS), is related to the average value for the European Union, which is set at 1. Data expressed in PPS, a common currency, allow for cross-country comparisons by eliminating differences due to price levels, thus enabling a more meaningful analysis of GDP size (European Commission, 2024).
CI	The price of Internet access, expressed as a percentage of GDP per capita, was defined in euros for the cheapest mobile Internet offer with 50 GB of data, excluding additional services, available in the respective member country.
DI	The percentage of households with next-generation Internet (NGA) access includes technologies such as optical fibre, 5G, Wi-Fi 6, and LTE/4G Advanced.
SW	The average age of the population in the age range of 16-74.
ON	The percentage of individuals with disabilities (functional or health limitations) within the economically and socially active population aged 16-74 years old (European Commission, 2024).
SB	The unemployment rate, is the percentage of the labour force (the total number of employed and unemployed individuals), as defined by the International Labour Organization ILO (European Commission, 2024).
WW	The percentage of individuals with education beyond secondary level, classified according to the International Standard Classification of Education ISCED 2011 (European Commission, 2024).
SO	Percentage of individuals participating in training through online technologies, regardless of the subject matter (European Commission, 2024).
JO	Percentage of individuals with knowledge of at least one foreign language. The data is self-reported.
OW	Percentage of individuals residing in predominantly rural areas. A predominantly rural area is defined as one where more than 50% of the population lives in areas classified as rural, with a population density of less than 150 persons per km ² (Zysk; Żróbek-Różańska, 2015).

Source: own presentation based on Eurostat.

4. Results and discussion

As previously mentioned, the empirical analysis covered 27 European Union countries. A linear correlation analysis was conducted for 11 variables.

The results of the study, presented in Table 2, reveal a significant correlation between education in its broadest sense, the economic situation, and the level of digital skills in society. Research highlights the multifaceted nature of the digital skills gap, with studies such as those by Van Dijk (2005) and Helsper (2021) confirming that it is primarily driven by social, economic, and educational factors.

Table 2.

Correlation between selected variables; critical value (with two-sided 0.05 critical area) = 0.381 for n = 27

	DSI	PKB	CI	DI	SW	ON	SB	WW	SO	JO	OW
DSI	1	0,449 *	-0,254	0,049	-0,458 *	0,294	0,025	0,483 *	0,782*	0,353	-0,176
PKB	0,449 *	1	-0,521 *	0,364	-0,675 *	-0,219	-0,198	0,598 *	0,413*	0,226	0,053
CI	-0,254	-0,521 *	1	-0,169	0,443*	-0,126	-0,242	-0,406 *	-0,302	-0,290	-0,150
DI	0,049	0,364	-0,169	1	-0,308	-0,434 *	-0,155	0,036	0,050	-0,297	-0,269
SW	-0,458 *	-0,675 *	0,443 *	-0,308	1	0,099	0,146	-0,710 *	-0,412 *	-0,329	0,022
ON	0,294	-0,219	-0,126	-0,434 *	0,099	1	0,110	-0,007	0,144	0,303	0,161
SB	0,025	-0,198	-0,242	-0,155	0,146	0,110	1	0,106	0,134	-0,103	-0,131
WW	0,483 *	0,598*	-0,406 *	0,036	-0,710 *	-0,007	0,106	1	0,489*	0,490*	-0,106
SO	0,782 *	0,413 *	-0,302	0,050	-0,412 *	0,144	0,134	0,489 *	1	0,341	-0,167
JO	0,353	0,226	-0,290	-0,297	-0,329	0,303	-0,103	0,490 *	0,341	1	-0,003
OW	-0,176	0,053	-0,150	-0,269	0,022	0,161	-0,131	-0,106	-0,167	-0,003	1

* - statistically significant at the 0.05 significance level

Source: own compilation based on data from Eurostat.

Research underscores that GDP per capita and the cost of Internet access are key determinants of digital exclusion (OECD, 2020; Robles et al., 2021). While the correlation analysis in this study did not reveal a significant relationship between Internet costs and the level of digital competence, Van Deursen and Helsper (2015) identified Internet cost as a critical factor, particularly for lower-income households. The lack of significance in this study may be attributed to the relatively low cost of Internet access in EU countries, especially when compared to the overall wealth of the population (GDP per capita). In addition, data presented by the United Nations further highlight that cost remains a significant barrier to internet access, particularly in developing countries (UN, 2020). In some of these nations, the price of internet access can reach as much as 20% of GDP per capita, while the United Nations has set a goal to reduce this figure to 2% of GDP per capita by 2030. Instead, GDP per capita emerged as a significant variable, supporting Szeles' (2018) earlier findings, which emphasize the pivotal role of economic development in enhancing digital competence. A higher GDP facilitates improved digital infrastructure and greater accessibility to modern technologies, thereby reducing the extent of digital exclusion.

The results of the study indicate that both informal education (SO indicator) and the level of formal education (WW indicator) are correlated with the level of digital skills, as measured by the Digital Skills Index (DSI). Furthermore, the correlation between the tertiary education indicator (WW indicator), the online education level indicator (SO indicator), and the foreign language proficiency indicator (JO indicator) suggests that individuals with higher education are more likely to enhance their qualifications and possess stronger foreign language skills. This is also supported by OECD research (OECD, 2023), which shows that educational attainment has a significant impact on foreign language skills: 10% of individuals with tertiary education, 23% with upper secondary education, and 41% with at most lower secondary education are unable to speak any foreign language. The significant role of education in shaping digital competencies is strongly emphasised in the literature. Both formal and informal education, including competence upgrading and lifelong learning, significantly influence

citizens' digital skills (European Commission, 2023; Rosman et al., 2022). A key driver of upskilling is employment, as more than four-fifths (81.8%) of non-formal education and training activities undertaken by adults in the EU are work-related (Eurostat, 2023). These findings confirm previous research by Szeles (2018), which emphasized that education and the development of digital skills are crucial for the labour market.

The findings of the correlation analysis revealed a negative correlation between age and the level of digital skills. However, no significant relationship was found between the level of digital skills and other demographic factors, such as the percentage of people with disabilities or place of residence (rural vs. urban). The literature indicates clear differences in digital competence levels based on age and place of residence (Helsper, 2010; Szeles, 2018). Additionally, previous studies (European Commission, 2021; Stephens, Mankee-Williams, 2021) have emphasized the impact of place of residence on access to digital infrastructure. This represents a discrepancy, as the results of the current correlation study did not demonstrate such a relationship. On the other hand, the correlation between the demographic factor of average age and the level of digital competence was confirmed, which may be attributed to both cognitive barriers and a lower perceived need to use digital technologies among older individuals (Adamczyk, Betlej, 2021).

The lack of a significant correlation between technological factors and the level of digital competence observed in the study may indicate that, in the European Union, technological infrastructure has reached such an advanced level (92.90%) that it is no longer a significant differentiating factor. Consequently, the digital skills gap appears to be more closely linked to socio-economic factors rather than access to technology. In developed countries, educational policies and programs designed to equalize opportunities in technology use are thus becoming increasingly important.

In conclusion, a comparison between the study findings and previous research reveals a consensus on the importance of education and economic factors in shaping digital competence. However, discrepancies emerge regarding the impact of Internet costs and place of residence - factors considered significant in the literature - which did not exhibit strong correlations in the analysis. This may indicate that certain digital barriers, such as Internet affordability and NGA Internet access, have already been minimised, while disparities linked to education level and economic status continue to play a crucial role.

5. Conclusions and recommendations

This paper examines the factors that may be related to the level of digital competence in European Union countries. The results demonstrate a statistically significant relationship between digital competence and factors such as education level, wealth, and age. A positive

correlation is observed for education level and economic status, while a negative correlation is found for age. Based on these findings, policy recommendations can be formulated in the context of economic and social policy.

The rapid development of technology, combined with an inadequately effective digital education system, may lead to a situation in which individuals with basic digital competencies gradually lose the ability to use them effectively. This process occurs due to the challenge of adapting to the rapidly changing technological demands, resulting in a renewed deficit in digital competencies and their gradual decline. To address these dynamic changes, it is essential to develop and implement inclusive educational initiatives that are adapted to the needs of various social groups and encompass all stages of life. A key element of the strategy should include both foundational training and advanced programmes, ensuring that digital education facilitates effective and secure participation in the digital environment. Moreover, the effectiveness of these programmes requires their adaptation to the diverse needs that arise from differing levels of technological skills and varying capabilities in utilizing digital tools. Given the rapid obsolescence of acquired technological knowledge, such educational efforts should be continuous to maintain digital competence over time.

Significant attention should be given to the needs of older adults, who often encounter both technological and psychological barriers, such as fear of technology, uncertainty about their own competencies, or feelings of embarrassment when interacting with younger technology users. It is important to note that older individuals are not a homogeneous group. Distinctions exist between the so-called "third age" (60-75 years), which is characterised by greater independence, and the "fourth age" (75-85 years), in which health issues and dependence on care are more prevalent (Adamczyk, Betlej, 2021). An important issue is also the limited scope of research on the digital competencies and needs of older adults, which typically includes individuals up to the age of 74. In the context of an aging society, this results in a lack of knowledge regarding the digital skills and Internet usage of older individuals, potentially leading to restrictions on their access to health, social, administrative, and financial services. Consequently, designing effective programs to prevent social, digital, and financial exclusion among seniors becomes more challenging. Access to digital technologies among older adults is further restricted due to economic barriers and the inadequacy of technological tools for their specific needs. Therefore, it is crucial to implement solutions that ensure broad access to technology in public spaces, such as libraries, local authorities, or senior citizens' clubs, which would help to equalise opportunities for using modern digital tools, irrespective of one's financial situation or place of residence. At the same time, an important consideration is the adaptation of applications and user interfaces to address health issues commonly faced by older adults, such as impaired vision or hearing, while also enhancing their overall intuitiveness. This approach can help reduce barriers to technology use and combat digital exclusion within this demographic group.

Digital exclusion is typically examined in older individuals, people with disabilities, and those with low economic status. However, younger Internet users are also affected, although in a different manner. Despite widespread Internet access, many of them may lack the necessary digital competencies to adequately manage the risks associated with online activities, such as cybercrime, disinformation, and online harassment or hate speech. Education should emphasise the use of digital tools by both students and teachers, fostering the development of digital competencies, particularly in the areas of analysing and critically evaluating online information, as well as ensuring safe use of digital technologies. Digital education at the primary education stage should lay a solid foundation for the further development of digital competencies, supporting lifelong learning. Furthermore, those in the working age group require systematic support in adapting to rapidly changing technologies and continuously upgrading their skills, enabling them to meet the evolving demands of the labour market. However, the available training programmes, primarily offered by employers, often prove insufficient. Therefore, it is crucial to implement a comprehensive and accessible skills enhancement system that encompasses various social groups and ensures equal access to digital education, regardless of one's place of residence or professional status. It is also worth noting that the younger generation could play a key role in supporting older individuals in developing digital skills, especially in rural areas and regions with limited access to adult education. However, this intergenerational support may be impeded by the younger and middle-aged generations' lack of awareness of the psychological barriers that older individuals often encounter.

Government initiatives, such as e-services for administration, healthcare, social care, and education, despite their significant potential, often do not reach the most socially excluded groups. This is primarily due to the fact that effective access to these services requires basic digital competencies, which these groups frequently lack. Therefore, public institutions should not only require digital skills but also actively foster them. Furthermore, a significant barrier to the use of technology remains the fear of cybercrime and concerns regarding privacy and data security. For this reason, it is essential for the state and public institutions to engage in digital education and the fight against cyber threats. To effectively counter digital exclusion, it is crucial to ensure universal access to technological infrastructure and develop strategies that support groups at risk of digital marginalisation. Consequently, the implementation of comprehensive educational programmes is necessary, both at the national and local levels, including both online courses and in-person training. Particular emphasis should be placed on eliminating psychological barriers, such as fears of surveillance, data leaks, and online fraud.

The consequences of inaction in this area may include both the widening and deepening of digital, social, and economic inequalities. Thus, digital exclusion is not merely a technological issue but also a complex social and economic challenge that can affect not only marginalized groups but also broader segments of society to varying degrees. It is therefore necessary to take action to improve digital competencies throughout society and to eliminate psychological barriers related to technology and Internet use, such as fear of surveillance or the need to protect personal and financial data.

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A TAXONOMIC ANALYSIS OF SELECTED REGIONS OF EUROPEAN COUNTRIES IN TERMS OF IMPLEMENTATION OF SMART CITY COMPONENTS – A DYNAMIC APPROACH

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Purpose: The aim of the study is to: apply synthetic measures as a tool for quantifying the development level of selected Smart City components in European countries and determine the development level of selected Smart City components in European countries by means of the WAP (multivariate comparative analysis) tools.

Design/methodology/approach: The study examines the use of the Internet and information and communication technologies selected regions of European countries, with particular attention devoted to the period of the Covid-19 pandemic. Data were drawn from Statistics Poland and Eurostat, taking into account the thematic area of the study and data availability. The first stage of the analysis included the construction of a synthetic variable. The synthetic variable made it possible to compare the level of development of the phenomenon in selected regions in 2020, 2021, 2022, 2023 and 2024. Then, a distance matrix was determined. Taking into account the distance matrices from each year, a matrix of intensity indicators was determined for the entire period.

Findings: The study examines the use of the Internet and information and communication technologies in the regions of selected European countries. Taxonomic analysis is an effective tool for assessing the influence of factors on selected characteristics of the development of the studied phenomenon.

Research limitations/implications: The inability to create a set of comparable statistical data over many years is the main limitation of the analysis.

Originality/value: The presented taxonomic analysis of the phenomenon under consideration can be used to compare different objects (countries, provinces, municipalities) or to carry out comparative analysis of other aspects of the issue, and the results of these studies will contribute to further research in this area.

Keywords: taxonomic methods, Internet and ICT usage, COVID-19.

Category of the paper: Research paper.

1. Introduction

Modern times are characterized by extensive usage of internet of things, artificial intelligence, machine learning, big data, etc. as well as efforts to identify the needs of urban dwellers with the aim of improving their quality of life. The proper implementation of the smart city concept requires finding optimal development solutions. Cities undergo transformation due to economic and social globalization, metropolization and technological advancements. Modern cities have to continuously adjust their transformation to the ever-changing knowledge economy and knowledge society and the development of new technologies, which, in turn, are affected by the ongoing demographic, social and cultural changes, the emergence of new services, etc (Makowski, Kidyba, 2018). These processes have an impact on the development and transformation of cities, whose purpose is to fulfill complex socio-economic needs. Another significant factor driving urban transformation was the Covid-19 pandemic, which brought about social, economic and health crises. It inspired creativity and innovation in cities, contributed to the implementation of the smart city concept and the promotion of sustainable development solutions. The pandemic showed the necessity for safer digital ICT and IT solutions. It also accelerated and intensified the use of artificial intelligence in city management and e-commerce.

Smart city is one of the most common current buzz phrases. It is usually associated with the development and application of modern technologies. Big data is used on a large scale, which helps cities to develop. Technologies make cities safer, streamline their management, increase mobility, and have a positive impact on public health. On the other hand, a smart city can be a hindrance, e.g. when it lacks proper strategic management.

To sum up, the constant development of urban areas and the improvement of the quality of life of their inhabitants pose one of the major global challenges to urban policies.

The aim of the study is to:

- apply synthetic measures as a tool for quantifying the development level of selected Smart City components in the regions of European countries,
- determine the development level of selected Smart City components in the regions of European countries by means of the WAP (multivariate comparative analysis) tools.

2. The set of diagnostic characteristics of the problems under study

The Smart City issue covers many different thematic areas. Due to the lack of statistical data, it was necessary to limit the thematic scope of the data set. The analysis presented is the first stage of research taking into account data from the thematic area of the use and

implementation of modern technologies and the Internet. Modern technologies help to integrate all systems within an urbanized area and improve communication (Wi-Fi routers for residents). Due to the possibility of collecting data for the analysis, regions were included for the countries compared.

The basis for the analysis was the final set of diagnostic variables in the years 2024, 2023, 2022, 2021 and 2020 with particular emphasis on the Covid-19 pandemic. In summary, the analysis transferred the smart city issue in the selected topic to the regions due to the possibility of collecting data.

Data were drawn from Statistics Poland and Eurostat. The dataset includes the scope of the study and the availability of data. The diagnostic variables adopted in the present study are measurable and best describe the development of the analysed phenomenon. Based on the calculated values of the coefficients of variation and the results of verifying correlation analysis conducted by means of an inverted correlation matrix, the final set of diagnostic characteristics which describes the phenomenon was obtained (Młodak, 2006; Chomątowski, Sokołowski, 1978; Pocięcha et al., 1988; Panek, 2009; Zeliaś, 2004; Strahl, 1990; Malina, 2008; Mika, 1995) (in the description of the data are used “S” - stimulant):

x_1 – Number of households with access to the Internet at home – [%] (S),

x_2 – Number of individuals who ordered goods or services over the internet for private use – [%] (S),

x_3 – Number of Individuals who used the internet, frequency of use and activities [%] (S).

3. Measure of development

We consider the set of stimulants Q at the time $t = 1, \dots, T$. The development of the phenomenon is described in the form of a block matrix (Strahl, 1990):

$$[y_{kj}^{1t}; y_{kl}^{2t}]_{(m+n) \times TK} \quad (1)$$

where:

$t = 1, \dots, T, k = 1, \dots, K, j = 1, \dots, m, i = 1, \dots, n,$

y_{kj}^{1t} – the value of j -this variable,

y_{kl}^{2t} – the value of l -this variable.

The normalization is determined according to the formula (Strahl, 1990):

$$y'_{kj} = \frac{y_{kj}^t}{s_j} \quad (2)$$

where

$$s_j = \sqrt{\frac{1}{KT} \sum_{k=1}^K \sum_{t=1}^T (y_{kj}^t - \bar{y})^2} \quad (3)$$

The absolute measure at the moment t proposed by M. Cieślak is defined according to the formula (Strahl, 1990):

$$m_k^t = \sum_{j=1}^m y_{kj}'^t \quad (4)$$

While the measure in all the study periods is determined by the formula:

$$m_k = \sum_{t=1}^T m_k^t. \quad (5)$$

4. Determination of a synthetic variable - an empirical example

After normalizing the variables, we synthesize each of the selected groups of measures and calculate the synthetic variable. The analysis covered 177 regions for selected European countries (in the analysis for selected countries, smaller territorial units were also left, e.g. Spain), the time interval was 5 years (2024, 2023, 2022, 2021 and 2020), and the number of variables was 3 ($k = 3$, variables listed in the previous chapter and two research topics). Table 1 presents the calculated values of the synthetic variable for the selected regions in the analyzed years.

Table 1.

Determined values of the synthetic variable - 2020, 2021, 2022, 2023, 2024

	2020		2021	2022	2023	2024
	Region designation	Region				
1	NO06	Trøndelag	NL34	NO02	NL31	NL11
2	NO07	Nord-Norge	NO06	NO07	NL21	NL34
3	NL23	Flevoland	NO02	NO0	NL32	NL33
4	FI1B	Helsinki-Uusimaa	IE04	ES64	NO07	NL23
5	DK01	Hovedstaden	NO07	NL13	NO02	NL3
6	NL21	Overijssel	NO0	NL32	NL3	NL31
7	NL2	Oost-Nederland	NL31	NL34	NL23	NL32
8	DK04	Midtjylland	FI1B	NO06	NL34	NL41
9	DK03	Syddanmark	NL21	NL31	NL42	NL2
10	NL31	Utrecht	DK01	FI1B	NL4	NL22
11	NL22	Gelderland	DK04	NL11	NL41	NL4
12	NL32	Noord-Holland	IE06	NL41	NL2	NL21
13	NO0	Norge	NL2	NL21	NO0	NL1
14	NL13	Drenthe	NL3	DK01	NL13	NL42
15	DEE	Sachsen-Anhalt	NL32	NL3	NL33	NO07
16	SE1	Östra Sverige	NL23	NL4	NL11	NL12
17	NL12	Friesland (NL)	NL22	NL22	NL1	NL13
18	NL1	Noord-Nederland	NL13	NL2	NO06	NO02
160	BG4	Yugozapadna i Yuzhna tsentralna Bulgaria	RO2	RO4	HU32	PT3
161	PT11	Norte	BG41	RO41	ITF2	PT30
162	RO31	Sud-Muntenia	ITF5	RO22	BG4	BG4
163	ITF3	Campania	RO31	RO2	PT1	BG32
164	RO21	Nord-Est	RO41	ITF3	RO31	RO22
165	RO2	Macroregiunea Doi	PT11	RO31	RO22	RO41
166	ITF2	Molise	ITF	PT11	ITF4	ITF4

Cont. table 1.

167	ITF	Sud	ITF2	RO21	PT11	ITF5
168	RO22	Sud-Est	BG33	BG33	ITF	PT11
169	ITF4	Puglia	RO22	ITF5	ITF3	BG33
170	ITF5	Basilicata	BG4	ITF	BG42	BG3
171	BG33	Severoiztochen	ITF6	ITF4	BG33	ITF2
172	ITF6	Calabria	ITF4	BG42	BG34	ITF
173	BG42	Yuzhen tsentralen	BG32	BG32	BG3	BG42
174	BG34	Yugoiztochen	BG42	BG3	BG32	ITF3
175	BG3	Severna i Yugoiztochna Bulgaria	BG3	BG34	ITF5	BG31
176	BG32	Severen tsentralen	BG34	BG31	BG31	BG34
177	BG31	Severozapaden	BG31	ITF6	ITF6	ITF6

Source: based on own research (<https://ec.europa.eu/eurostat>)

Due to the large amount of data, the table presents the first 16 highest values of the synthetic variable and the last 16 lowest values.

In 2020, the first two places were taken by regions from Norway, followed by regions from the Netherlands, Finland and Denmark. The last five places are occupied by regions from Bulgaria. In 2021, the first place was taken by a region from the Netherlands, then two regions from Norway. The last places were the same as in 2020.

In 2022, the top three places were taken by regions from Norway. The last places were taken by the Italian region, and the remaining four places were again taken by regions from Bulgaria.

In 2023, the lead of the Dutch regions increased - the first three places. The positions of the last places remained unchanged - also in 2024.

In 2024, the first ten places were occupied by regions from the Netherlands.

5. Analysis of the intensity of distance changes over time

We construct the matrix of observations of diagnostic variables in year t and determine the standardization of variables. We determine the distances between objects in year t according to the formula (Nowak, 1990):

$$d_{ij}^t = \frac{1}{K} \sum_{k=1}^K |z_{ik}^t - z_{jk}^t| \quad (6)$$

We determine the distance matrix T :

$$D^t = \begin{bmatrix} 0 & d_{12}^t & \dots & d_{1N}^t \\ d_{21}^t & 0 & & d_{2N}^t \\ \vdots & & \ddots & \vdots \\ d_{N1}^t & \dots & & 0 \end{bmatrix} \quad (7)$$

To determine the intensity of changes in the level of distance between objects in the period $[1, T]$, we use an individual indicator of the intensity of changes in distance (Nowak, 1990):

$$v_{ij} = \frac{1}{T-1} \sum_{t=2}^T |d_{ij}^t - d_{ij}^{t-1}| \quad (8)$$

We calculate the assessment of the strength of changes in time in the level of distance between all objects in the period $[1, T]$ (Nowak, 1990):

$$v = \frac{2}{N(N-1)} \sum_{i=2}^N \sum_{j>i} v_{ij} \quad (9)$$

The lower the value of the v indicator, the more stable the distances between all objects in time.

6. Analysis of the intensity of distance changes - an empirical example

The analysis included as objects selected regions of European countries in 2020, 2021, 2022, 2023 and 2024 ($k = 177$). The diagnostic variables were presented in the previous chapter. Distance matrices were determined for each year. Due to the large dimension of the matrix (177 rows and 177 columns), it was not presented. The determined distance matrices made it possible to determine the matrix of individual change intensity indicators.

On the basis of the determined matrix of distance intensity change indicators, we can examine fluctuations in the development of the phenomenon during the analyzed period. Taking into account the values of the elements of the obtained matrix, we can conclude that the greatest fluctuations in the years 2020-2024 were the distances between the Italian region (ITF6) and the Belgian region (BE2) and between the Norwegian region (NO06) and the Belgian region (BG31), and then the German region (DED) and the Belgian region (BE1).

The most stable over time are the distances between the Norwegian region (NO07) and the Dutch region (NL2) and the Norwegian region (NO06) and the Dutch region (NL11). The results for the Polish region (PL9) were also examined. The greatest fluctuations were observed in this region with the Belgian regions (BG31, BG32, BG34), and Hungary (HU12). The distances between the Polish region and the Austrian region are the most stable. (AT34, AT33, AT31).

The value of the integral indicator determined over time is: $v = 0.198$.

This value means that there are significant fluctuations in the level of distance for all the regions analyzed. The reason may be the different development of the phenomenon in the analyzed regions (Nowak, 1990).

7. Conclusion

The aim of the paper was to:

- apply synthetic measures as a tool for quantifying the development level of selected Smart City components in the regions of European countries,
- determine the development level of selected Smart City components in the regions of European countries by means of the WAP (multivariate comparative analysis) tools.

The study covered the years 2024, 2023, 2022, 2021 and 2020, including the period of the Covid-19 pandemic. The first step in the study was to define a synthetic variable.

The synthetic variable can present a complex phenomenon by means of one variable. The synthetic variable represented the level of development of the analyzed phenomenon in the regions of the European countries in the selected years. The values of the synthetic variable also made it possible to rank the regions from the most advanced to the least advanced in terms of the phenomenon studied. The distance matrix was then determined for the years 2024, 2023, 2022, 2021 and 2020. The distance matrices also contain information on the distances between each of the regions selected for analysis.

Taking into account the distance matrix, it was possible to determine the intensity indicator matrix for the entire time period considered. To sum up, the taxonomic analysis tools selected in the analysis have made it possible to study the phenomenon both in one year and for a total of 5 years. The results obtained showed the level of development of the analyzed phenomenon in the regions in one period and in total over the entire period considered. Additionally, the information obtained made it possible to compare which regions are characterized by similar development and which are significantly different. The issue of smart cities is an important one that concerns us all. The analysis included a thematic area related to the use of modern technologies and the Internet. The results showed, among other things, that the Polish region was subject to the smallest fluctuations in distance during the period analyzed compared to the regions of Austria (after all, Vienna has been called the smartest city in the world). The results obtained make it possible to compare regions in European countries in terms of the level of use of new technologies and Internet penetration. In different countries with diverse economies and different economic, socio-cultural, technical, and administrative-legal conditions, certain regions may achieve a similar level of the analyzed phenomenon. Additionally, with the possibility of collecting a larger amount of data, and thus expanding the analysis, one can examine and identify factors and conditions that influence the achievement of a certain level of the phenomenon—while ensuring that regions and cities do not lose the uniqueness that makes them distinctive.

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ECONOMIC ANALYSIS OF DEEP THERMOMODERNIZATION OF THE BUILDING

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Purpose: The aim of this paper is to examine the multifaceted field of deep thermomodernization of the 11-storey hotel building located in Bialystok, with an emphasis on unraveling the complex interaction between energy efficiency and economic considerations.

Design/methodology/approach: Today, there are several methods used to gauge the most effective ways of cutting energy demand, including Simply Pay Back Time (SPBT), Pay Back Time (PBT), Net Present Value (NPV), Net Present Value Ratio (NPVR), Internal Rate of Return (IRR), and Dynamic Pay Back Time (DPBT). In Poland, studies mostly based on SPBT due to its precision and accuracy, which offers clearer and more reliable outcomes compared to other methods. However, combining multiple methods can enhance result clarity and reliability even further. During examination, we initially used SPBT to assess the impacts of energy-saving measures, resulting in clear and dependable insights into efficiency improvements.

Findings: Total energy gain after deep thermomodernization is 42%. It shows that after the implementation of deep thermomodernization, annual heating expenditures were reduced by almost half (by 41%). The simple payback time (SPBT) for individual thermal modernization projects ranged from 4,32 years for external walls to 15,41 years for external doors and 13.74 years for ventilated flat roof and 10,34 for windows.

Practical implications: Our research efforts have made our building more durable and valuable. Additionally, we have economized our building by minimizing energy consumption and reducing annual heating costs as much as possible.

Social implications: Deep thermomodernization can reduce energy costs, increase environmental awareness, and improve quality of life by increasing society's energy efficiency. This can reinforce a sense of social responsibility and shape environmental policies. Change can be achieved in the industry by encouraging it through public policy.

Originality/value: Research has shown that as technology advances, it should also be reflected in the construction sector. Instead of demolishing old buildings and rebuilding, which is costly and environmentally unfriendly, deep thermomodernization offers a more economical and eco-friendly solution for renovation. Calculations and comparisons have pointed to its effectiveness.

Keywords: Energy savings, investment costs, economic analysis.

Category of the paper: Research paper.

1. Introduction

In today's global pursuit of sustainable development and climate action, deep thermomodernization is emerging as a compelling strategy in the built environment. This comprehensive approach to renovating or retrofitting buildings aims not only to reduce carbon emissions, but also to increase energy efficiency and resilience to climate impacts, with the main aim being to minimize energy loss and reduce heating costs. However, the decision to deep thermomodernization involves complex economic considerations, ranging from initial investment costs to long-term financial returns and financing mechanisms for such projects.

This article discusses the economic analysis and importance of deep thermomodernization, aiming to explain the complexities, challenges and transformative impact potential in structures. Examining the costs, benefits, and systemic consequences of deep thermomodernization initiatives, this analysis aims to provide information that can inform policy formulation, guide investment strategies, and inspire innovative solutions to address both environmental and economic imperatives.

Deep thermomodernization involves fundamental changes to a building's structure and systems. This approach is applicable to all buildings, regardless of age, to deliver lasting energy savings, reduce environmental impact and increase actual property value. The European Union has set ambitious targets for building renovations to meet energy efficiency standards, with initiatives such as the "Clean Energy for all European Union countries" package. In Poland, the Long-Term Building Improvement Strategy outlines deep thermomodernization plans targeting near-zero energy building standards and increased use of renewable energy sources. Engineers and planners must carefully balance energy efficiency with economic viability, considering factors such as construction materials, design complexity, and long-term sustainability.

2. Methods used in the building thermomodernization proces

The methods used in the building thermomodernization process include a variety of techniques aimed at increasing energy efficiency and reducing environmental impact. Here are some common methods used in this process.

Insulation upgrades: Insulation upgrades is known as the application of materials that reduce or prevent heat transfer between the interior and exterior of buildings and increase thermal performance.

- External wall insulation.
- Internal wall insulation.
- Roof insulation.
- Floor insulation.
- Cavity wall insulation.

Window and door upgrades: Changing or improving windows and doors is an important detail to minimize heat transfer, air leakage and increase overall energy efficiency.

- Double or triple glazing.
- Low-e coatings.
- Insulated doors.
- Weather stripping.

HVAC system upgrades: It refers to upgrading or optimizing heating, ventilation and air conditioning (HVAC) systems to improve energy efficiency, indoor air quality and overall system performance in buildings.

- High-efficiency furnaces.
- Heat pumps.
- Programmable thermostats.
- Zoned heating and cooling.

Renewable energy integration: The incorporation of renewable energy sources, such as solar panels or wind turbines, to generate electricity for a building, reducing dependence on non-renewable sources.

- Solar photovoltaic (PV) panels.
- Solar thermal systems.
- Wind turbines.
- Geothermal heating systems.

Smart building technologies: It refers to the application of advanced technologies such as smart thermostats and automatic lighting systems to manage and optimize building operations for increased energy efficiency in buildings

- Building energy management systems (bems).
- Smart thermostats.
- Automated lighting controls.
- Occupancy sensors.

Green roof installation: Green roof is known as the addition of vegetation to the roof surface of a building, providing insulation, absorbing rainwater and providing environmental benefits.

- Extensive green roofs (mainly vegetation).
- Intensive green roofs (include a variety of plants).
- Roof gardens.

Facade renovation: It is the process of improving or changing the external appearance of a building to improve insulation in structures, eliminate thermal bridging problems and improve overall energy performance.

- External cladding.
- Thermal bridge reduction.
- High-performance facade materials.

Thermal mass integration: Incorporating materials with high thermal mass to absorb, store, and release heat, contributing to temperature regulation and energy efficiency

- Use of high thermal mass materials.
- Thermal mass placement for temperature regulation.

Each of the above methods addresses different aspects of deep thermomodernization of buildings, and the selection of specific methods should take into account the characteristics of the building, the local climate and the desired level of energy efficiency.

3. Materials used in thermomodernization

Thermomodernization of buildings involves the use of various materials to enhance the energy efficiency, insulation, and overall performance. More than 40 types of major thermal insulation materials are available worldwide. Based on the types of raw materials used, these thermal insulation materials can be divided into two broad groups: organic (carbon-based) and inorganic (lacking carbon-hydrogen bonds, mineral) insulations.

Organic materials, non-organic materials, and HI-TECH materials insulations can be further subdivided into natural and synthetic insulations based on the sourcing of raw materials and their processing. Here are some common materials used in thermomodernization.

Expanded Polystyrene (EPS) Insulation: A thermal insulation made from expanded polystyrene beads, manufactured by heat-expanding the beads using high-pressure steam. It's commonly used in construction due to its lightweight and insulating properties.

Extruded Polystyrene (XPS) Insulation: Another type of thermal insulation made from polystyrene, manufactured by mixing beads with additives and a blowing agent in an extruder. The resulting foam is shaped, cooled, and cut to size.

Polyethylene (PE) Insulation: Also known as PE foam, used primarily for insulating pipes and soft packaging. It's made from polymerized ethylene and various catalysts, extruded into foam form.

Spray Foam Insulation: A type of insulation applied as a spray, expanding to fill gaps and cavities. It can be closed-cell or open-cell foam and is known for its effectiveness but has faced health and environmental concerns.

Structural Insulated Panels (SIPs): Composite panels with thermal insulation, increasingly used in construction for faster building. They consist of two sheets of wood or steel with insulation bonded between them.

Magic Wallpaper and Thermal Paint: Thin coatings claimed to mitigate condensation, made from various aggregates, resins, and additives like expanded polystyrene, carbon black, or graphite.

Hemp-Lime Insulation (Hempcrete): A biocomposite insulation and wall material made from hemp fibers and lime. It's considered carbon-negative due to the sequestration of more carbon by hemp plants than emitted during production.

Mineral Wool Insulation: Made from rock or glass wool, known for its thermal and acoustic insulation properties. It's widely used in construction.

Polyisocyanurate (PIR) and Polyurethane (PUR) Insulation: Closed-cell plastic foam insulation produced from polyol and isocyanate. Used in areas with limited space due to its high insulating efficiency.

Sheep Wool Insulation: A niche product made from sheep wool, known for being hygroscopic (adsorbing moisture) yet hydrophobic (repelling liquid water).

Phenolic Insulation Boards: Known for their high thermal efficiency and fire safety, made from phenol, urea, and melamine-formaldehyde polymers.

Cotton Waste Insulation: Made from recycled textile fibers like cotton, wool, and denim waste. It's eco-friendly and available under various product names.

Aircrete (Aerated Concrete and Autoclaved Aerated Concrete): Lightweight concrete blocks with better thermal performance than traditional blocks, made from pulverized fuel ash with added cement, lime, and a foaming agent.

Insulating Clay Bricks: Similar to regular clay bricks but with honeycomb air holes for insulation. Used to enhance thermal performance in building envelopes.

Glass Wool Insulation: Made from glass fibers arranged with a binder, offering both thermal and acoustic insulation properties. Widely used in construction.

Thermal Break Windows and Doors: Feature insulating materials between interior and exterior surfaces to minimize heat transfer, reducing energy loss.

Wood Fibre Insulation: Provides insulation and a natural aesthetic, chosen for sustainability and design versatility. It's known for its high moisture buffer and moderate thermal conductivity.

Waterproof Membranes: Essential for preventing water infiltration into building structures, ensuring the integrity of roofs.

The materials which are using during thermomodernization could save the energy and extends the life of the building. Beside this it makes the building more economical for the future and increases value of the building.

4. Case study of the economic profitability of the thermal modernization process

Rotary House ul., also known as Assistant Hotel. Zwierzyńska in Białystok is an important architectural building affiliated with the Białystok University of Technology. The design and development of this building has been meticulously documented over the years, providing a historical summary of its architectural evolution and various changes. Information about the building was obtained from the energy audit of the building (Sadowska, Sarosiek, 2018).

4.1. Description of the building selected for analysis and of the existing state

The first architectural design of the Rotary House was prepared by the General Construction Design Office in Warsaw in 1978. This basic document outlines the structural aspects and plan of the building, capturing the essence of its original design. Meticulous details from this period provide a glimpse into the architectural trends and ideas prevalent in the late 1970s.

One of the critical aspects of the building, as documented in existing design materials, is the central heating installation. The 1978 design includes plans and specifications for the heating system, which is an integral part of the comfort and functionality of the building. The centrality of this system is a testament to the foresight in providing a conducive environment within the Assistant Hotel.

Fast forward to 2006, Rotary House is undergoing a modernization project for its warming center. This initiative reflects the determination to keep pace with technological advances and meet the evolving needs of the facility. Documents from this period shed light on the engineering considerations and innovations used in improving heating infrastructure.

In 2013, the focus shifted to sustainable energy solutions with the construction design of a solar hot water installation. This forward-looking approach is in line with contemporary environmental awareness and emphasizes the integration of renewable energy sources into building systems. In addition, the partial demolition and construction of the new lightning protection facility underlines the commitment to safety and compliance with modern standards.

The involvement of the plumbing design studio further highlights the collaboration of specialized professionals in the development of the building's infrastructure. Their contributions in June 2013 were instrumental in resolving water supply issues and ensuring the safety of building occupants through an improved lightning protection system.

The commitment to energy efficiency is even more evident in the intention to implement the measures proposed in the energy audit (Sadowska, Sarosiek, 2018) carried out in accordance with the Law of 21 November 2008 on the promotion of thermal modernization and renovation (Act of 21 November 2008...). This proactive measure is in line with contemporary practices in ensuring sustainable and cost-effective building management.

The declared maximum self-contribution of 0% and the loan option covering 100% of the total planned costs demonstrate a strategic financial approach to the modernization project. This financial structure creates comprehensive improvement opportunities without placing an undue burden on the investor's immediate financial resources.

The building, also designated as a Mass Housing building, was built in 1979 and was officially opened for use in 1980. Prefabricated materials were used in the construction of the building, which was a common practice in such structures at that time.

The Mass Housing building, consisting of a total of 120 flats, provides housing opportunities for a significant number of residents. The estimated occupancy rate of the building is around 217 people (Sadowska, Sarosiek, 2018). The decision to embark on deep thermomodernization processes demonstrates a commitment to improving the energy efficiency and overall environmental performance of the building in line with contemporary standards and regulations for sustainable and resource-efficient construction.

Ultimately, the Rotary House is a testament to architectural evolution and adaptability. From its founding in 1978 to its most recent modernization efforts, the documentation and collaborative efforts of professionals reflect the dedication to maintaining a state-of-the-art facility. Integration of sustainable energy solutions, adherence to building standards, and financial planning strategies position Rotary House as a model for responsible and forward-thinking building management in academia.

4.2. Selection of methods to reduce energy demand

Today, there are various methods available for determining the most effective ways to reduce energy demand. Among these methods are Simply Pay Back Time (SPBT), Pay Back Time (PBT), Net Present Value (NPV), Net Present Value Ratio (NPVR), Internal Rate of Return (IRR), and Dynamic Pay Back Time (DPBT).

While there are numerous methods to choose from, studies conducted in Poland predominantly utilize Simply Pay Back Time (SPBT). This method is favored because it offers more precise and accurate results. However, employing multiple methods can lead to even more precise outcomes than those obtained through singular calculations, enhancing the clarity and reliability of the results.

In our examination of a building, we began calculating the effects of changes using Simply Pay Back Time (SPBT). This allowed us to obtain clear and reliable results, providing valuable insights into the efficiency of energy reduction measures.

Thermal conductivity or U-value measures how much heat passes through building materials. Lower U-values indicate better insulation, which translates to energy savings, improved comfort, and compliance with regulations. Investing in high-quality insulation with low U-values ensures sustainable and cost-effective buildings. The values seen in the table show the pre-thermomodernization values of our current building. As understood from the values, it can be seen that our building is old and energy savings are significant.

Table 1.*Thermal transmittance of partitions before thermomodernization*

Building Element	For the Existing Building 'U' = (W/(m ² .K))
Warm ceiling downwards	0,783
Ventilated flat roof	0,422
External walls of staircases (rounded part)	0,403
External wall first floor	1,122
External wall(ground floor)	1,267
Window (For ground floor)	2,6
Window (For all another floors)	2,6
Doors	3

Source: Own study.

The deep thermomodernization process aims to provide solutions to these problems. This process aims to reduce energy consumption by increasing the energy efficiency of the building and therefore reduce operating costs. Therefore, examining the data obtained after deep Thermomodernization is of great importance. This data will help us evaluate the effectiveness of improvements made and guide future decisions.

Table 2 contains information on the results of thermal modernization. It has been determined that the energy consumption of the existing building and the cost spent on heat are quite high annually when taken into account before deep thermomodernization. Total annual energy consumption was calculated as 1,870,884.18 kWh. This shows that the current structural condition of the building is not energy efficient and causes unnecessary energy losses.

Table 2.*Results of the economic analysis for existing stage*

Energy Needs	Unit	Before Thermomodernization
Energy needs for heating	kWh/year	1 196 266,43
	GJ/year	4306,56
Heat for domestic hot water	kWh/year	674 617,75
	GJ/year	2 428,62
Total energy needs	kWh/year	1 870 884,18
	GJ/year	6 735,18
Annual cost of heat supplied	PLN/year	466 658

Source: Own study.

In the same period, the annual cost of the building for heating was determined as 466,658 PLN. The high cost highlights the inefficiency and energy waste of current heating systems. This increases the operating costs of the building and creates an unsustainable situation in the long term.

According to the calculations made before Deep Thermomodernization on our current building, it was determined that our building was classified as B2 in terms of energy efficiency. This implies that our current building regulations falls within the B2 energy efficiency class according to building regulations.

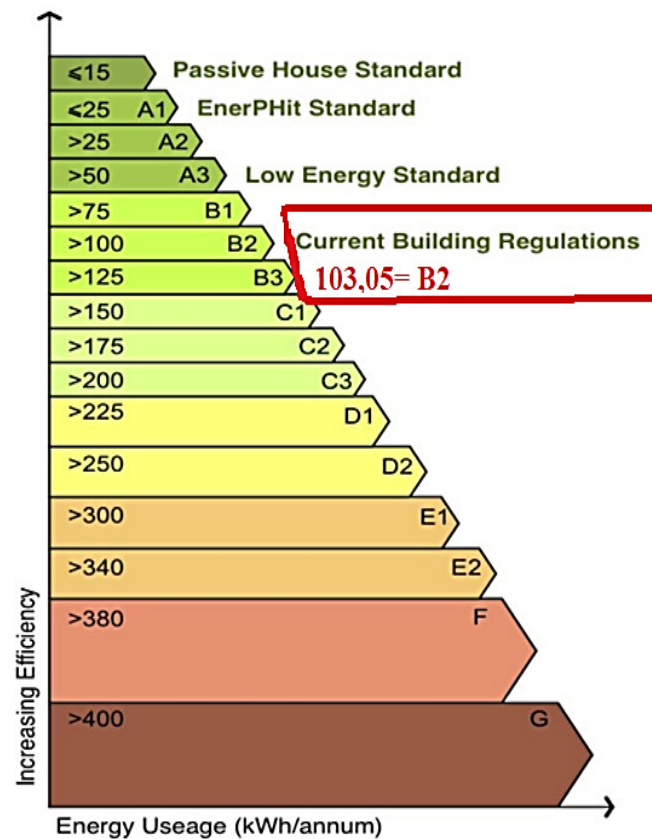


Figure 1. Classification of building before deep thermomodernization.

Source: Own study, <https://termomodernizacja.pl/klasy-energetyczne-sprawdz-w-ktorej-bedzie-twoj-dom/>

Energy classification is typically used as a measure to assess buildings' energy consumption and efficiency. The B2 class usually indicates buildings with moderate energy efficiency. Thus, it means that our building's energy consumption is at the current level and could be made more efficient. Such classification helps identify the need for improvements aimed at energy savings and reducing environmental impact.

4.3. Determination of energy saving in individual thermal modernization variants and economic analysis

Let's examine the economic changes that occur after deep thermomodernization is carried out in our current building. The comprehensive scope of thermomodernization activities for the optimum scenario encompasses a series of measures aimed at enhancing a building's thermal performance and energy efficiency. These measures are designed to strengthen the building envelope and optimize energy consumption.

Initially, an energy study and assessment are conducted. This involves analyzing the current energy usage and identifying potential energy losses within the building. Subsequently, improvements are implemented on the building's exterior. This includes selecting high-performance insulation materials and installing external insulation systems to increase thermal resistance.

Table 3.*Thermal transmittance of partitions After Deep thermomodernization*

Building Element	For the Existing Building 'U' = (W/(m ² .K))	After renovation 'U' = (W/(m ² .K))
Warm ceiling downwards	0,783	0,783
Ventilated flat roof	0,422	0,15
External walls of staircases (rounded part)	0,403	0,2
External wall first floor	1,122	0,2
External wall(ground floor)	1,267	0,2
Window (For ground floor)	2,6	0,9
Window (For all another floors)	2,6	0,9
Doors	3	1,3

Source: Own study.

Regarding the roof, the modernization process requires updating or installing insulation for flat or pitched roofs, focusing on ensuring adequate ventilation. Additionally, windows and doors are replaced or upgraded to energy-efficient models. This may involve installing glazed windows with low-emissivity coatings and improving door sealing mechanisms to minimize heat loss and improve overall thermal efficiency.

As a result of our investigations, we determined that the current heat permeability coefficient of the building is significantly lower than the standards it must meet after renovation. In reality, all the values we reviewed are well below the required standards.

This situation shows in the table above how important the renovation work is for our building. After the renovation, we focused on minimizing heat loss. In this process, the standards in Bialystok, Poland were taken into account.

Table 4.*Results of the economic analysis after thermomodernization*

Energy needs	Unit	Before thermomodernization	After thermomodernization
Energy needs for heating	kWh/year	1 196 266,43	706 476,60
	GJ/year	4306,56	2543,3
Heat for domestic hot water	kWh/year	674 617,75	674 617,75
	GJ/year	2 428,62	2 428,62
Total energy needs	kWh/year	1 870 884,18	1 381 094,35
	GJ/year	6 735,18	4 971,92
Annual cost of heat supplied	PLN/year	466 658	275,597.30

Source: Own study.

Table 4 shows the annual energy demand for heating before and after thermal modernization. With the application of all considered treatments, energy demand was reduced by 42%. This shows how important deep thermal insulation is and that energy losses should be minimized in every building. Since no improvements have been made to this system, no changes have been made to the domestic hot water heating processes.

Following the implementation of deep thermomodernization, a significant reduction in the total annual heating cost was seen. The annual heating cost, which was originally 466,658 PLN, has now dropped to 275,593.30 PLN. This success shows that annual heating expenditures were reduced by almost half (41%) after the implementation of deep thermomodernization.

The data collected highlights the effectiveness of deep thermomodernization in preventing heat loss and improving energy efficiency. Research findings show that this technology not only significantly reduces operating costs but also carries the potential for long-term energy savings in the future.

In this context, it can be concluded that deep thermomodernization is a significant long-term investment. It not only optimizes costs, but also contributes to environmental sustainability by minimizing heat loss and increasing energy efficiency. We believe that our efforts to minimize heat loss and increase energy efficiency are an important step towards optimizing operating costs and reducing environmental impact

Conclusions

1. Deep thermomodernization of the casing of the 11-story Rotary House of the Asystenta Hotel at the Białystok University of Technology campus, including thermal insulation of walls, roof and replacement of windows and doors, allows for energy savings of 42%.
2. The greatest percentage of energy savings was achieved by insulating the external walls 23%, followed by replacing windows 16,5%, ventilated flat roof improvement about 2%, and replacing doors 0,5%. The total exchange after deep thermomodernization is 42%.
3. After taking into account the amount of heat for preparing domestic hot water (constituting a significant share in the total heat demand), the percentage savings as a result of thermal modernization would amount to 26.2%.
4. The simple payback time (SPBT) for individual thermal modernization projects ranged from 4,32 years for external walls to 15,41 years for external doors and 13.74 years for ventilated flat roof and 10,34 for windows.
5. After the application of deep thermomodernization, the total annual cost for heating has seen a significant reduction. The yearly heating cost, which was initially 466,658 PLN, has now decreased to 275,593.30 PLN. This achievement indicates that annual expenditure on heating has nearly halved (by 41%) following the implementation of deep thermomodernization.

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ANALYSIS OF THE USE OF SUSTAINABLE MANAGEMENT IN GRAND CHALLENGE PROJECTS

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Purpose: analysis of the potential for introducing sustainable project management into grand challenge projects, using IT and R&D projects as examples.

Design/methodology/approach: qualitative research in a case study research strategy was applied. Two types of projects were studied: IT projects (here a single holistic case study was used, where the data collection technique was individual interviews), R&D projects (here a multiple embedded case study was used, where the data collection technique was diada interviews).

Findings: there is considerable potential in grand challenge projects to implement sustainable project management practices. However, there is currently a lack of consistency, standardisation and integration with the strategic objectives of the organisation, which limits the effectiveness of the activities. There is a need to structure the approach, adapt the practices to the specifics of the projects and promote education and awareness.

Research limitations/implications: small number of cases, specificity of grand challenge projects, subjective selection of cases, interpretation of data, limitations of data collection technique.

Practical implications: identifying recommendations for organisations implementing grand challenge projects: standardising approaches to sustainable project management, educating and raising awareness of the importance of sustainable project management, adapting processes to the specifics of projects, integrating with the organisation's strategic objectives, monitoring and reporting progress, working with partners.

Social implications: the direction of change in sustainable project management is now being set by individuals with the knowledge and skills to deliver projects using sustainable methods. Applying the recommendations identified from the research should allow organisations to grow economically without negative social and environmental impacts.

Originality/value: linking the theme of sustainable project management to the theme of project management in grand challenge projects.

Keywords: sustainable project management, grand challenge projects, IT projects, R&D projects.

Category of the paper: research paper.

1. Introduction

1.1. Explaining the importance of sustainable project management (SPM)

One of the most widely used definitions of sustainability is that sustainability is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Komisja Brundtland, 1987). In 2008, the World Congress of the International Project Management Association (IPMA) highlighted the need for project managers to take responsibility for sustainability. At the time, sustainability was still in its infancy. It was beginning to be recognised that the Earth was facing serious threats, so sustainability was necessary to ward them off. It was concluded that sustainable development required a concerted effort to build a sustainable and disaster-resistant future for the whole world (Silvius et al., 2012). In 2009, it was noted that sustainability was not being taken into account in programmes and projects, highlighted the gap that had been created and that this gap needed to be filled (Gareis, Huemann, Martinuzzi, 2013). Authors Silvius and Tharp in 2013 observed that there has been an increased interest and implementation of sustainability in projects. They concluded that the sustainability trend is interesting, but that it comes with challenges that need to be addressed. These challenges bring with them the need to accurately define the prevailing concepts in sustainability (Silvius, Tharp, 2013). Over the past decade, the definition of sustainability has changed and many organisations have had to re-evaluate the activities they undertake in order to meet the challenges and adopt appropriate practices to benefit society and the environment. It has become necessary to make changes in project management to meet the demands of contemporary management strategy (Carboni et al., 2021).

Sustainability comprises three pillars: economic, environmental, social. The intention of sustainable development is that these pillars are interlinked and influence each other. Created in 2015, the 2030 Agenda, UN member states adopted a global action plan with 17 Sustainable Development Goals (Figure 1).



Figure 1. Sustainable development goals.

Source: THE 17 GOALS | Sustainable Development (access: December 2024).

Organisations need to make changes in order to achieve sustainability, and change is realised through projects. The important role of projects in the transition to sustainability for companies, organisations and societies calls for a rethinking of how projects are planned, organised, implemented, managed. As a result, the concept of sustainable project management (SPM) has gained much recognition among researchers and practitioners and is being included in an increasing number of studies (Barendsen et al., 2021). Projects generate 30 per cent of global GDP, there is a need to rethink the impact, process efficiency and long-term results delivered by projects (Bednarczyk, Leśniowski, Palarczyk, 2021). Projects are closely linked to sustainable management, but the topic of practical implementation of sustainable management is only just being considered by organisations. The PRiSM™ methodology is prominent (Carboni et al., 2021). Ongoing global environmental and social changes are driving new directions in project management and the running of organisations. A sustainable management approach combines efficiency, productivity, environmental concerns and social and economic aspects. The directions of change in sustainable project management are now being set by individuals with the knowledge and skills to deliver projects using sustainable methods. The sustainable project management model used should allow organisations to grow economically without negative social and environmental impacts.

1.2. Introduction to the concept of Grand Challenge (GC) projects

Grand Challenges in the literature are defined as "global problems that can be solved through a coordinated and concerted effort" (George et al., 2016) or "specific critical barriers that, if addressed, will help solve an important social problem with a high probability of global impact through widespread implementation" (George et al., 2016; Grand Challenges Canada, 2011). Grand Challenges include the world's most pressing issues, such as poverty, social protection, global pandemics, sustainability transformation, migration, human rights, urban planning, affordable housing, precarious work and livelihoods, food security and effective states (Etzion et al., 2017; Fukuda-Parr, Muchhala, 2020; Ika et al., 2020; Howard-Grenville, 2021; George et al., 2024). Addressing grand challenges typically involves intervening in both current situations and uncertain futures (Whyte, Mottee, 2022), through 'grand challenge projects' (Ika Munro, 2022; Locatelli et al., 2023). Driven by the impulse to 'save the world from the harmful threats posed by grand challenges' (Ika, Saint-Macary, 2023), policy makers are often drawn to such projects, which may be the logical next step after major policy initiatives (Sanderson, Winch, 2017). In general, grand challenge projects can be interpreted as time- and financially-limited interventions, often implemented as part of a portfolio of national development plans or programmes aligned with sustainable development. Additionally, they have an additional characteristic: the concept of a 'mega-project' contrasts with the typical definition of a project as a temporary endeavour undertaken to deliver a unique product, service or outcome. A 'grand challenge project' cannot be expected to fully solve a particular problem once and for all, as it tends to generate its own set of challenges due to its high level of

complexity and uncertainty and its focus on the long term, as well as the social, political and ethical struggles involved (see Winch et al., 2023 and Ika, Munro, 2024). In summary, grand challenge projects are characterised by: complexity and multidimensionality, long-term goals and global reach, high risk and uncertainty. In grand challenge projects, there is often a lack of standardised solutions, a need for cross-sectoral and/or international collaboration, a need to involve different stakeholders.

1.3. Definition of the main research problem and the aim of the analysis

Today, the topic of sustainability is no longer just a trend, but has become a key part of our reality. Social inequalities, climate change, which are worsening, contribute to the commitment of businesses to sustainability. It requires a concerted effort by businesses around the world in building a sustainable and resilient future for all people and the planet. For sustainability to be achieved, three key elements need to be coherent: environmental, social and economic. These are interconnected and are all vitally important to achieving the wellbeing of individuals and society as a whole. Sustainable project management is an increasingly popular approach in various industries, both nationally and internationally (Carboni et al., 2021).

The aim of this article is to analyse the potential for introducing sustainable project management (SPM) into grand challenge (GC) projects. For the objective thus formulated, the following research questions were posed:

- RQ1: What is the understanding of sustainability and sustainable project management among grand challenge contractors?
- RQ2: Do differences in the type of activities of grand challenge organisations (e.g. IT, R&D) affect the implementation of sustainable project management?
- RQ3: To what extent are aspects of sustainable project management included in grand challenge projects and what is staff awareness of this?

Qualitative research was carried out to achieve the objective. Two types of projects were studied: IT projects (here a single holistic case study was used, where the data collection technique was individual interviews), R&D projects (here a multiple embedded case study was used, where the data collection technique was diada interviews). The case studies were shaped to meet the characteristics of grand challenge projects, at the same time IT and R&D projects have many consistent characteristics, including one of the most important - the uncertainty of achieving the planned results.

2. Methodology

As mentioned in Chapter 1, two case studies of different types were carried out for projects representing the grand challenge project type. The first case study concerned IT projects and the second case study concerned R&D projects. Table 1 presents an assessment of the organisations studied, and in particular the projects they carried out, in terms of the characteristics of grand challenge projects.

Table 1.

Checking whether the IT and R&D projects are grand challenge projects

	Characteristic - complexity and multidimensionality	Characteristic - need for cross-sectoral and/or international cooperation	Characteristic - need to involve different stakeholders
Single holistic case study (IT projects)	✓	✓	✓
Multiple embedded case studies (R&D projects)	✓	✓	✓

Source: own work.

IT companies are important in the modern economy and thus have a major impact on it and on the environment or society. Nowadays, by implementing environmentally and socially friendly IT practices, it is possible to achieve sustainability goals. The concept of sustainability in IT is an approach that takes into account its impact on the environment, society and the economy. The concept of sustainability and sustainable project management in the IT industry is emerging in the literature (Clinning, Marnewick, 2017), although at a slow pace, which may raise questions about the state of sustainability in the IT industry, in projects implemented in the industry and what actions are being taken in this direction.

R&D projects can also be managed sustainably (Schimpf, Binzer, 2012), and this approach is becoming increasingly popular, especially in the context of growing environmental and social awareness. Sustainable management in R&D projects means taking into account economic, environmental and social aspects at every stage of the project, from planning to implementation. For a more in-depth justification of the assessment results from Table 1, see subsections 3.1 and 3.2 of this article.

2.1. Single holistic case study - for IT projects

The data in this single holistic case study was collected through semi-structured interviews and analysis of internal documentation. The interviews were conducted online and were recorded. Company X, the unit of analysis, is a market-leading company providing services and technology solutions to investment and pension funds, insurance companies and banks, providing the following services: transfer agent, fund accounting and valuation, corporate accounting, IT solutions and managed services. Interviews were conducted to gather

information on the feasibility and benefits of applying sustainable project management to an IT company:

- Interview with the head of the AML department¹ at company X,
- two interviews with managers of various IT projects that produce software at Company X,
- interview with a director at company X.

2.2. Multiple embedded case studies - for R&D projects

The characteristics of the multiple holistic case study are presented in Table 2. The interviews conducted in this case study were diada type interviews, six pairs of respondents/respondents were interviewed: manager + team member. The interviews were conducted by a moderator using an instant messenger. The case studies were selected to ensure literal and theoretical replication. According to recommendations formulated by R.K. Yin, each case study should be carefully selected to assume similar outcomes (literal replication) and different outcomes but for predicted reasons (theoretical replication) (Yin, 2014). Literal replication means selecting two (or more) cases because of the predicted similarity of their outcomes. Theoretical replication is the selection of two (or more) cases due to their expected different outcomes for predicted reasons. To ensure theoretical replication, large organisations were selected for the multiple immersion case study (the number of people employed was taken as a criterion for allocating projects to this group). Public sector organisations (universities) were selected to ensure theoretical replication.

Table 2.
Characteristics of a multiple holistic case study - R&D projects

Cases examined	Description of a multiple case study - R&D projects			
	Interview	Implementing organisation	Company size	Industry
Case 1	Analysis department project team in a large organisation	Research and development projects	More than 50 people	Telecommunications
Case 2	Research project team at a public university	Research and development projects	More than 50 people	College
Case 3	A project team specialising in the management of projects from EU funds	Research and development projects	Micro, up to 9 people	Project management, consulting
Case 4	Research team in a large marketing corporation	Mainly research projects, less frequently R&D projects	Corporation, over 50 people	Marketing, consulting
Case 5	A team of academics dedicated to a large ecology and the environment	Mainly research projects, less frequently R&D projects	Over 50 persons	College
Case 6	Team at a market research company	Mainly research projects, less frequently R&D projects	10-49 persons	Market research, marketing

Source: own work.

¹ AML is anti-money laundering and counter-terrorist financing.

2.3. Type of data analysis adopted in the case studies carried out

In qualitative case study type research, different types of data analysis can be used to allow in-depth interpretation of the information collected. The case studies conducted used thematic analysis of the data. Thematic analysis involves identifying and interpreting patterns (themes) in the data. The researcher codes the data to create thematic categories, which are then analysed to understand the key themes in the study. It is useful when the aim is to understand the main themes or narratives present in the case study.

3. Feasibility of using SPM in GC projects

3.1. Results for single holistic case study - for IT projects

3.1.1. Description of results (IT projects)

Company X has joined the UN Global Compact Network Poland and undertakes sustainable development initiatives that have an impact on the environment. Company X's group of companies is convinced that development is always based on creating a responsible business guided by best practices that accompany daily work, which are reflected in ESG principles. Company X's ESG programme is implemented through designated principles relating to the environment, social responsibility, corporate governance.

The company undertakes initiatives to promote greater environmental responsibility. In the X corporate group, a precautionary approach to environmental problems is actively encouraged, initiatives are taken to promote greater environmental responsibility and the development and dissemination of environmentally friendly technologies is supported. The company is committed to environmental protection and dedicates resources to planting trees, thus being able to meet its goal of reducing CO₂ emissions. In order to achieve its goal, the company participates in environmental initiatives and projects carried out by volunteers to plant trees throughout Poland and to support all initiatives that restore tree stands in Polish forests. The company also implements an initiative - 'Green office', with waste sorting, use of recycled paper, elimination of plastics, reduction of printing, reuse of office materials, energy saving, efficient use of office equipment and going paperless implemented in each office. Company X was certified as a Green Office by the Foundation for Environmental Education in 2021.

Company X creates environmentally friendly technology by designing solutions and technologies to reduce paper consumption. One of the pioneering solutions is the Durable Medium platform, which allows financial institutions to transmit documents to their customers using a durable medium.

For Company X, social responsibility is important, attention is paid to caring for the local community and employees. It is important for employees to enjoy a healthy working environment and to function in a friendly environment. Objectives related to building social responsibility are: support for employee initiatives, charitable activities, equal opportunities and diversity. Company X's strategy in the area of social responsibility focuses on ensuring employee satisfaction through employee development support, engaging employees in training and work culture. The company seeks to contribute to social change by supporting NGOs working to combat poverty, the drive for equal opportunities in education and digital exclusion. Company X's concept of diversity management is based on 3 concepts - equal opportunities, diversity and the inclusion of all employees in joint activities, which is reflected in the company's employment structure. Particular attention is paid to quotas. Company X is one of the few companies in the financial market to boast almost 50% female representation in the company and an equally high percentage of women in management positions.

At company X, values are put into practice through transparent policies and defined procedures. Company X aims to achieve its corporate governance objectives through transparent governance policies, corporate governance principles bring together the company's strategy and values, as well as a set of programmes, policies and procedures that are formally defined within the company to help employees and business partners understand how to operate and fulfil their role in the wider community. It is important to respect the practices in place, shareholder rights, as well as accountability and to provide a broader framework for transparency in operations, including a whistleblower protection programme in place.

Company X is committed to the highest standards of conduct and ethics. In line with this commitment, an external company has been appointed to provide employees with a confidential whistleblowing service. If a Company X employee has serious grounds for irregularities, illegal, dishonest or prohibited activities occurring in the workplace, they can report them in a secure manner. Reports will be taken seriously and addressed appropriately for consideration of a potential investigation. An essential criterion for whistleblowing is that the whistleblower is acting in good faith, i.e. based on facts and other objective considerations, as opposed to personal considerations, i.e. a sense of injustice, a desire for retaliation, or vested interests of the individual. The employee, either through the hotline or by filling in the relevant online application, can take advantage of the possibility to report violations. According to the UN Protect, Respect and Remedy framework, companies must respect human rights and provide remedies if their actions have caused or contributed to a negative impact on human rights. Complaint mechanisms at the operational level, for those potentially affected by a company's activities, are recommended as an effective process through which companies can enable remediation. Company X is a technology company implementing company-wide sustainability initiatives. It also pursues sustainable project management goals. There is information within the company about the need to save energy and resources. In contrast, Company X does not use methodologies dedicated to sustainable management in

software production. The methodology used in software development is Scrum. Environmental, social, economic factors are not taken into account in projects.

AML is anti-money laundering and anti-terrorist financing. Company X creates such solutions and sells and uses them itself for background checks because it has such services for its clients. These activities are the implementation of Sustainable Development Goal.

3.2. Results for multiple embedded case study - for R&D projects

3.2.1. Description of results (R&D projects)

Case 1

The project team undertakes projects almost exclusively for an internal client, mainly for the board of directors and others responsible for key business decisions within the organisation. The main philosophy guiding the team is to use data effectively to support business decisions, while minimising cost impact and focusing on the time and scope of projects. The term 'sustainable management' is a foreign concept to the team leader, but it seems that despite this, this type of management is to some extent unconsciously applied to his team. The term sustainable project management is spontaneously associated by the manager with striking a balance in terms of fulfilling specific project goals, rather than doing something for the environment or future generations. What stands out in terms of sustainability is the theme of data democratisation understood as dissemination, making knowledge available to others - mainly other people in the organisation, but also sharing experiences and insights with a wider audience. For example, during competitions or webinars. The ecological and economic aspect - other sustainability issues are mainly relevant to project themes - there are issues such as the sharing economy (of a fleet of company cars or office space), which can be a project theme, mainly because of its added benefits in terms of cost reduction. This, however, applies to selected projects.

Case 2

The team usually implements grant projects, often with funding from the European Union or local authorities. Therefore, the way in which projects are managed is very often dictated by criteria imposed directly by the institution. On the one hand, they point to the high value of introducing elements of sustainable management (mainly environmental and social aspects), while on the other hand they recognise the difficulty in perceiving this type of action associated with the imposition of such requirements by the beneficiary. Rigid requirements often make people react with reactivity, resistance to change. Those responsible for implementing the project must therefore use the language of benefits, most often economic, to convince others of the type of sustainability solutions. In addition, the snowball effect was discussed, where it is important not only to convince someone to take pro-environmental action, but to get that person to become a promoter of change themselves and introduce this type of action in their teams or projects.

Case 3

The surveyed team mainly undertakes projects implemented with European Union funds. It acts as an external provider, as direct support to the grant beneficiary. In the case of sustainable project management, this is not only a requirement of the beneficiaries, but applications that have more of this are also considered favourably. Actually, all aspects of sustainability are relevant, although the ecological and social dimensions are somewhat more so. The ecological aspect is strongly inscribed in EU projects - here, the beneficiary must prove not only the absence of a negative effect on the environment, but that this effect will be positive. As far as the social aspect is concerned, the greatest emphasis is placed on both excluded groups (e.g. the disabled, poorer areas) and an increase in the quality of life for society in general (e.g. better infrastructure, easier access to services). Despite the fact that these are top-down requirements, the manager points out how important it is that certain aspects are not just ticking off points from a contract, but also have a real impact on someone's life. On the other hand, the thought of sustainable management of projects that do not have a global scale causes a crush and a bitter taste of success in the context of ESG issues worldwide.

Case 4

This team mainly deals with research projects for corporate clients and research and development projects for the internal client (for management). Success within the organisation is mainly defined as the satisfaction of the target customer, often assessed on scales (e.g. NPS - net promoter score). For the team, on the other hand, what is important is the use of the research results themselves, i.e. translating them into business decisions and their positive long-term effect. It is this exerting a positive effect on the target customer that is associated more with the sustainable management of the project itself. Furthermore, when the team defines success through the lens of sustainability aspects, it is primarily the social issue that stands out - whether the project has changed the customer's perception of society/consumer in a way that can positively influence the company's actions towards people. Sustainable project management itself is generally not used in the team. The area of sustainability itself is not something that comes to the fore in projects, especially commercial ones. Sustainability elements appear almost exclusively in social projects, or where the project theme itself is closely related to ESG. The lack of emphasis on sustainable management is due, according to the team, in part to the corporate (internal client) emphasis on profit and long-term relationships with external clients, but it is also due to low knowledge of the subject and therefore low interest in this aspect of the work. Sustainability criteria are closely related to profitability for corporations. If they are not cost-effective, it is still difficult to implement them. They are linked to so-called 'greenwashing', i.e. when companies communicate that they are pursuing sustainability goals in order to gain a positive image, rather than because their action actually has a positive impact on society and the environment.

Case 5

The team is currently involved in several projects in the field of nature conservation and the promotion of ecological knowledge as part of its research work at a state university. They do most of their research with grants and support from EU and local government funds. They define the success of a project mainly by the fulfilment of all requirements set by the benefactors and the correct closure of the project. The second important criterion is the number of scientific publications or patents. In addition to these, social aspects such as the establishment of relationships, teamwork and gaining experience are also important, although not a priority. Despite the work being closely related to sustainability, it is surprisingly not part of project management. Team members try to smuggle in ecological elements if that will make for more efficient management of funds, but it is not a very important issue in terms of running the process itself. The thing that is related to this is that the very concern for sustainable management can have negative consequences for project team members, for example imposing additional responsibilities, such as accounting for savings made. Even environmentalists themselves, point out that institutions impose their requirements in the context of sustainability, which restricts society. Thus causing strong resistance and negative associations with ecology itself. There is also a sense of discouragement and negative perception of such guidelines by the team members themselves.

Case 6

The team is involved in market research for external clients, primarily business clients, of various industries. The team's definition of success is, above all, client satisfaction and meeting his/her expectations. In addition, criteria such as whether the project was carried out efficiently or smoothly, and whether the methodology was properly matched to the client's business objectives and goals, as well as a criterion such as whether the results of the research would be translated into concrete business decisions, were mentioned. The team had no exposure to sustainable project management methodologies, and sustainability itself is not an important part of project work, nor is it an important part of assessing project success. The issue of sustainability mainly concerns occasional activities in the spirit of ecology, smuggled in from the bottom up by team members or the team leader. As they emphasise, such activities are not a priority in the research process. It was hard to spontaneously list criteria that have to do with sustainable project management or sustainability itself, indicating that the team may pay little attention to this type of activity. After clearly targeting various aspects of sustainability, the team points primarily to economic issues - clients are more likely to choose a sustainable company if it pays off for them or leads to reasonable savings, without compromising the quality of the solutions provided.

3.3. Knowledge synthesis - applicability of SPM to GC projects

This section of the article aims to provide synthetic conclusions on the research conducted and answers to the research questions formulated (Table 3-5).

Table 3.

Response to RQ1: What is the understanding of sustainability and sustainable project management among grand challenge contractors?

IT projects	R&D projects
From the interviews, it appears that sustainability goals are implemented on a company-wide level (there is awareness of them). In IT projects, on the other hand, where software is produced, no sustainable project management methodologies or any sustainability elements are implemented.	The concept of running projects using the sustainable management method is unfamiliar to the majority of respondents. Sustainable project management is understood differently depending on the organisation. For some, it is a new concept, while other institutions, especially those financed by public or EU funds, have specific sustainability practices already in place.
In the company's objectives, sustainability goals are included in the strategy and the company is committed to the environment, the community and the economy. However, the principles of sustainable project management, i.e. in planning, are not implemented. The project becomes a separate entity from the company's overall sustainability mindset.	Social, environmental and economic aspects, if already included in projects, are rather in a less structured way - in a natural way, even if they are not formally classified as elements of sustainable management.

Source: own work.

Table 4.

Response to RQ2: Do differences in the type of activities of grand challenge organisations (e.g. IT, R&D) affect the implementation of sustainable project management?

IT projects	R&D projects
The company is involved in various scopes of IT activities. In some scopes it meets the principles of sustainable management, e.g. infrastructure management, development and maintenance of network infrastructure, data protection solutions and services, and in other scopes the objectives of sustainable management are not met, e.g. software development.	R&D projects in the public and academic sectors often have a stronger emphasis on sustainable practices due to external and grant requirements. In the sector private, especially in corporations, sustainable management may be less visible, unless it is directly related to the company's mission or market perception.
The company provides an ESG report, acts in compliance, i.e. in accordance with certain established standards, ensures compliance with the law and non-legal standards.	The use of the results of R&D projects and their impact on strategic decisions is crucial, but may be constrained by imposed timeframes and budgets, hence may there is a reluctance to introduce elements of sustainable development, can often carry the risk of impacting on project time and budget. Sometimes there are seen explicitly as an additional, and not necessarily necessary, risk.

Source: own work.

Table 5.

Response to RQ3: To what extent are aspects of sustainable project management included in grand challenge projects and what is staff awareness of this?

IT projects	R&D projects
The company undertakes a lot of activities in the area of AML, including the fight against financial crime and corruption. As a result, the company boasts ethical activities and a transparent way of operating, which is the basis of corporate social responsibility (CRS), also included in the P5 ontology in the ethical behaviour category as anti-corruption.	Sustainable management practices are more often applied to projects that naturally involve environmental or social aspects. In the case of corporate or purely commercial projects, elements of sustainable development may be less visible.
Managing financial risks, including money laundering risks, is an integral part of sustainability management. A company that manages risk effectively is better equipped to meet long-term challenges and is better able to adapt to changing market conditions.	Project managers often play a key role in promoting practices sustainable management, although their understanding and commitment to these issues may vary.
AML activities can lead to better management of a company's resources through the detection and elimination of fraud and financial irregularities, which can serve to meet standards of equal opportunity and dignity, diversity, fairness and inclusiveness. Sustainable resource management is an important element of sustainable development. Providing training for employees on AML is in line with the principles of labour practices and decent work as indicated in the P5 ontology. Training on AML can perhaps be part of an educational programme on sustainable development.	

Source: own work.

4. Conclusions

Based on the analysis of the literature and the results of the empirical study, the following conclusions are drawn on the use of sustainable project management in grand challenge projects:

1. Low awareness of sustainable management in projects: in both IT and R&D, sustainable project management is not a common practice. IT projects lack methodologies to support sustainability, while in R&D projects the idea is often alien or poorly understood.
2. Divergence in the organisation's approach: R&D projects vary considerably in their implementation of sustainability principles, depending on the source of funding and the profile of the institution. Organisations benefiting from public or EU funding show more awareness and apply a structured approach to sustainable practices. In IT, there are no such differences - sustainability goals are a more consistent part of corporate strategy, but are not applied in practice at project level.

3. Lack of formal structures and tools: in both types of projects (IT and R&D), social, environmental and economic aspects are addressed in a fragmented or intuitive way, rather than being an integrated part of formal project management methodologies.
4. Limitations due to low level of standardisation: the lack of a clear and universal understanding of sustainable project management leads to differences in the interpretation and implementation of practices in R&D projects. In IT, on the other hand, even intuitive project-level measures are not applied.
5. Impact on project efficiency: IT and R&D projects have the potential to support sustainability, but in practice they operate as separate entities, which reduces their coherence with organisational goals and makes it difficult to achieve maximum environmental, social and economic benefits.
6. The role of project managers: project managers play an important role in promoting sustainable management practices. Their involvement and understanding of the issues are key to successful implementation.
7. There are differences in the sectors in which grand challenge projects are implemented: the public and academic sectors often show more commitment to sustainability due to external and grant requirements. The private sector, especially corporations, may be more focused on financial performance and short-term goals. The reasons for the differences may vary:
 - a) external requirements - public and academic institutions are often subject to more stringent sustainability regulations and requirements,
 - b) funding: projects in the public and academic sectors are often funded by grants that require certain sustainability criteria to be met,
 - c) mission: public and academic institutions often have sustainability measures enshrined in their mission statement.
8. There is a relationship between project type and sustainable development practices: projects of a social or environmental nature naturally incorporate elements of sustainability. In commercial projects, their presence may be less evident, but AML's activities can underpin the implementation of broader sustainable management practices.

5. Summary and recommendations

In both IT and R&D projects, there is significant potential to implement sustainable project management practices. However, currently there is a lack of consistency, standardisation and integration with the strategic objectives of the organisation, which limits the effectiveness of activities. There is a need to structure the approach, adapt the practices to the specifics of the

projects and promote education and awareness in this area. Recommendations for organisations implementing grand challenge projects are as follows:

- Standardise the approach to sustainable project management: implement structured methodologies for sustainable project management (e.g. PRiSM) that take into account environmental, social and economic aspects throughout the life cycle of projects.
- Educating and raising awareness on the importance of sustainable project management: conducting training and workshops for IT and R&D project leaders to increase their awareness and understanding of sustainable management.
- Adapting processes to the specifics of projects: creating guidelines and tools dedicated to R&D and IT projects that take into account their specificities, e.g. emphasis on resource savings in IT or inclusion of environmental criteria in research projects.
- Integration with the organisation's strategic objectives: ensuring that all projects - regardless of their nature - are fully integrated with the organisation's sustainability objectives.
- Monitor and report progress: establish metrics for IT and R&D projects, such as carbon footprint reduction, use of sustainable materials, or social impact. Monitor progress towards sustainability goals on a regular basis and adjust actions according to emerging challenges and opportunities.
- Cooperation with partners: Collaborations should be established with other companies, NGOs and research institutions to exchange experiences and jointly develop solutions.

6. Research limitations

In the context of the conducted research, the following limitations can be pointed out, which result from the adopted research strategy: a) small number of cases (in both single and multiple embedded case studies, the number of analysed projects was limited. This makes it difficult to generalise the findings to a wider population of IT and R&D projects), b) the specificity of grand challenge projects (the selection of grand challenge projects introduces additional limitations. While this allowed for a deep understanding of this specific category of projects, it may make comparison with other types of projects difficult), c) subjective case selection (a deliberate selection of projects for the study was made, which introduced an element of subjectivity), d) data interpretation: qualitative analysis requires interpretation of the data, which is always to some extent dependent on the researcher's perspective, e) limitations of the data collection technique (individual and diadic interviews, while a rich source of data, can be susceptible to the effects of socially desirable responses and to the influence of the researcher-participant relationship).

Despite the limitations indicated, the research carried out provides valuable information on the specifics of grand challenge projects.

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DETERMINANTS OF ORGANIZATIONAL AGILITY IN SOCIAL WORK IN THE LIGHT OF OWN RESEARCH

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Purpose: This article explores the determinants of organizational agility in social work and identifies how agile practices enhance the effectiveness and adaptability of organizations in this field. The study provides theoretical insights and practical recommendations to improve the responsiveness of social work organizations to dynamic social challenges.

Design/methodology/approach: The research is based on a survey conducted in April-May 2023 with 303 respondents representing organizations involved in social work. A structured questionnaire was used to gather data on key agility factors, and Multiple Correspondence Analysis (MCA) was applied to identify relationships between variables and dimensions of agility.

Findings: The study reveals that agility in social work organizations is driven by quick responses to beneficiary needs, flexibility in adapting activities, collaboration with diverse institutions, continuous communication, and the use of technology. Continuous improvement of methods and inclusion of beneficiaries' voices are also critical. These factors collectively shape organizations' capacity to adapt and innovate in complex environments.

Research limitations/implications: The study is limited by its reliance on a single method (survey) and cross-sectional design, which captures a snapshot of agility but not long-term trends. Future research could include longitudinal studies or mixed-method approaches for a more comprehensive understanding.

Practical implications: Organizations can enhance agility by fostering collaborative networks, integrating technological solutions, and prioritizing beneficiary engagement to align strategies with evolving social needs.

Social implications: Improving agility in social work can enhance service quality and accessibility for vulnerable populations, enabling organizations to address pressing social issues and foster resilient, inclusive communities.

Originality/value: This study offers a novel perspective on the intersection of organizational agility and social work, a topic with limited exploration in the literature. By combining empirical data with theoretical analysis, it contributes to understanding and implementing agility in social work organizations.

Keywords: social work, organizational agility, organizational, corporate social responsibility, social sector.

Category of the paper: research paper.

1. Introduction

Organizational agility plays an increasingly important role in a dynamically changing world, where organizations must continuously adapt their activities to new challenges and environmental needs. Social work, as a field particularly sensitive to social changes, requires flexibility and the ability to adapt strategies to effectively respond to the specific needs of beneficiaries (Kijak, Podgórska-Jachnik, Stec, 2019). Despite the growing importance of this topic, there is a limited number of studies on the application of the concept of agility in social work, which justifies the need for an in-depth analysis of this issue.

The aim of this article is to address this research gap by identifying the key determinants of organizational agility in social work and understanding their impact on the effectiveness of organizations in a changing social environment. Particular emphasis is placed on practical guidelines that can help organizations better align their activities with dynamically evolving needs and conditions. Organizational agility, which enables effective resource management, building relationships with stakeholders, and implementing innovative solutions, can be a cornerstone for enhancing the efficiency and inclusivity of operations (Aguinis, Glavas, 2012).

2. Literature review

2.1. The idea of social work in modern enterprises

Modern businesses increasingly recognize the importance of social work as an essential element of their operations (Business Pillars, 2023). In a world where social needs are becoming increasingly complex and the role of companies goes beyond providing products or services, social work is becoming a tool for building relationships with employees, local communities and other stakeholders. This approach stems from the need to create more sustainable and responsible models of operation that take into account not only economic goals, but also social and environmental ones (Młyński, 2021).

As part of social work, companies engage in activities that support employees in difficult life situations, such as providing access to psychological counseling, helping to solve family problems or supporting their health and well-being (Szczepkowski, 2018). Such initiatives may also include professional reintegration programs aimed at the long-term unemployed or those who have difficulties returning to the labor market. Companies that undertake such activities not only strengthen the loyalty and commitment of their employees, but also contribute to building a more inclusive work environment (Mrugalska, Ahmed, 2021).

Social work in enterprises increasingly goes beyond the organizational framework, encompassing activities aimed at local communities (Joiner, 2019). These may include educational programs, initiatives supporting the elderly, assistance to children from dysfunctional families, or projects related to environmental protection. Such activities not only respond to specific social needs, but also build the image of the enterprise as an organization involved in the life of the local community and caring for its development (Ramadhana, 2021).

One of the challenges of social work in enterprises, however, is the need to balance these activities with business goals (Chen, Siau, 2020). Companies must take into account budget constraints and properly plan and measure the effectiveness of their social programs. At the same time, for social work to be effective, a collaborative approach with non-governmental organizations, public institutions, and community representatives who have the closest contact with those in need is crucial (Smolińska-Theiss, 2014).

The introduction of social work into corporate structures is part of a broader trend of corporate social responsibility (CSR), which prioritizes care for people and the environment (He, Harris, 2021). This approach not only changes the way companies are perceived, but also gives their activities a deeper meaning, showing that they can be a force for positive change in society. Social work in modern companies is no longer just an addition to their core business, but an integral part of their strategy, which allows them to not only respond to social needs, but also build long-term value, both for the organization and its environment (Carroll, Brown, 2018).

2.2. Social work in agile organizations

Social work in agile organizations plays an important role in adapting to dynamically changing social and economic conditions. Organizational agility in this context is defined as the ability to flexibly respond to the needs of beneficiaries, effectively manage resources, and introduce innovative solutions that allow for the implementation of social goals in a more effective and responsible manner (Kt, Sivasubramanian, 2023). In agile organizations, social work is based on key elements that support their ability to adapt, including speed of response, flexibility of actions, cooperation with external institutions, internal communication, use of technology, continuous improvement of work methods, and taking into account the voice of beneficiaries (Prieto, Talukder, 2023).

One of the foundations of social work in agile organizations is the ability to respond quickly to the needs of beneficiaries (Ministry of Family, Labor and Social Policy, 2015). Agile organizations must operate in a dynamic manner, which requires both precise monitoring of the social situation and the ability to make decisions immediately (Kamiński, 2017). The speed of response allows for more effective coping with crises and limiting negative consequences for beneficiaries (Chen, Li, 2021). At the same time, flexibility in adapting activities is crucial, which allows organizations to modify their strategies in response to new

challenges and needs. This flexibility is manifested both in planning activities and in the operational implementation of social programs (Porter, Kramer, 2006).

Agile organizations place particular emphasis on cooperation with various institutions (Szmagalski, 2012). These partnerships enable better use of resources, exchange of experiences and integration of activities, which is particularly important in social work, where it is often necessary to join forces in order to solve complex social problems. Cooperation with public institutions, non-governmental organizations and the private sector allows for a more comprehensive approach to social work, in which different entities can complement each other's competences and resources (Raschke, 2010).

An important aspect of social work in agile organizations is also maintaining continuous communication with the team (Kurnia, Chien, 2020). This communication supports the flow of information, builds employee engagement and enables quick problem solving (Anderson, Wilson, 2017). In agile work environments, communication is not only an operational tool, but also an element of building an organizational culture based on trust, cooperation and openness. This strengthens the organization's ability to operate effectively in difficult and changing conditions (Włodarkiewicz-Klimek, 2018).

Another important element is the use of technology in social work. In agile organizations, technologies play a key role in streamlining processes, analyzing data, and communicating with beneficiaries. Digital tools enable more precise identification of social needs, monitoring the results of activities, and faster delivery of support. The use of modern technologies in social work also contributes to increased organizational efficiency and improved quality of services provided (Chen, Siau, 2020).

Continuous improvement of work methods is another determinant of agile organizations (Szmagalski, 2007). The pursuit of improving the quality of activities and introducing innovative solutions is the basis for organizations that want to effectively respond to changing social needs. Agile organizations systematically analyze their activities, learn from mistakes and implement new approaches that allow them to better achieve their goals (Stolarska-Ślęzak, 2023). One of the most important aspects of social work in agile organizations is taking into account the voice of beneficiaries in the process of planning and implementing activities (Sobczak, 2018). Including beneficiaries in the decision-making process allows for a better understanding of their needs, increases the effectiveness of social programs and builds a sense of shared responsibility for their implementation (Aguinis, Glavas, 2019). In agile organizations, treating beneficiaries as subjects is not only a manifestation of social responsibility, but also a key element of the management strategy that increases the trust and commitment of all stakeholders (Sztumski, 1995).

Social work in agile organizations is based on the synergy between flexibility, responsiveness, cooperation and the use of technology and innovation. This approach allows for effective management of resources, building lasting relationships with beneficiaries and implementing activities that respond to social needs in a dynamic and comprehensive way

(Chen, Li, 2021). As a result, agile organizations not only cope better with changing conditions, but also contribute to building a more sustainable and just society.

2.3. The idea of social work in agile organizations – case studies

Modern organizations increasingly integrate the principles of agility with social work practices, adapting their activities to the dynamically changing environment. An example of such an approach is the PGE Capital Group, which, as part of its corporate social responsibility (CSR) strategy, engages in numerous initiatives for local communities. These activities include educational programs, support for people with disabilities, and pro-ecological projects, implemented using agile management methods, which allows for flexible adaptation to the needs of beneficiaries (PGE, 2023).

Another example is Telecom Italia, which has implemented agile management methods, promoting tools that enable effective internal communication. This allows employees to respond quickly to emerging needs, which is crucial in the implementation of social work projects (Telecom Italia, 2020).

In Poland, agile work methods are gaining popularity, as evidenced by the fact that 80% of Polish companies declare their use. One example is the CCC company, which implemented agile methods in its social activities, which allowed for a faster and more effective response to the needs of local communities (Filary Biznesu, 2023).

These examples show that integrating agile management methods into social work practices allows organisations to respond more effectively and flexibly to social needs, which translates into better outcomes and greater engagement of both employees and beneficiaries.

3. Methods

The aim of the research was to identify key determinants of organizational agility in social work and to determine how individual factors affect the ability of the organization to flexibly and effectively respond to the needs of beneficiaries in a dynamically changing environment. The research hypothesis was formulated that organizational agility in social work is determined by such elements as quick response to the needs of beneficiaries, flexibility in adapting activities, cooperation with various institutions, use of technology and continuous improvement of work methods.

The research questions focused on identifying and analyzing key aspects of organizational agility, including: which factors are most important for organizational agility in social work, what relationships exist between selected categories, and how organizations can optimize their activities based on agility determinants. The study was conducted using a survey method,

which was implemented in April-May 2023 on a sample of 303 respondents representing various organizations related to social work.

In order to deepen the data analysis, the multivariate correspondence analysis (MCA) method was used, which allows for the identification of dependencies between categories and graphical presentation of complex relationships in the space of two main dimensions. MCA analysis was used to better understand which factors differentiate organizational agility the most and which groups of categories are related to each other. Thanks to the use of this method, it was possible to obtain a more comprehensive picture of the phenomenon of organizational agility in social work, which allowed for the formulation of conclusions and practical recommendations.

4. Results

The research aimed to identify the determinants of organizational agility in social work by analyzing the opinions of 303 respondents (Table 1).

Table 1.

Determinants of organizational agility in social work (N = 303)

Category	Definitely not	Rather not	No opinion	Rather yes	Definitely yes
Quick response to the needs of beneficiaries	12	25	45	145	76
Flexibility in adapting activities	10	20	40	150	83
Collaboration with diverse institutions	15	28	38	140	82
Maintaining continuous communication with the team	18	30	35	135	85
Use of technology in social work	20	25	50	130	78
Constant improvement of methods	16	22	47	142	76
Including the voice of beneficiaries	14	18	40	150	81

Study: own.

Table 1 shows the distribution of responses to the seven key aspects. In the category of rapid response to the needs of the mentees, 12 people indicated that it was definitely not important, 25 people considered it rather unimportant, 45 respondents had no opinion, while 145 people indicated that it was rather important and 76 considered it to be definitely important. In the context of flexibility in adapting activities, 10 people expressed a definitely negative attitude, 20 considered it rather unimportant, 40 respondents had no opinion, while 150 people indicated that it was rather important and 83 rated it as definitely important.

In relation to cooperation with various institutions, 15 people considered this element to be definitely unimportant, 28 rather unimportant, and 38 respondents did not express an opinion. On the other hand, 140 people indicated its rather important importance, and 82 respondents considered it to be definitely important. The category of maintaining constant communication with the team was assessed as definitely unimportant by 18 people, as rather unimportant by 30 respondents, and 35 people did not express an opinion. At the same time, 135 participants of the study assessed this aspect as rather important, and 85 indicated its definitely important.

In the area of using technology in social work, 20 people considered this element to be definitely not important, 25 rather not important, and 50 respondents had no opinion. At the same time, 130 people indicated that technology was rather important, and 78 people assessed it as definitely important. The category concerning continuous improvement of methods of action was assessed as definitely not important by 16 people, as rather not important by 22 people, while 47 respondents did not express an opinion. At the same time, 142 people considered this element to be rather important, and 76 assessed it as definitely important. The last category was taking into account the voice of the wards, which 14 people assessed as definitely not important, 18 as rather not important, while 40 respondents had no opinion. At the same time, 150 people indicated that this aspect was rather important, and 81 respondents assessed it as definitely important.

Table 2.

Results of MCA Analysis: Dimensions of Organizational Agility in Social Work

Category	Dimension 1	Dimension 2
Quick response to the needs of beneficiaries	-0.8	0.5
Flexibility in adapting activities	-0.6	-0.3
Collaboration with diverse institutions	-0.2	0.7
Maintaining continuous communication with the team	0.1	-0.1
Use of technology in social work	0.5	-0.6
Constant improvement of methods	0.7	0.8
Including the voice of beneficiaries	1	-0.4

Study: own.

Table 2 presents the results of the multivariate correspondence analysis (MCA) concerning the determinants of organizational agility in social work. Each category was described by the values of two main dimensions, which reflect the key axes of differentiation between the analyzed aspects. The category concerning quick response to the needs of clients obtained the value of -0.8 on the first dimension and 0.5 on the second dimension, which indicates its specific location in the analytical space. Flexibility in adapting activities is characterized by the values of -0.6 on the first dimension and -0.3 on the second dimension. Cooperation with various institutions reached the values of -0.2 on the first dimension and 0.7 on the second dimension, which emphasizes its positive links with the dimension related to integration and cooperation.

In the case of maintaining continuous communication with the team, these values were 0.1 and -0.1, respectively, which indicates a more neutral place in the analyzed space. The use of technology in social work was assigned values of 0.5 on the first dimension

and -0.6 on the second dimension, which may suggest more technical and specific characteristics of this aspect. Constant improvement of methods of action was characterized by values of 0.7 on the first dimension and 0.8 on the second dimension, which indicates its close connection with positive aspects of agility. Considering the voice of the mentees reached values of 1.0 on the first dimension and -0.4 on the second dimension, which places this category as one of the most pronounced in the analyzed space.

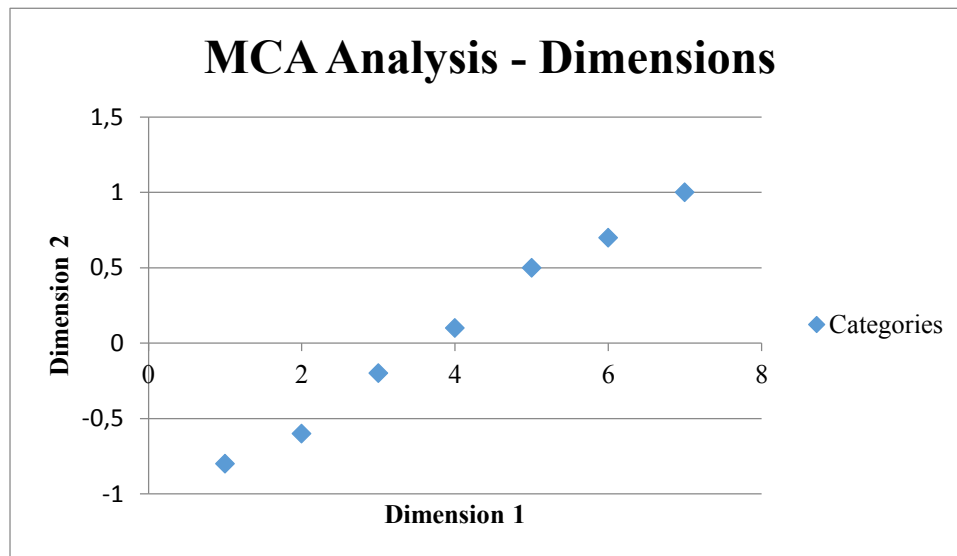


Figure 1. MCA Analysis – Dimension.

Study: own.

The data presented in Table 2 are visualized in Figure 1, which presents the results of the MCA analysis in the form of a scatterplot. The axes marked as “Dimension 1” and “Dimension 2” are arranged in a way that illustrates their mutual connections and differences. Each point on the graph represents one category, and its position reflects the values obtained in both dimensions. This visualization allows us to see which aspects are more distant from each other, indicating their differences, and which categories are grouped, suggesting their similarity in the context of organizational agility in social work.

5. Discussion

The conducted research and theoretical analysis allow for the formulation of conclusions regarding the determinants of organizational agility in social work and their importance in practice. The results of the multidimensional correspondence analysis (MCA) indicate clear differences in the perception of individual aspects of agility by the surveyed respondents. Key categories were identified that differentiate organizations in the context of their adaptability and level of flexibility. The highest values in the first and second dimensions were

obtained by the categories "Taking into account the voice of beneficiaries" and "Continuous improvement of methods of operation". This means that these two factors play a key role in shaping organizational agility, and taking into account the opinions of social work beneficiaries is the basis for building a more open and flexible approach to the organization's activities. Continuous improvement of methods of operation is an indicator of the continuous pursuit of efficiency and adaptation to changing conditions and social needs.

The category "Rapid response to the needs of clients" also occupies an important place in the analysis, indicating the importance of time and the ability to immediately adapt activities in social work. This result emphasizes the necessity of an efficient system for monitoring needs and quick decision-making. "Flexibility in adapting activities" and "Cooperation with various institutions" also obtained positive values, which suggests that organizations with high agility are characterized by the ability to dynamically change strategies and the ability to build a network of cooperation with external partners. The results also indicate the importance of technology in social work, which, although it does not occupy a central place in the analysis, plays a supporting role, enabling better organization of work and access to resources necessary for quick action.

The category "Maintaining constant communication with the team" obtained values close to neutral, which may indicate that although internal communication is important, its impact on organizational agility is not as clear as other analyzed aspects. This may be due to the fact that communication is treated as a standard element of organizational activity, and not as a distinctive factor of agility.

The research results emphasize that organizational agility in social work depends on the ability to react quickly, flexibility and the ability to learn and improve methods of action. Understanding and taking into account the voice of the beneficiaries is also crucial, which indicates the need to build relationships based on trust and cooperation. The identified factors can be the basis for designing a development strategy for organizations dealing with social work, especially in the context of changing social challenges and expectations of beneficiaries. The analyses conducted indicate the need for a balanced approach, in which organizations will be able to combine flexibility with efficiency, while taking into account the needs of local communities and the dynamically changing environment.

Based on the conclusions from the conducted research, recommendations can be formulated for companies operating in the field of social work, which can significantly contribute to increasing their organizational agility and effectiveness of operations. A key recommendation is to develop mechanisms that allow for a faster response to the needs of beneficiaries, which requires investment in monitoring systems and the introduction of data-based decision-making processes. Companies should strengthen their competences in the field of flexibility, which means the ability to dynamically adapt activities and strategies to changing conditions and emerging challenges. To this end, it is necessary to create a work environment that promotes openness to change and experimenting with new approaches.

It is also recommended to build partnerships with various institutions and organizations operating in the public and private sectors, which will enable more efficient use of available resources and facilitate the implementation of common social goals. Cooperation with local communities should be an integral part of the strategy, because it allows for a better understanding of local needs and strengthens the involvement of beneficiaries in the implementation of projects. It is also important to increase the role of technology in social work, especially through the introduction of digital tools supporting communication, organization of activities and data analysis. Investments in technology can not only increase operational efficiency, but also enable better adaptation of services to the needs of beneficiaries.

Companies should place particular emphasis on the continuous improvement of methods of operation, which requires the creation of systems enabling regular evaluation of the effectiveness of undertaken actions and implementation of changes based on the obtained results. It is also important to take into account the voice of beneficiaries in the decision-making process, which increases the sense of joint responsibility for the implemented initiatives and allows for the provision of services more adapted to their expectations. In this context, the development of consultation systems and constant dialogue with beneficiaries is recommended in order to better identify and meet their needs.

In addition to operational activities, it is recommended to promote an organizational culture based on trust, cooperation and openness to change. Team competences should be strengthened through training in flexible management and communication, as well as skills related to the use of modern technologies should be developed. Creating a work environment that is conducive to cooperation and innovation will contribute to increased organizational agility, which will allow companies to operate more effectively in a dynamically changing social environment. Ultimately, implementing these recommendations can lead to increased effectiveness of activities and better matching of services provided to the real needs of beneficiaries, which is a fundamental goal of organizations dealing with social work.

Technology plays a crucial role in shaping organizational agility, particularly in the context of social work, where the effectiveness of actions depends on quick access to information, efficient communication, and flexible resource management. Modern technological solutions, such as information management systems, communication platforms, and analytics tools powered by artificial intelligence, enable organizations not only to respond more quickly to beneficiaries' needs but also to better anticipate changes and adapt activities to dynamic conditions. An example of technology application is digital mapping of social needs, which allows for precise identification of groups requiring support, significantly improving resource allocation. Additionally, technology supports monitoring the outcomes of organizational activities, enabling ongoing evaluation and the implementation of improvements. By integrating such tools, social work organizations can manage data more effectively and make evidence-based decisions, thereby enhancing their adaptive capacity.

However, leveraging technology requires adequate organizational preparation, including staff training, the implementation of data security systems, and fostering a culture that encourages innovation. Without these elements, the potential of technology may remain underutilized, limiting an organization's ability to enhance its agility. Therefore, future research could focus on analyzing the extent of technology adoption in social work and its impact on key aspects of agility, such as responsiveness, flexibility, and inclusivity.

6. Conclusions

Comparing the results of the conducted research with the findings of other researchers, one can notice both similarities and differences in the perception of organizational agility in social work. In our own research, the key importance of such factors as taking into account the voice of the beneficiaries and continuous improvement of methods of operation was emphasized. Similar conclusions appear in the literature on the subject, where organizational agility is defined as the ability to quickly respond to changes and flexibility in adapting to a dynamic environment. In the publication by Włodarkiewicz-Klimek (2018), enterprise agility is described as the ability to quickly adapt to changes and take advantage of emerging opportunities, which is consistent with the results of this research.

However, other studies draw attention to additional aspects of agility that were not highlighted in these analyses. For example, Stolarska-Ślęzak (2023) emphasizes the importance of innovation and the ability to learn quickly as key elements of organizational agility. In the context of social work, innovation can manifest itself in the search for new methods and tools for working with clients, which was not directly taken into account in the discussed studies.

Moreover, the literature on the subject often emphasizes the role of technology in building organizational agility. Włodarkiewicz-Klimek (2018) indicates that the use of modern information technologies can significantly support adaptation processes in organizations. In this study, this aspect was taken into account, but it does not occupy a central place in the analysis, which may suggest the need for further research in this area. It is also worth noting that some studies draw attention to barriers in the implementation of agility in organizations. Szmagański (2012) indicates bureaucratization of processes and lack of flexibility as the main obstacles to building agile structures in social work. The results of this study, which emphasize the importance of flexibility and rapid response, are consistent with these observations, suggesting the need to simplify procedures and increase the autonomy of social workers.

In summary, the results of the conducted research are largely consistent with the findings of other researchers regarding the key determinants of organizational agility in social work. However, there are areas, such as innovation or the use of technology, that require further exploration to fully understand their role in building agile organizations in the social sector.

The limitations of the conducted research result from several key factors that should be taken into account when interpreting the results. First of all, the research was based on a sample of 303 respondents, which, although ensuring representativeness to a certain extent, does not allow for full generalization of the results to all organizations involved in social work. In addition, the use of multivariate correspondence analysis (MCA) as the main method of data analysis introduces limitations related to the interpretation of the results, as this method provides only a simplified picture of the relationships between the studied categories.

Another limitation is the subjective nature of respondents' responses, who could have had different understandings of individual questions about organizational agility. Differences in interpretation could have affected the distribution of responses and made it difficult to precisely identify the actual relationships. Additionally, the studies focused mainly on the perspective of the organization, omitting the broader socio-economic context that also affects organizational agility, such as government policies, regulations, or the economic situation in the region.

Another limitation was the insufficient consideration of the role of technology in shaping organizational agility. Although this aspect has been partially explored, its impact has not been thoroughly analyzed, which may limit the full understanding of its importance in social work. The research also lacked comparative analysis with other sectors, which could help to determine the specific features of agility in social work compared to other industries.

Finally, it is important to note that the study was cross-sectional, meaning that data collected at a single point in time were analyzed. The lack of a longitudinal perspective limits the ability to understand the dynamics and changes in organizational agility over a longer period of time. These limitations suggest a need for further, more comprehensive research that could take into account a broader context and provide more detailed results.

Future research directions could focus on a more detailed analysis of the determinants of organizational agility in social work, taking into account both internal and external factors that affect the functioning of the organization. Particular attention could be paid to the analysis of the long-term effects of implementing agility-based strategies, which would allow for a better understanding of the dynamics of organizational change over time. Research could also expand the scope to include comparisons of different sectors of activity to determine whether the specific features of agility found in social work are unique or universal.

An important area for future research is the role of digital technologies in increasing organizational agility. One could focus on examining the impact of specific technological tools, such as artificial intelligence, information management systems or communication platforms, on the ability of organizations to adapt and respond to change. It is also important to deepen knowledge about innovation in social work, especially in the context of developing new

methods of working with clients and implementing solutions that support cooperation and engagement of local communities.

An international perspective can provide valuable information on differences in the perception and practice of organizational agility in different countries and social systems. Cross-cultural comparisons could help identify best practices and barriers that hinder the implementation of agile strategies. Additionally, it is worth considering changing social needs and expectations of beneficiaries, especially in the context of global crises such as the pandemic or climate change, which may affect the priorities of social work organizations.

Another important area of research is the analysis of the interactions between organizational agility and employee engagement, psychological well-being, and motivation. This can help to better understand how agile strategies affect organizational structure and work culture. Additionally, future research can also focus on developing and validating measurement tools that more accurately reflect the multidimensional nature of organizational agility in social work. The development of such tools will enable a more precise assessment of the effectiveness of implemented strategies and programs, while providing practical guidance for leaders and decision-makers.

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USING DESIGN THINKING IN AGILE ORGANIZATIONS IN THE ASPECT OF SUSTAINABLE DEVELOPMENT OF THE ORGANIZATION

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Purpose: The aim of the article is to analyze the application of Design Thinking in agile organizations in the context of sustainable development. The study focuses on identifying the determinants of the effective implementation of this approach and assessing its impact on the adaptability, innovation and long-term effectiveness of the organization.

Design/methodology/approach: The study used a survey method, based on a survey questionnaire conducted among 303 respondents. The results were subjected to multiple correspondence analysis (MCA) to identify the relationships between key aspects of Design Thinking and their impact on the functioning of the organization.

Findings: The results indicate that Design Thinking plays an important role in agile organizations, supporting iterative processes, interdisciplinary collaboration, and a flexible approach to changing conditions. The highest ratings were given to aspects related to prototyping, iterative process improvement, and rapid identification of problems and needs.

Research limitations/implications: The study is based on a survey conducted on a sample of 303 respondents, which limits the possibility of full generalization of the results. Multiple correspondence analysis identifies relationships between variables but does not determine cause-effect relationships. The lack of analysis of the long-term impact of Design Thinking indicates the need for longitudinal studies and extension of the analysis to different sectors.

Practical implications: The use of Design Thinking in agile organizations can contribute to more effective innovation management, better alignment of strategies with stakeholder needs, and implementation of practices consistent with the principles of sustainable development. The research results can be the basis for recommendations for organizations striving to increase their adaptive capacity and optimize management processes.

Social implications: Implementation of Design Thinking supports creation of more inclusive and socially responsible solutions, adapted to real needs of users. Interdisciplinary cooperation and creative approach support building business models that take into account sustainable development and positive impact on the environment.

Originality/value: The article provides empirical evidence for the importance of Design Thinking in agile organizations, emphasizing its impact on sustainable development and long-term effectiveness. The use of MCA analysis allows for a detailed determination of the

relationships between the key elements of this approach, which is a significant contribution to the development of research on innovative management methods.

Keywords: Design Thinking, agile organizations, sustainable development, questionnaire, efficiency.

Category of the paper: research paper.

1. Introduction

Modern organizations operate in a dynamic and unpredictable environment, where the ability to quickly respond to changes and adapt strategies becomes a key factor for success. The growing importance of organizational agility and the need to implement innovative management methods encourage the search for approaches that combine creativity, flexibility and user focus. One of them is Design Thinking, which not only supports innovation processes, but also fits into the concept of sustainable development, combining business goals with social and environmental responsibility (Michalska-Dominiak, Grocholiński, 2019).

The use of Design Thinking in agile organizations opens up new possibilities in terms of improving processes, creating innovative products and more effective resource management. Iterativeness, interdisciplinarity and prototyping allow for reducing the risk associated with implementing new solutions, while supporting the creation of strategies that respond to the real needs of stakeholders. The increasing role of sustainable development in organizational strategies means that this approach can be an important element of long-term building of competitive advantage and adapting operations to social and ecological requirements (Stickdorn, Schneider, 2011).

The aim of the article is to analyze the determinants of effective implementation of Design Thinking in agile organizations and to assess its impact on sustainable development. The research value of the work results from the use of multiple correspondence analysis, which allows for the identification of relationships between key elements of this approach and their practical use in organizations. The obtained results can be the basis for formulating recommendations for companies striving to increase their flexibility and implement innovative strategies consistent with the idea of sustainable development.

The structure of the article includes a theoretical part, which presents the concept of Design Thinking, its application in agile organizations and connections with the idea of sustainable development. Then, the determinants of effective implementation of this approach are discussed, as well as the research methodology, based on survey analysis and the MCA method. The next part contains a presentation of the results and their interpretation, while the summary presents conclusions and practical recommendations for organizations implementing Design Thinking in order to increase their innovation and long-term effectiveness.

2. Literature review

2.1. The idea of Design Thinking in agile organizations

The idea of design thinking in agile organizations is a key element supporting innovative, adaptive and development processes. Modern organizations operating in a dynamic market environment must constantly adapt their strategies and operating models to changing conditions. Organizational agility is based on quick response to market needs, flexible approach to management and iterative improvement of processes, which naturally combines with the principles of design thinking (Aguinis, Glavas, 2012).

Design thinking as an approach focused on the user and their experience fits perfectly into the philosophy of agile organizations, which strive to continuously improve products, services and internal processes. In practice, this means using methods based on empathy, interdisciplinary collaboration, creative problem solving and iterative testing of prototypes. Applying these principles allows organizations to better adapt to customer expectations, while increasing their operational efficiency. The design thinking process in agile organizations includes several key stages that are cyclically repeated in order to optimize solutions (Lewrick, Link, Leifer, 2018). The first step is to thoroughly understand the needs of users, which requires conducting qualitative research, observations and interviews. The next stage is to define problems in a way that allows them to be effectively solved by using unconventional thinking. In the idea generation phase, interdisciplinary teams develop various possible solutions, which are then tested and improved as part of prototyping. The iterative cycle allows for rapid implementation of changes and adaptation of concepts to real challenges faced by users (Brown, 2009).

Agile organizations using design thinking gain a competitive advantage thanks to their ability to quickly experiment and implement improvements (Galli, 2013). The key here is openness to errors and readiness to correct them during the work on the project. Traditional management approaches are often based on careful planning and risk minimization, while agile organizations using design thinking accept uncertainty as part of the innovation process (Kelley, Kelley, 2013). The use of design thinking in agile organizations brings benefits not only in the area of creating new products and services, but also in the scope of internal management processes. It allows for a better understanding of employee needs, improves communication and cooperation between departments, and supports an organizational culture based on experimentation and continuous improvement. In the context of sustainable development of the organization, design thinking can support activities aimed at efficient use of resources, minimizing negative impact on the environment, and building relationships with stakeholders based on the principles of transparency and social involvement (Kelley, Kelley, 2013).

Although the integration of design thinking with the agility philosophy brings many benefits, implementing this approach also requires meeting certain organizational conditions. The organizational culture is crucial and should support openness to change, cooperation, and experimentation. It is also important to provide appropriate resources, both in the form of tools enabling effective testing and iterative improvement of solutions, as well as access to competences related to conducting research, data analysis, and creative approach to problem solving (Martin, 2009).

Implementing design thinking in agile organizations also requires the involvement of leaders who should promote an approach based on empathy and flexible management. Leadership based on supporting innovation and encouraging experimentation is crucial for the effective application of this approach in the long-term strategy of the organization (Kelley, Kelley, 2013).

In summary, design thinking is an important element supporting organizational agility, enabling better adaptation to a dynamic environment and building innovative and sustainable solutions. Through user focus, interdisciplinary cooperation and iterative process improvement, organizations can increase their efficiency and ability to create value at various levels of their activities. Combined with management methods characteristic of agile organizations, design thinking allows for a more effective response to the challenges of the modern market, supporting both technological development and a sustainable approach to resource management and relations with the environment.

2.2. Design Thinking in the Aspect of Sustainable Development of Organizations

Design Thinking in the aspect of sustainable development of an organization is an approach enabling the creation of innovative solutions taking into account the balance between economic, social and environmental aspects. Modern organizations increasingly recognize the need to integrate the principles of sustainable development with management processes, and Design Thinking offers tools for effective identification and implementation of such solutions. A key element of this methodology is understanding the real needs of stakeholders and testing ideas in a way that minimizes the risk of wasting resources and inefficient investments (Knapp, Zeratsky, owitz, 2016).

The Design Thinking design process in organizations focused on sustainable development allows for a deeper analysis of the impact of business decisions on the environment. Considering the perspective of the user, employees and the broadly understood community of stakeholders leads to building solutions that respond to both market needs and environmental or social requirements. Creating innovative business models based on responsible consumption, a closed-loop economy or an ethical approach to the supply chain becomes possible thanks to the use of iterative research and design processes, in which testing and adaptation are key stages of activities (Liedtka, Ogilvie, 2011).

One aspect of integrating Design Thinking with sustainable development is the optimization of resource use by designing products and services that take into account long-term efficiency. Modern organizations are increasingly paying attention to the need to minimize negative impact on the environment, which is associated with the search for innovative solutions in the field of materials, production processes and product life cycle management. An approach based on experimentation and rapid testing allows for the creation of solutions that meet the criteria of durability and environmental responsibility, while maintaining high functionality and market attractiveness (Mootee, 2013).

In the social context, Design Thinking in sustainable organizations promotes the creation of more inclusive solutions that meet the needs of different user groups. Human-centered design allows for the consideration of the perspectives of people from different backgrounds, which translates into increased accessibility of products and services and building a more diverse and open market. Organizations implementing sustainable practices based on Design Thinking strive to improve working conditions, strengthen an organizational culture based on empathy, and support social initiatives that contribute to improving the quality of life and building long-term relationships with stakeholders (Kumar, 2012).

The economic dimension of Design Thinking in the sustainable development of an organization is manifested in the pursuit of process optimization and cost reduction through the conscious design of business models based on resource efficiency. Organizations using an iterative approach can more effectively eliminate design errors at an early stage, which leads to a reduction in financial losses associated with unsuccessful investments. At the same time, dynamic adaptation to changing market conditions allows for a faster response to customer needs and building a competitive advantage based on innovation and social trust (InnovaOps, 2019).

One of the challenges facing organizations using Design Thinking in the context of sustainable development is the need to integrate this approach with a long-term business strategy. Implementing solutions based on iterative testing and adaptation requires a flexible approach to management and openness to experimentation. Organizations must not only create products and services consistent with the principles of sustainable development, but also consistently adapt their operating models and management structures in such a way that they support a culture of innovation and social responsibility (Liedtka, Ogilvie, 2011).

The future of integrating Design Thinking with the approach of sustainable development depends on the ability of organizations to develop mechanisms that enable the systematic implementation of this approach at all levels of activity. It is necessary to combine technological, social and economic aspects in such a way that it is possible to design solutions that not only respond to current needs, but also create long-term value for both the organization and its stakeholders. Implementing the principles of responsible management based on experimentation and iterative testing of innovations can be a key factor enabling sustainable growth in a dynamically changing business environment.

2.3. Design Thinking Determinants in Agile Organizations in the Context of Sustainable Organizational Development

Organizations operating in a dynamic environment require methods that enable rapid adaptation to changes, process optimization, and effective response to stakeholder needs (Ramadhana, 2021). In this context, the factors that determine the effectiveness of design thinking implementation are of key importance, which determine the organization's ability to use this approach in a way that supports their long-term development (Czarnecki, 2011). One of the basic factors influencing the effectiveness of design thinking is the organization's ability to prototype and test solutions in an iterative manner. This process allows for quick testing of hypotheses, reducing the risk of implementing unsuccessful initiatives, and optimizing final solutions through systematic improvement (Nath, Agrawal, 2020). Organizations that implement this mechanism in their operations can more effectively develop innovative products and services while reducing the negative impact on the environment and reducing costs associated with inefficient use of resources (Chen, Li, 2021). It is also crucial to adopt an experimentation-based approach that enables organizations to identify the most effective adaptation strategies (Prieto, Talukder, 2023).

The second important factor determining the effectiveness of design thinking in agile organizations is the flexibility in adapting activities to changing conditions (Gao, Zhang, Gong, Li, 2020). Modern organizations operate in an environment characterized by high variability, which requires the implementation of mechanisms that enable quick decision-making and real-time strategy adjustment. This flexibility allows not only for effective response to changing market needs, but also for more conscious resource management, which is one of the key elements of sustainable development (Gothelf, Seiden, 2013). Organizations oriented towards design thinking use this ability to optimize production processes, minimize losses, and introduce solutions that are more adapted to the real needs of recipients (Mrugalska, Ahmed, 2021).

Another important aspect influencing the effectiveness of design thinking is the interdisciplinary cooperation of teams, which is the foundation of innovation and a creative approach to problem solving (Brown & Katz, 2019). In agile organizations, working in cross-functional teams allows combining different perspectives, which leads to the development of more comprehensive and effective solutions. This allows not only to increase the effectiveness of the design process, but also to create strategies that are more consistent with the principles of sustainable development. Organizations using an interdisciplinary approach are able to identify key challenges related to the implementation of new products and services more effectively (He, Harris, 2021), which allows for better use of available resources and minimizing the negative impact on the environment (Luo, Ren, Cao, Hong, 2020).

In the context of organizational agility, an important factor determining the effectiveness of design thinking is also iterative process improvement (Kurnia, Chien, 2020). Organizations that implement this mechanism constantly optimize their activities by analyzing the results obtained

and introducing incremental improvements (Burnett, Evans, 2020). This way of working allows for the reduction of losses, improvement of management methods and continuous adaptation to market needs and environmental requirements. Iteration in organizational processes allows for the gradual implementation of sustainable development strategies in a way that is effective and adapted to market realities (Joiner, 2019).

The effectiveness of design thinking in agile organizations also depends on the ability to quickly identify problems and needs. Organizations that can recognize significant challenges in a timely manner and understand their impact on business operations are able to implement solutions that are consistent with the principles of sustainable development more effectively. Quick identification of problems allows for effective response to threats and creation of strategies that take into account both the user perspective and the long-term goals of the organization (Juchnowicz, Wolińska-Skuza, 2021).

Creativity in problem solving is another important determinant of design thinking in agile organizations (Kt, Sivasubramanian, 2023). Organizations that implement creative thinking methods are able to develop innovative solutions adapted to dynamic market conditions and environmental requirements. This approach allows for designing strategies that not only respond to current user needs, but also take into account future challenges related to economic, social and environmental transformation (Krzyszowska-Dąbrowska, 2020).

One of the key aspects determining the effectiveness of design thinking in agile organizations is also the user-centric approach and their experience. Organizations that focus on the real needs of their stakeholders are able to provide more valuable and lasting solutions. Taking the user's perspective into account in the design process promotes the creation of products and services that are not only functional, but also more in line with the principles of sustainable development (Mierzecka, Wałek, 2020).

Integrating the above design thinking determinants with organizational practices requires building an appropriate organizational culture and implementing tools that enable effective management of the innovation process (Berger, 2014). In organizations oriented towards design thinking, not only the willingness to experiment is crucial, but also the ability to draw conclusions from previous experiences and adapt to changing environmental conditions. Implementing strategies based on these determinants allows for a more effective combination of the iterative approach with long-term sustainable development goals, which helps build organizations capable of creating value in both the business and social dimensions (Lewrick, Thommen, Leifer, 2020).

3. Methods

The aim of the research was to determine to what extent the Design Thinking approach is used in agile organizations and what impact it has on sustainable development of these organizations. The focus was on analyzing key aspects of this approach, such as prototyping, flexibility, interdisciplinary collaboration, iterative process improvement, rapid problem identification, creative problem-solving methods, and user-centricity.

It was hypothesized that Design Thinking in agile organizations is widely used and promotes sustainable development by improving process efficiency, innovation and better matching solutions to the actual needs of users .

The research aimed to answer the following questions: to what extent do agile organizations use Design Thinking in their operations, which aspects of this approach are most frequently used and which are challenging, and whether there is a relationship between the use of Design Thinking and the perceived effectiveness of the organization in terms of sustainable development .

The research method was a survey conducted in April-May 2023 on sample of 303 respondents. In order to deepen the analysis, multiple correspondence analysis (MCA) was used, which allowed for the identification of relationships between individual aspects of Design Thinking and the assessment of their importance in the studied context. Thanks to this method, it was possible to determine which elements of the Design Thinking approach are related to each other and what factors influence their implementation in organizations operating in an agile manner.

4. Results

The study attempted to analyze the application of the Design Thinking approach in agile organizations in the context of sustainable development. The table presents the respondents' answers regarding different aspects of this approach (Table 1).

Table 1.

The use of Design Thinking in agile organizations in the aspect of sustainable development of the organization (N = 303)

Category	Definitely not	Rather not	No opinion	Rather yes	Definitely yes
Prototyping and testing solutions	4	10	30	120	139
Flexible approach to changing conditions	3	8	20	125	147
Interdisciplinary team collaboration	5	12	35	115	136

Cont. table 1.

Iterative process improvement	2	10	25	130	136
Rapid identification of problems and needs	4	9	28	127	135
Application of creative problem-solving methods	3	7	22	132	139
User-centered approach and user experience	4	11	26	125	137

Source: own study.

The study attempted to analyze the application of the Design Thinking approach in agile organizations in the context of sustainable development. Table 1 presents the respondents' answers regarding different aspects of this approach. In the case of the prototyping and testing of solutions category, a small number of respondents strongly rejected this aspect, as only four people indicated the answer "definitely not" and ten chose "rather not". The group of people who did not have an opinion on this topic amounted to thirty, which indicates a moderate degree of neutrality. On the other hand, a much larger number of respondents assessed this element positively, as 120 people indicated "rather yes" and as many as 139 respondents gave the answer "definitely yes".

In the context of a flexible approach to changing conditions, almost identical values as in the previous case were recorded for the least numerous response categories, i.e. "definitely not" and "rather not", which amounted to three and eight, respectively. No clear opinion was declared by twenty people, which is the smallest group in this category. On the other hand, the answer "rather yes" was chosen by 125 respondents, and the largest number of indications, amounting to 147, appeared in the case of "definitely yes", which suggests high acceptance of this element among the study participants.

In relation to interdisciplinary team collaboration, the negative responses were slightly higher than in the previous categories, as five people indicated "definitely not" and twelve "rather not". People who had no clear opinion on this subject constituted a group of thirty-five people. On the other hand, the majority of respondents expressed a positive assessment of this aspect, as 115 people indicated "rather yes" and 136 "definitely yes".

Iterative process improvement was assessed in a similar way to the previous categories. A very small percentage of respondents completely rejected this aspect, as only two people indicated "definitely not" and ten "rather not". No clear position was expressed by 25 people. On the other hand, 130 respondents indicated "rather yes" and 136 "definitely yes", which also shows a significant predominance of positive answers.

A similar distribution of answers also concerned the quick identification of problems and needs. In this case, four people indicated "definitely no" and nine "rather no". The group of people who did not have a clear opinion was 28. The answer "rather yes" was marked by 127 respondents, and 135 answered "definitely yes". In the case of the use of creative problem-solving methods, only three people completely rejected this aspect, and seven

answered "rather no". 22 people declared no opinion on this topic. The answers "rather yes" and "definitely yes" were indicated by the majority of respondents, by 132 and 139 respondents, respectively, which indicates a high level of acceptance of this method. The last aspect, i.e. focus on the user and their experience, was assessed similarly to the previous elements. Negative answers appeared sporadically, as four people selected "definitely no" and eleven "rather no". 26 respondents remained without an opinion. The vast majority, i.e. 125 people, indicated "rather yes" and 137 "definitely yes".

Table 2.
Multiple Correspondence Analysis (MCA) of Design Thinking in Agile Organizations

Category	Dimension 1	Dimension 2	Dimension 3	Eigenvalue	Explained Variance (%)
Prototyping and testing solutions	0.45	0.32	0.25	1.24	30.5
Flexible approach to changing conditions	0.52	0.41	0.28	1.1	27.3
Interdisciplinary team collaboration	0.39	0.36	0.31	1.05	25.9
Iterative process improvement	0.47	0.39	0.29	1.15	28.1
Rapid identification of problems and needs	0.5	0.42	0.27	1.2	29.4
Application of creative problem-solving methods	0.44	0.33	0.3	1.18	28.7
User-centered approach and user experience	0.49	0.38	0.26	1.12	27.8

Source: own study.

The Multiple Correspondence Analysis (MCA) of Design Thinking in agile organizations includes seven categories, for which values were determined across three dimensions, along with eigenvalues and the percentage of explained variance (Table 2). In the category of prototyping and testing solutions, the values in the respective dimensions are 0.45, 0.32, and 0.25, with an eigenvalue of 1.24 and an explained variance of 30.5%. The highest value in the first dimension (0.52) was recorded for the category of a flexible approach to change, where the values in the second and third dimensions were 0.41 and 0.28, respectively. The eigenvalue reached 1.10, with 27.3% of the explained variance.

Interdisciplinary collaboration is characterized by values of 0.39 in the first dimension, 0.36 in the second, and 0.31 in the third, with an eigenvalue of 1.05 and an explained variance of 25.9%. In the category of iterative process improvement, the values are 0.47, 0.39, and 0.29, with an eigenvalue of 1.15 and an explained variance of 28.1%.

Rapid identification of problems and needs shows values of 0.50, 0.42, and 0.27, with an eigenvalue of 1.20 and an explained variance of 29.4%. The application of creative problem-solving methods has values of 0.44, 0.33, and 0.30, with an eigenvalue of 1.18 and an explained variance of 28.7%. User orientation and experience show values of 0.49, 0.38,

and 0.26, with an eigenvalue of 1.12 and an explained variance of 27.8%. The analysis of these categories allows for further interpretation of the relationships between various aspects of Design Thinking and the practices used in agile organizations.

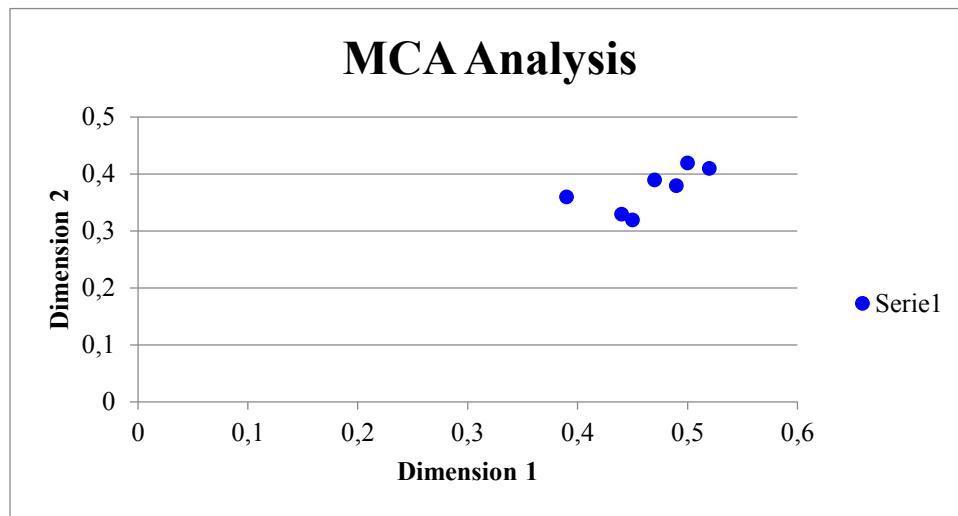


Figure 1. MCA Analysis – Dimension.

Source: own study.

Figure 1 presents a visualization of the data contained in Table 2, illustrating the multiple correspondence analysis (MCA) for different aspects of Design Thinking in agile organizations. The points on the graph correspond to individual categories, and their arrangement on the plane of the first two dimensions reflects the dependencies and similarities between them. The location of the categories in relation to each other indicates their relative proximity in the analyzed space, which allows for a better understanding of the structure of the data. The distribution of values on the axes of Dimension 1 and Dimension 2 shows the differences in the perception of individual aspects of Design Thinking, which is the basis for further interpretation and inference.

5. Discussion

The research results confirmed that the Design Thinking approach is an important element of the functioning of agile organizations, and its application significantly affects management processes and long-term sustainable development. High values in the responses regarding most of the analyzed aspects indicate that organizations using the Design Thinking principles are characterized by greater flexibility, a better ability to identify problems, and a more user-oriented approach to creating solutions.

One of the key findings is the dominance of positive assessments for such aspects as prototyping and testing solutions, iterative process improvement, and interdisciplinary team collaboration. High values assigned to these categories indicate that agile organizations place great emphasis on continuous testing and adapting products and services to changing conditions. This approach minimizes the risk associated with implementing new solutions and ensures better alignment with real user needs. The importance of flexibility in adapting activities confirms that organizations that apply Design Thinking principles are more resistant to changing market conditions and are able to respond faster to new challenges.

Multiple correspondence analysis (MCA) showed strong links between individual aspects of Design Thinking, which suggests that this approach is not used in isolation from other organizational processes, but functions as a coherent system of practices supporting organizational agility. The highest values in the first and second dimensions of the MCA analysis were obtained for a flexible approach to changing conditions, quick identification of problems, and interdisciplinary cooperation of teams. This means that organizations effectively combine these elements, which allows them to dynamically and effectively adapt to changes.

Despite the overwhelmingly positive assessments, a certain group of respondents showed a lack of a clear opinion on some aspects. The most neutral answers concerned categories related to iterative process improvement and the use of creative problem-solving methods, which may suggest that not all organizations have developed procedures in this area or do not see their impact on daily functioning. This may also result from differences in the level of advancement of Design Thinking implementation in individual organizations.

High values assigned to user orientation and the use of creative problem-solving methods confirm that organizations strive to best adapt the offered solutions to the needs of customers and stakeholders. However, these values, although high, did not achieve the highest results compared to other categories, which may indicate that despite the declared use of these methods, organizations may encounter difficulties in their full implementation.

Undoubtedly, research results indicate that Design Thinking is an integral part of the functioning of agile organizations, contributing to their greater adaptability, innovation and operational efficiency. Strong interdependencies between the individual aspects of this approach confirm that it is not used selectively, but is a holistic system supporting organizational development. However, differences in the level of involvement of organizations in iterative process improvement and the use of creative methods may suggest that there are still areas requiring further strengthening. The applied MCA analysis allowed for a better understanding of the interdependencies between the elements of Design Thinking and their importance in the context of agile management and long-term development of the organization.

To effectively implement the Design Thinking approach in agile organizations, it is necessary to further strengthen the practices related to prototyping and testing solutions. Organizations should even more systematically use iterative methods of process improvement, which will allow for faster adaptation to changing market conditions and more effective

response to user needs. In order to fully utilize the potential of Design Thinking, it is worth taking care of increasing awareness among employees about the importance of interdisciplinary cooperation and creative methods of solving problems.

The research results suggest that flexibility and rapid identification of problems are already largely implemented in organizations, but there is still room for deepening the practices related to their application. Not only will it be important to quickly diagnose challenges, but also to implement mechanisms that enable effective evaluation of tested solutions and their adaptation in subsequent stages of the process. The analyses also showed that despite the general acceptance of iterative methods and user orientation, some organizations do not have developed procedures in these areas, which may limit their effectiveness. It may be necessary to develop more transparent standards and promote tools that enable more effective implementation of the Design Thinking approach in everyday activities.

Particular attention should be paid to further developing an organizational culture that supports the use of innovative work methods. Organizations should strive to create space for interdisciplinary cooperation and strengthen mechanisms supporting a creative approach to problem solving. Not only the formal implementation of tools and methods related to Design Thinking will be crucial, but also the long-term building of an environment that promotes their natural use by employees at various levels of the organization. It is also worth paying attention to the need for education and training that can contribute to more effective use of creative methods and iterative decision-making processes in business practice.

Given the strong connections between the individual aspects of Design Thinking, organizations should treat this approach as an integral element of their management strategy, not just as a set of individual tools. It is necessary to include it in long-term development planning and adapt structures and processes in such a way that they support its full implementation. Achieving the full benefits of Design Thinking requires a systemic approach, in which both processes and organizational culture are oriented towards iteration, flexibility, and collaboration with users.

6. Conclusions

The results of the research on the application of Design Thinking in agile organizations indicate the important role of this approach in the processes of management and sustainable development. Similar observations are presented by other researchers in their works. For example, in Juchnowicz and Wolińska-Skuza (2021) they emphasize that agile organizations that integrate methods such as Design Thinking achieve better results in terms of innovation and adaptability. The researchers draw attention to the importance of employee

creativity and the organizational conditions conducive to its development, which is consistent with the conclusions from the discussed studies.

In addition, Mierzecka and Walek (2020) discussed the dualistic nature of Design Thinking, combining thinking and action, which allows for effective problem solving in organizations. The authors emphasize that the involvement of organizations in the Design Thinking process promotes better adaptation of solutions to the needs of users, which is consistent with the results of the discussed studies.

In addition, the report "Design Thinking in Project Management" published by InnovaOps (2019) indicates that the use of Design Thinking in project management leads to better coping with uncertainty and problems, which is crucial in agile organizations. The authors emphasize that the integration of this approach allows for a more flexible and creative approach to management, which correlates with the conclusions from the discussed studies. Therefore, the results of the discussed studies are consistent with the findings of other researchers who also indicate the positive impact of Design Thinking integration in agile organizations on their innovation, flexibility and ability to adapt in a dynamically changing environment.

Future research directions may focus on further exploration of the impact of design thinking on the efficiency and innovation of agile organizations in various sectors of the economy. It will be particularly important to extend the analyses to industries with high change dynamics, such as information technology, creative sector or healthcare, where the ability to iteratively improve processes and quickly adapt to changing market conditions are crucial. It will also be possible to in-depth study of the long-term impact of design thinking on the sustainable development of organizations, especially in the context of resource management, waste reduction and building an organizational culture that supports creativity and cooperation.

Further research may also focus on measurable effects of design thinking implementation, analyzing how this approach affects financial indicators, employee satisfaction level and organizational innovation. It will be crucial to develop methodologies that allow for precise determination of the degree of design thinking implementation and its correlation with business results, which will allow for a better assessment of the effectiveness of this approach. It is also worth analyzing factors limiting the implementation of design thinking, such as employee resistance, organizational structure or lack of appropriate tools supporting this process, which could provide valuable tips for organizations planning to implement this approach.

An interesting area of further research may also be the analysis of design thinking in combination with other modern management methods, such as lean management, agile or open innovation, in order to determine the synergies and potential barriers resulting from the integration of different approaches. It will also be possible to extend research on the impact of digital technologies on the development of design thinking, especially in the context of the use of artificial intelligence, process automation or tools supporting cooperation in distributed organizations.

Further exploration of the topic may also include comparative cross-cultural research, examining how cultural and structural differences in organizations affect the implementation and effectiveness of design thinking in different countries and regions. It may also be crucial to examine how social and public sector organizations can effectively use design thinking to solve social problems and improve the quality of public services.

The limitations of the conducted research result primarily from the nature of the method used and the specificity of the research sample. The study was based on a survey, which means that its results reflect the subjective opinions of respondents and may be susceptible to the declarative effect. It is possible that some answers were formulated in a way that was consistent with social expectations and did not necessarily reflect actual organizational practices. The research sample consisted of 303 respondents, which is a significant group, but does not allow for full generalization of the results to all organizations using the design thinking approach. The study did not take into account the division into different industries and sectors, which could provide more detailed information on the specifics of implementing design thinking in different business contexts. An additional limitation is the lack of comparative analysis with organizations that do not use this approach, which could allow for a more precise determination of its impact on the effectiveness and innovation of the organization.

Another methodological limitation is the use of MCA analysis, which allows for the identification of relationships between variables, but does not allow for the establishment of direct cause-effect relationships. In order to obtain more precise conclusions, it would be worth using data triangulation methods, taking into account both quantitative and qualitative methods, for example by conducting in-depth interviews with representatives of organizations implementing design thinking.

The time perspective was also not taken into account, which means that the study was cross-sectional and did not analyze the long-term effects of implementing design thinking in organizations. The ability to track changes over time would allow determining whether organizations consistently use the iterative approach or treat it only as a temporary tool introduced in selected projects.

The analysis of Design Thinking application in agile organizations can gain a broader perspective by referring to studies conducted in various economic sectors and geographical regions. Research in the technology sector indicates the effectiveness of Design Thinking in enhancing innovation and organizational flexibility, as evidenced by IT companies implementing iterative design processes. In the healthcare industry, this method facilitates the development of solutions tailored to patients' real needs, while in the education sector, it contributes to the advancement of interdisciplinary learning programs. Cultural and structural differences may influence implementation effectiveness, as demonstrated by studies in Asian organizations, where greater emphasis is placed on hierarchy and a structured approach to change management. Expanding the analysis to other industries and regions would allow for

a better identification of the determinants of Design Thinking effectiveness and potential barriers to its implementation.

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THE PROBLEMS OF CONSISTENT IFRS INTERPRETATION – THE CASE OF POLAND AND THE UK

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Purpose: The paper addresses the question whether Polish and British accounting professionals, confronted with identical IFRS excerpts, interpret probability expressions differently.

Design/methodology/approach: For the purpose of this study, a questionnaire was distributed, and a sample of accountants and auditors from Poland and the UK was asked to interpret the ‘in context’ probability expressions used in IFRS, establishing the threshold for the recognition of various accounting elements.

Findings: Our results indicate differences in the interpretation of probability expressions by the Poles and the British. Additionally, we show that the Polish accountants’ attachment to the prudence principle affects their interpretation. However, we are not in a position to state that this principle would not affect the probability level assigned by the British accountants.

Originality/value: The paper contributes to the findings of prior studies by providing the first comparative results for Poland and the UK in the field of surveying professional judgements under IFRS. Poland, like other transition economies, offers an interesting, yet challenging area for accounting studies, because its institutional orientation is significantly different to the Anglo-Saxon origins of IFRS.

Keywords: IFRS, interpretation, professional judgement, probability expressions.

Category of the paper: Research paper.

1. Introduction

The IFRS include a number of verbal probability expressions (VPEs) such as “probable”, “expected” and “remote” which are used to determine the recognition, measurement and disclosure of various items in the financial statement. Following IAS 37, par. 14, the provision is recognized when “the necessity of expenditure containing economic benefits for the purpose of settling obligations” is probable.

Many accounting studies reported differences in the interpretation of VPEs (Simon, 2002; Doupnik, Richter, 2003, 2004; Doupnik, Riccio, 2006; Salleh et al., 2011) which may result in the same standard being applied differently (Du et al., 2016). The interpretation of VPEs used in IFRS is inconsistent to such an extent that the cross-country comparability of financial statements might be under question (Simon, 2002; Doupnik, Riccio, 2006).

With the above in mind, the paper addresses the question whether Polish and British accounting professionals, confronted with identical IFRS excerpts, interpret VPEs differently. We hypothesise that differences in the interpretation will exist. Our survey data provide partial support for our hypothesis. Considering the Polish accounting professionals' attachment to the prudence principle and their British counterparts' attachment to the true and fair view principle (TFV), we also hypothesize that the prudence principle will have a significant impact on the interpretation of VPEs by Poles. By contrast, we assume that this principle will have no impact on British accounting professionals. We found strong support for this hypothesis for the Poles and no support for this hypothesis for the British.

There is a clear distinction between the two countries we have chosen for our study. Poland is considered an example of the Continental European model of accounting (Jaruga, 2002; Winiarska, 2009), whereas the UK as clear example of the Anglo-Saxon one (Doupnik, Perera, 2009). Despite IFRS implementation, Poland, in contrast to the UK, is still heavily dominated by the prudence principle, and taxes (Kabalski, 2012).

Our paper contributes to the findings of prior studies by providing the first comparative results for Poland and the UK in the field of surveying professional judgements under IFRS. Poland, like other transition economies, offers an interesting, yet challenging area for accounting studies, because it is a post-communist economy and so its institutional orientation is significantly different to the Anglo-Saxon origins of IFRS. Furthermore, we deliver the first survey results of the prudence principle impact on the interpretation of VPEs. To the best of our knowledge, no such research has previously been carried out.

This paper provides valuable insights into the consistent application of the IFRS. Our study should provide some tentative implications for standard setters to consider in using VPEs in IFRS.

The paper is structured as follows. It starts with a development of the hypothesis, followed by a description of the methodology and results. The final section concludes.

2. Literature review and hypothesis development

It has been argued that national accounting regimes of various countries differ remarkably in accounting rules and practices (Jaggi, Low, 2000; Schultz, Lopez, 2001; Richardson, 2007) and international differences are likely to continue under IFRS (Nobes, 2006). For Poland and

the UK, the following factors may have an influence on accountants and may result in different judgements.

Firstly, whilst Poland has long been dominated by the tradition of tax rules in accounting regulations, which affects their interpretation and application (Kabalski, 2012), financial accounts in the UK are said to be mostly free from tax influences (Roberts et al., 2008).

Secondly, the Polish tradition exhibits a more codified approach to accounting regulations than the common law convention which is the basis of accountancy in the UK (Hung, Subramanyam, 2007).

Third, for Poland and the UK, national cultural values identified by Hofstede (2010) differ significantly, especially in the degree of uncertainty avoidance. These values may affect accountants at an individual level and therefore may also be relevant in their judgements (Wehrfritz, Haller, 2014).

Fourth, the research conducted by Huerta et. al. (2016) shows that the manner in which the VPEs are interpreted might also depend on the language spoken to express a given expression. Following Hall's theory (1976), English is classified as a low-context language (Copeland and Griggs, 1985), whereas Polish is a high-context one (Zieba, 2008). Low-context languages are more precise than high-context ones (Huerta et al., 2016).

Finally, the translation from English is very likely to have a significant impact on the interpretation of the phrases expressing probability (Doupnik, Richter, 2003). The standards are set and published in English, but are also applied, after translation, in numerous local languages. Translations into other languages should, ideally, reflect the same ambiguity and scope for judgement as the English language original, and result in equivalent interpretations. However some empirical research finds that interpretations of uncertainty expressions in translation differ from those of the English original (Kettunen 2017; Davidson, Chrisman, 1993). For example a survey run in Canada by Davidson and Chrisman (1993) testing anglophone and francophone accountancy students showed that uncertainty expressions they gave to the English terms and their French counterparts were not equal. More recently, Kettunen (2017) provides interview evidence about IFRS translation into Finnish that suggests that the same degree or nuance of ambiguity can often not be preserved in translation.

Based on the above discussion we posit that:

H1: Polish accounting professionals interpret the VPEs used in IFRS differently than their British counterparts.

The prudence principle has been present in Polish accounting since 1934, due to German influences when the Polish Commercial Code, based on the German one, was implemented (Helin, 2005).

During the communist era, accounting aimed at providing the information required by central planners with "no place for the concept of the fair presentation nor for the TFV principle" (Lesko, 2007, p. 57). TFV occurred for the first time in 1991 when the Regulation on Accountancy Principles presenting a number of rules included in the 4th EU Directive was

introduced. The Regulation did not contain directly the prudence principle, yet it was clear in the guidelines to the methods of assets and liabilities valuation (Kabalski, 2012).

The new Accounting Act adopted in 1994 incorporated TFV, at the same time emphasizing that all transactions must be disclosed with prudence so as not to overstate the financial result. Thus, the prudence principle and the cost valuation method remained the dominant concept throughout the Act and accounting practice as well (Lesko, 2007).

In order to bring Polish accountancy closer to the IAS, the Accounting Act of 1994 was amended in 2000, decreasing the importance of the prudence principle (Kosmala, 2005). However, studies show that Polish accountants still “deem prudence the most important principle of evaluation in accountancy and consider it a realistic image of the company rather than pessimistic” (Hońko, 2008, p. 265).

In the UK, TFV is most likely to be the commonest solution applied to accountancy by having a major impact on the valuation and information presentation in the financial statements. The prudence principle is of little importance there. It is commonly believed that a prudential approach to resource and flow valuation might infringe the principle of true information presented in the statements (Hung, Subramanyam, 2007).

Prudence (conservatism) is defined as a “differential verifiability” required for the recognition of profits compared to losses. As Laughlin and Gray (1988) state, “the prudence or conservatism convention refers to the accountant’s tendency to be cautious - cautious almost to the point of pessimism.” The level of conservatism shared by the accountants might affect their interpretations of VPEs as they are used to establish the threshold for the recognition of various items (gains, assets, losses, liabilities) (Doupnik, Richter, 2004).

Based on the above discussion we propose the following hypotheses:

- H2:** The prudence principle affects the probability assigned by Polish accounting professionals. This principle is not influential on the probability assigned by British accounting professionals.
- H2₁:** Polish accounting professionals require a greater degree of probability in VPEs, resulting in them recognising items which increase the financial result rather than recognising items which decrease it.
- H2₂:** British accounting professionals require a lesser degree of probability in VPEs, resulting in them recognising items which increase the financial result rather than recognising items which decrease it.

3. Methodology

For the purpose of our study, we distributed a questionnaire including eleven excerpts selected from the IFRS containing the following VPEs: “probable”, “not probable” and “reasonable assurance”. We asked a sample of professional accountants to interpret these expressions establishing the threshold for the recognition of various accounting elements. We used a scale of 0 to 100 percent for each VPE. This approach is often used in accounting research (Doupnik, Richter, 2004; Doupnik, Riccio, 2006; Teixeira, Silva, 2009; Salleh et al., 2011; Chand et al., 2012).

In Poland, the questionnaire was sent to accountants and auditors selected during obligatory training courses offered by the National Chamber of Auditors. The training centres were selected randomly. Official Polish translations of the IAS excerpts were used. The English version of the questionnaire was e-mailed to members of the ACCA and ICAEW who work in accounting and auditing companies selected randomly from the website www.auditregister.org.uk. The authors’ intention had been to address a group of respondents of the same or similar size target group, and since a number of the forms did not reach all of the reference group, a new selection was required.

Because VPEs are used in particular IFRS in different contexts, both for the measurements of items resulting in a financial result increase or decrease, the respondents’ approach to the prudence principle is expected to have an impact on how they are interpreted.

The point estimates of probability expressions were summarized using mean, standard deviation. To find out whether the probability extent for events resulting in a financial result increase differs substantially from the probability extent for events resulting in its decrease, the Wilcoxon signed rank test was applied.

4. Results

Responses

Table 1 presents the response rates and respondent profiles.

Table 1.
Sample characteristics

Subject	Number of persons		No data	
	Poland	THE UK	Poland	THE UK
Questionnaires mailed:	984	995		
Study sample Total:	332	75	-	-
Response rate:	33.74%	7.54%	-	-

Cont. table 1.

Profiles of Respondents				
Gender:			2	12
– female	236	9		
– male	94	54		
Occupation:			14	22
– auditor/chartered accountant	183	36		
– financial director, chief accountant	60	7		
– księgowy				
– other ¹	75	10		
An ACCA qualification	37	11	23	24
Professional experience in a multinational company	80	8	21	21
Application of the IFRS in their work:			12	21
– regularly	61	17		
– occasionally	190	25		
– never	69	12		

Source: Own elaboration.

To determine whether the profiles of respondents affected their interpretation of the VPEs the U Mann Whitney, Kruskal Wallis and Spearman's rank correlation tests was conducted. The analyses showed that only for IAS 16, par. 7 (for Poland and the UK) did the older and more experienced respondents give the highest probability extent for the given standards ($p < 0.05$). In the UK none of the remaining factors had an impact on the probability assessment.

Test of H1

Table 2 presents the results of the interpretation of VPEs.

Table 2.

Mean level of probability assigned by Polish and British accounting professionals for VPEs used in the IFRS

IAS or IFRS/Par.	Polish translation	POLAND N = 316/332		English expressions	THE UK N = 54/75		p-value
		M	SD		M	SD	
Group 1: Resulting in measurement of items increasing the financial result							
12/24	jest prawdopodobne	63.81	23.80	is probable	65.06	16.24	.95
16/7	istnieje prawdopodobienstwo	67.82	23.61	is probable	63.55	18.02	.08
20/7	nie istnieje wystarczajaca pewność	61.38	27.84	reasonable assurance	71.67	17.71	< .05
38/57	prawdopodobne	64.68	23.91	probable	66.29	15.11	.81
Group 2: Resulting in measurement of items decreasing the financial result							
12/36	nie jest prawdopodobne	47.79	28.80	is not probable	50.07	19.42	.29
36/12	prawdopodobne jest	55.25	23.64	are expected	66.67	18.16	< .001
37/14	prawdopodobna jest	56.27	24.07	is probable	62.35	17.45	< .05

Source: Own elaboration.

¹ This group includes lower rank accountancy employees.

The Polish equivalent of the English expression “is probable” covers a number of phrases: “istnieje prawdopodobieństwo”, “jest prawdopodobne”, and “prawdopodobne jest”, the meanings of which are equal and convey the same sense as the one used in the original term. However, the expression “reasonable assurance” indicates “nie istnieje wystarczająca pewność”, which literally translated into English means “no reasonable assurance”. Although the meaning is the same, the Polish translation appears to be a contradiction of the phrase used in the original language version.

Moreover, in IAS 36 par. 12, the English phrase “are expected” has been translated to mean the same as “is probable” (“prawdopodobne jest”). Yet, following research findings (Doupnik, Richter, 2004), the phrase “are expected” has the value of a higher level of probability than “is probable”.

The findings show that the statistically significant differences in determining the level of probability by accounting professionals in Poland and the UK were noted in three out of seven analysed IAS excerpts. Poles assigned a significantly lower level of probability than the British. The most significant differences referred to those expressions whose translation was not a very strict meaning of the phrases used in the original version (IAS 20/7 and IAS 36/12).

Considering the above, the first hypothesis may be partially supported.

Test of H2₁

To test H2₁, a comparison of the mean level of probability was conducted for the Polish equivalent expressions of the English “probable” used in the IAS excerpts resulting in the measurement of items increasing or decreasing in the financial result (Table 3).

Table 3.

Comparison of mean level of probability assigned by Polish accounting professionals for the “probable” expression resulting in an increase or decrease in the financial result

Comparison of IAS/IFRS (N = 316/332)			Consistence with our expectations	z	p-value
Resulting in measurement of items increasing the financial result - mean level of probability	Resulting in measurement of items decreasing the financial result - mean level of probability				
12/24 – 63.73	36/12 – 55.25	>	yes	-4.80	.000
16/7 – 67.51	36/12 – 55.14	>		-7.26	.000
38/57 – 64.74	36/12 – 55.01	>		-6.56	.000
12/24 – 64.05	37/14 – 56.27	>	yes	-4.98	.000
16/7 – 67.85	37/14 – 56.37	>		-6.68	.000
38/57 – 64.51	37/14 – 56.47	>		-5.58	.000

Source: Own elaboration.

The Poles indicated a higher level of probability for items resulting in an increase in financial result than for items resulting in a decrease. These differences occurred in all comparisons and were statistically significant. Thus, we are in the position to state that the prudence principle affects the level of probability indicated by the Poles.

Test of H2₂

To test H2₂, an analogous comparison was carried out as in the Polish case. However, the results for IAS 36 par. 12 were not considered because in the English version, the phrase “are expected” was used instead of “probable”. Table 4 presents the results.

Table 4.

Comparison of mean level of probability assigned by British accounting professionals for the “probable” expression resulting in an increase or decrease in the financial result

Comparison of IAS/IFRS			Consistence with our expectations	z	p-value
Resulting in measurement of items increasing the financial result - mean level of probability	Resulting in measurement of items decreasing the financial result - mean level of probability				
12/24 – 65.69	37/14 – 62.35	>	no	-1.73	.08
16/7 – 64.65	37/14 – 62.35	>		-0.97	.33
38/57 – 66.30	37/14 – 62.35	>		-2.34	< .05

Source: Own elaboration.

The results are not as clear as in the Polish case. They indicate that in all comparisons, the British – contrary to our expectations – determined a higher level of probability for items resulting in an increase in the financial result than for items resulting in a decrease. However, only in two cases were these differences statistically significant. Thus, there are no grounds for a statement that the prudence principle does not affect the level of probability indicated by the British.

5. Conclusion

The results indicate the differences in the interpretation of VPEs by Poles and the British. In four out of eight examined IAS excerpts, Poles determined a significantly lower level of probability than the British. These findings allowed H1 to be partially supported. The results of our research are in line with those obtained by Doupnik and Richter (2003, 2004), Doupnik and Riccio (2006), Chand et al. (2012), and Hu et al. (2013). Additionally, those authors determined inconsistent interpretation of VPEs between respondents coming from different countries.

The analyses show that Poles assigned a higher level of probability for items resulting in an increase in the financial result than for items resulting in a decrease. It is consistent with their attachment to the prudence principle. Contrary to our expectations, the British did not require a lower level of probability to recognize items resulting in an increase in the financial result than items resulting in its decrease. Therefore, we are not in a position to state that the prudence principle would not have an impact on the probability level assigned by the British.

The most significant differences referred to the interpretation of VPEs whose translation did not truly reflect the English meaning. Our study, however, did not allow us to state whether the differences were the effect of the translation from English into Polish, or of a different understanding of the core of the given words and phrases used by individuals speaking different languages. Finding answers to these questions calls for more research.

This study is subject to some limitations. First, the results may be biased by the fact that most of the respondents were statutory auditors/chartered accountants. However, in both the British and Polish samples, the position held did not affect the accounting judgments made by respondents, which reduces the probability of such a bias in our results. Future research should extend the investigation to financial statements preparers, who may take a different view of accounting decisions than statutory auditors/chartered accountants. Another limitation of our study that needs to be recognized is the small sample size of British accounting professionals, which may have limited the generalizability of the results. Finally, the use of a number of different IFRS excerpts may have resulted in participants not being aware of the practical outcomes of their accounting judgments, especially if they do not frequently apply them at work. Hence, their decisions might have been different if they had been made in real-life work situations.

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ORGANIZATIONAL AND INDIVIDUAL DETERMINANTS OF ORGANIZATIONAL CYNICISM. CYNICISM AND OCCUPATIONAL BURNOUT

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Purpose: The aim of this review of research was to present the issue of organizational cynicism and its individual and organizational determinants. In addition, the relationship between burnout and organizational cynicism was discussed, which focused on an attempt to answer the question of whether cynicism leads to burnout or is a defensive reaction to burnout. A new direction of research was indicated, which concerns emotional predispositions that may allow for understanding this relationship. Instead, organizational cynicism is determined by individual and organizational factors, and the aim of this paper is to present findings in this area. Research conducted by scientists indicates many questions that remain unanswered. The main direction of research concerns the relationship between organizational cynicism and burnout. This topic is presented in this article.

Design/methodology/approach: The main research method was a critical analysis of the relationship between burnout and organizational cynicism.

Findings: It was found that the research that was not conducted does not provide a clear answer to the questions about the relationship between burnout and organizational cynicism. The review of research indicates the need to take into account psychological variables.

Research limitations/implications: The presented review of research indicates that it would be worthwhile to deepen the understanding of the emotional and behavioral component of organizational cynicism in the future. In addition, it is also advisable to search for the psychological determinants of cynical attitudes in organizations.

Practical implications: Research indicates that focusing on the organizational determinants of cynicism is insufficient. In understanding this phenomenon, it may be helpful to take into account the emotional sphere of employees, which accompany burnout and organizational cynicism.

Originality/value: A review of the research allows us to understand the need to continue research in this area, because many questions still remain unanswered. It presents the findings to date and indicates the need to include variables in emotional research.

Keywords: organisational cynicism, occupational burnout, types of cynicism, determinants of cynicism.

Category of the paper: Literature review.

1. Introduction

The Oxford English Dictionary (1989) defines a cynic as 'a person who shows a tendency to disbelieve in the sincerity or goodness of human motives and actions and tends to express this through derision and sarcasm; a sneering critic'. The concept of cynicism as a way of life emerged in ancient Greece and was treated as a virtue. It was defined as withdrawal from the world, affairs and avoidance of pleasure (Copleston, 1998).

It is most likely that the Cynics called dog sons took their name from a *gymnasium* called Cynosarges. Copleston (1998) threatens another etymology of the term. This was the unconventional life of the students of the school founded by Antisthenes, who opposed the authority of government and religion (Copleston, 1998). The concept has persisted to the present day. Cynicism is defined as a pessimistic attitude towards people's hidden and unclear goals; explaining events in a disillusioning way; and as showing concern for other people in an instrumental way to retain one's own benefits (Moutner, 1997; Tokgöz, Yılmaz, 2008).

Modern cynics are characterised by apathy and withdrawal and do not take action towards social change. They do not see the benefits in following moral rules, only limiting themselves to avoiding manipulation and malevolent authority (Kanter, Mirvis, 1989). Cynicism is no longer confined to specific groups of philosophers or schools of thought. It is considered to be present everywhere (James, 2005).

Anderson and Bateman (1997) consider a cynical person to be someone who looks only after their own interests and values them above all else without seeing the needs of others. It is also regarded as a negative attitude towards changing environmental factors.

2. Organisational cynicism

Organisational cynicism has been attempted to be defined as a personality trait (Cook, Medley, 1954) and as such has been regarded as a relatively constant disposition to be hostile towards the world and other people. Cynicism was expressed in the belief that other people should not be trusted (Costa, Zonderman, McCrae, Williams, 1986) because people are selfish and have bad intentions towards others (Graham, 1993 in: Dean, 1998). Graham includes among the traits of the cynical personality the perception of others as selfish, deceitful and uncommitted. Cynics, in his view, question the motives of others and are cautious, hostile and unwilling to make demands of others in interpersonal relationships. They do not exhibit friendly and helpful behaviour. They believe that being honest, kind and following the rules is not beneficial (Singelis, Hubbard, Her, An, 2003). Negative beliefs about human nature define cynicism and lead them to think negatively about their organisation. This causes them to look

for the source of their failures at work, unfulfilled expectations (no promotion, no raise) within the organisation. Cynics in the place of work distrust the motives of their leaders and believe that their employers, when given the opportunity, are going to take advantage of their efforts (Kanter, Mirvis, 1989). The results of this and related research allow for a more detailed test of cynicism and its relationship to specific managerial and organisational characteristics. As indicated by Chiaburu et al. (2013) cynicism as a trait is expected to be positively related to organisational cynicism. Organisational cynicism perceived in this way is independent of working conditions (Barefoot et al., 1989). Treating cynicism as a personality trait or stable disposition has not been confirmed by research (Guastello et al., 1992; Kanter, Mirvis, 1989; Mirvis, Kanter, 1991).

Most researchers tend to define organisational cynicism as an attitude that takes on a three-dimensional structure: cognitive, affective and behavioural (Andersson, 1996; Andersson, Bateman, 1997; Cole et al., 2006; Dean et al., 1998). Dean et al. (1998) suggest that organisational cynicism is not a personality trait, but an experienced state that can change over time depending on a particular objective.

As regards the cognitive dimension of organisational cynicism, employees believe that organisations betray them through a lack of fairness, integrity, reliability, sincerity and integrity (Özgener, Ögüt, Kaplan, 2008 in: Şen, Basım, 2005) and believe that organisations are self-interested and unscrupulous (Dean et al., 1998; Valentine, Elias, 2005).

Naus (2007) cites several studies indicating that the affective dimension of cynicism is represented by frustration and disappointment (Andersson, 1996; Andersson, Bateman, 1997) as well as pessimism (Reichers et al., 1997; Wanous et al., 1994). Andersson (1996) as an attitude characterised by disillusionment, uncertainty, anger, and distrust of institutions or individuals, groups and ideologies, as well as social skills possessed (Anderson, 1996). This definition greatly expanded the scope of cynicism explicitly by including an affective component.

The behavioural dimension of employee cynicism, on the other hand, manifests itself in perceptions of hostility in other people (Turner, Valentine, 2001), as well as distrust of groups, ideologies, social convention or institutions (Andersson, 1996; Andersson, Bateman, 1997; Turner, Valentine, 2001). Research by Anderson (1996) found that loyalty behaviour and other transcending roles decreased when former employees were cynical about the organisation.

Mirvis and Kanter (1989) define organisational cynicism by emphasising the lack of fulfilled expectations. With the formation of unrealistic high expectations comes the disappointment of not seeing them realised. Blau (1974) refers to this as 'reality shock'. Young apprentices with an idealistic attitude try to make the world a better working environment, but they are not always enabled to do so and are even hindered. They encounter neglect and even hostility from employers and customers. The focus on disappointment and growing frustration leads to the emergence of organisational cynicism (Andersson, 1996).

Moreover, management that promotes managers who treat employees badly with one-sided communication with employees can be a source of cynicism (Mirvis, Kanter, 1991).

Matrecia S.L. James (2005), on the other hand, defines organisational cynicism as an attitude associated with the employing organisation. This attitude is characterised by negative beliefs, feelings and associated behaviours. She indicates that cynicism is a type of response to situations experienced by an individual and is susceptible to change under the influence of the environment. Additionally, it is a response to a history of personal and/or social experiences that are susceptible to change by environmental influences. According to James (2005), organisational cynicism should be viewed as a negative attitude towards work rather than a fixed personality trait. When reviewing the literature, she noted that theorists distinguish five forms of cynicism:

- personal cynicism referring to enduring personality traits,
- social cynicism referring to negative emotions towards society,
- cynicism towards change refers to an employee's specific distrust of any organisational change. Reichers et al. (1997) noted that cynicism can perform many functions when it comes to organisational change. It can help to understand confusing events in their environment and serve as a defence, and cynical attitudes arise from experience and are justified when they are useful in the context of useful objectives.
- cynicism at work, which Durrah et al. (2019) considers as a component of occupational burnout,
- employee cynicism refers to the behavioural outcomes and negative attitudes of employees (Koçoğlu, 2014; Durrah, 2019).

As James (2005) notes, organisational cynicism does not necessarily encompass all forms of cynicism, as individuals who display cynical attitudes do not necessarily possess a fixed personality trait termed cynicism (Andersson, Bateman, 1997; Dean et al., 1998). Most contemporary researchers rather define cynicism as an attitude of contempt of frustration and distrust (Bateman et al., 1992; 1995; Kanter, Mirvis, 1989; Mirvis, Kanter, 1992; Wanous, Reichers, Austin, 1994).

The Andersson (1996) model is the most comprehensive theoretical model (Cole et al., 2006). It takes into account agreement violations, poor communication, unfair rude treatment and management incompetence that increase the level of employee cynicism. With her model, Lynne M. Andersson (1996) noted that individual dispositions of individuals can shape attitudes of cynicism. These include self-esteem, positioning of control, sense of justice, negative emotionality, machiavellianism, cultural norms and demographic variables.

3. Cynicism and occupational burnout

The occurrence of cynicism in organisations is widespread. This is indicated by a number of tests conducted in the USA, Europe Asia (Kanter et al., 1989; Durrah et al., 2019). The attitude of cynicism develops on similar grounds as occupational burnout, but with regard to a specific company rather than society or profession (Andersson, 1996; Maslach, Leiter, 1997; Macko, Łaciak, 2012). Strong negative emotions resulting from uncertainty of company rules, loss of meaning in work, suspicion of supervisors and disillusionment with tasks lead to decreased satisfaction with participation in the organisation, discouragement, exhaustion, emotional alienation and a sense of exclusion from the work environment (Abraham, 2000).

A number of factors are mentioned that can lead to cynicism at work and generate strong negative emotions. Cem Şen and H. Nejat Basım distinguish two types of factors determining the emergence of organisational cynicism: individual and organisational. The former refer to demographic variables:

- Age, gender, marital status and educational level (Chiaburu et al., 2013; Mirvis, Kanter, 1991). It is emphasised that ineffective national and inter-national institutions lead to disillusionment with injustice resulting from exclusion based on gender, race, education, background, disability or income (Macko, Łaciak, 2012). Mirvis and Kanter (1989) point out that the result is the development of a cynical attitude towards the employing organisation.
- Duration of employment (James, 2005).

Organisational reasons include a range of cognitive, emotional and behavioural factors:

- Andersson (1996) argues for the distinction of three factors. In his view, psychological contract violations and perceived contract violations are the main determinants of employee cynicism. He argues that the formulation of unrealistically high expectations; the experience of disappointment with the non-fulfilment of these expectations; and the subsequent disappointment leads to negative attitudes and behaviour, as unfulfilled expectations are the primary focus of contract violations (Andersson, 1996). Similarly Abraham finds that psychological contract violation is an important predictor of the occurrence of organisational cynicism (Abraham, 2000). As Abugre (2017) points out, cynicism in the place of work can result from violations of the psychological contract model and ultimately lead to an intention to change. This is why in his opinion it is so important to implement appropriate practices and policies that encourage effective relationships between co-workers, especially those related to adherence to the psychological contract in order to avoid progressive cynicism.

Organisational determinants of cynicism include:

- Selfish behaviour: power struggles, which often involves a lack of integrity (Davis, Gardner, 2004).
- Lack of support from the organisation (Fleming, 2005; Wanous et al., 2000).
- Lack of trust. Trust is indicated to play a key role in enhancing employee engagement and nurturing a supportive and collaborative work environment (Addison, Teixeira, 2020). It is based on the legibility of decision-making rules and open and honest communication (Bowen et al., 2016). Employees with higher levels of trust are shown to have positive attitudes towards the organisation and exhibit less cynical behaviour (Ozyilmaz et al., 2018; Singh, Srivastava, 2013 in: Khan, Firmansyah, 2024). Khan and Firmansyah's (2024) research supports the notion that an organisational environment in which employees perceive procedural and process justice results in a tangible reduction in their cynicism, fostering a positive and cooperative work environment.
- Lack of consistency between policy and practice, unethical behaviour (Dean et al., 1998),
- Lack of integrity (Dean et al, 1998),
- Organisational social responsibility and unfair remuneration policies, excessive working hours, organisational rules including bullying and poor management (Cartwright, Holmes, 2006).
- Role conflict and role ambiguity stems from the perceived contradiction and imbalance between the demands society places on them and the few resources they are given to do their jobs (Meyerson, 1990; Andersson, 1996),
- Poor communication, ineffective leadership and lack of respect for employees (Cole et al., 2006),
- Restructuring, downsizing and redundancies cause employees to experience a lack of meaningful work and have an unmet need for self-fulfilment (Abraham, 2000; Andersson, 1996; Andersson, Bateman, 1997; Bateman et al., 1992). Naus (2007) emphasises that the exchange relationship between employees and the organisation is then disturbed. Naus refers to the observations of Cartwright and Holmes (2006), who noted that organisations expect more from their employees and provide nothing but work or employment opportunities,
- Low organisational performance (Andersson, Bateman, 1997),
- Management failure to implement change and lack of staff involvement (Andersson, 1996; Ferres, Connell, 2004).

The consequences of organisational cynicism include a decline in organisational commitment, motivation and job satisfaction (Abraham, 2000; Turner, Valentine, 2001; Wanous et al., 1994, 2000; Urbany, 2005), an increase in suspicion, distrust and contempt of the organisation (Kanter, Mirvis, 1989, 1991) and other forms of psychological disengagement

and detachment (Guastello et al., 1992; Andersson, 1996; Feldman, 2000; Johnson, O'Leary, 2003; Fleming, 2005).

A growing problem seen in organisations is emotional exhaustion characterised by chronic emotional and interpersonal stress at work (Lahana et al., 2017). It results from excessive emotional demands from the organisation on the employee that the employee is unable to handle, resulting in depletion of emotional resources (Liu et al., 2020; Schaufeli, Buunk, 2003). Atalay (2022) suggests that emotional exhaustion lowers identification with the organisation and employees then withdraw from the organisation to preserve their emotional resources and protect themselves from further exhaustion. They further conclude that their beliefs do not align with the organisation, which reduces their trust in the organisation, and triggers cynicism (Chiaburu et al., 2013). In this case, cynicism acts as a defence mechanism to protect against occupational burnout. Cynicism is characterised by a negative attitude towards the organisation whereas trust in the organisation is expressed in a positive attitude towards it and impartiality towards it. Some researchers situate cynicism and distinctiveness on one continuum although some researchers have emphasised their distinctiveness (Dean et al., 1998). Chiaburu (2013) conducting meta-analyses found that cynicism and trust are strongly related but are still separate constructs. Meta-analyses showed that positive affectivity is negatively related to organisational cynicism, while negative affectivity and cynicism as a trait are positively related to this outcome. Organisational cynicism is enhanced by individual negative emotionality and trait cynicism and reduced by positive affectivity.

Research by Ahmed et al. (2024) highlighted the key role of organisational cynicism in mediating the relationship between toxic leadership and undesirable deviant behaviour in the workplace.

Occupational burnout is a metaphor commonly used to describe a state of mental fatigue occurring as a response to chronic stress. It was thought to apply to employees working with people (Maslach, Schaufeli, 1993). Nowadays, it is already accepted that it concerns occupations not exclusively related to service with other people (Maslach, Leiter, 1997). There are three dimensions of occupational burnout. The first is emotional exhaustion, the second is cynicism manifested by distancing oneself from one's work and the third dimension is a lack of achievement at work.

Demerouti, Bakker, Nachreiner and Schaufeli (2001) note that physical demands at work, such as time pressure, shift work are associated with exhaustion, while the lack of work resources such as performance feedback, job control, participation in decision-making, social support is associated with withdrawal, which is identified with cynicism (cf. Schaufeli, Bakker, 2004). Schaufeli and Bakker's (2004) research managed to observe that negative psychological states, i.e. occupational fulfilment (which in their view consists of emotional exhaustion and cynicism) and positive psychological states such as work engagement play a similar role in quite different processes. The former act as a mediator in the energetic process between high

demands and health problems. Involvement, on the other hand, mediates the relationship between available resources and organisational attachment.

In a study by Margaretha Viljoen and Nicolaas Claassenb (2017), cynicism was positively related to stress, as confirmed by an increase in cynicism as stress levels increased. A positive correlation was also found between cynicism and anxiety as a trait, but not anxiety as a state. This suggests that people who are more prone to stress and worry are also more likely to become cynical. It has been indicated that an increase in anxiety symptoms has previously been linked to cynicism, and this has been linked to occupational burnout, with cynicism seen as a causal factor (Ding, 2014). Margaretha Viljoena and Nicolaas Claassenb (2017) suggest that a tendency to worry and stress predisposes to cynicism, and that cynicism may favour the development of anxiety.

Research by Fatimah A. Altamimi et al (2021) verified the mediating role of occupational burnout. The researchers indicate that organisational support reduces both occupational burnout and cynicism. The research results also indicate a relationship between occupational burnout and organisational cynicism. It has also been confirmed that occupational burnout plays a mediating role in the relationship between organisational support and organisational cynicism.

Christina Maslach & Susan E. Jackson (1982), on the other hand, points out that the psychological and physiological consequences of organisational cynicism manifest themselves as emotional exhaustion, which essentially consists of the depletion of affective energy or resources and is characterised by physical and emotional breakdown. Cynicism is positively related to stress which confirms that cynicism increases with stress levels and ultimately causes burnout (Maslach et al., 1996; James, 2005). The concept of cynicism is similar to the depersonalisation dimension of the occupational burnout concept. It can be presented as a state of extreme physical or mental fatigue (exhaustion), a cynical attitude towards work and a tendency to evaluate oneself negatively in relation to job performance (Maslach, Jackson, Leiter, 1996).

Pamela Brandes and Diya Das (2006) disagree with this approach. In their view, there are several key differences. The researchers believe that depersonalisation as a component of occupational burnout cannot be regarded as a manifestation of organisational cynicism. Both concepts are characterised by a derisive attitude towards others, with depersonalisation being a concept that refers to customers and recipients of the employee's services. Organisational cynicism, on the other hand, is a negative attitude towards the employing organisation and the senior management of the organisation. In addition, they point out that organisational cynicism does not exclude professional commitment. In the case of occupational burnout, employees have a negative perception of their own performance as well as a denial of the value of their profession. Differences are also marked at the affective level. Disappointment and frustration are observed in both cases, but the objective of these emotions is different. Professionally burned-out people react negatively towards colleagues or themselves. Organisational cynicism on an emotional level refers to the company's management.

These concepts are thought to encompass negative emotions, but have a different objective. Johnson and O'Leary-Kelly (2003) found that (affective) organisational cynicism predicts a subscale of emotional exhaustion. If we consider the behavioural level, occupational burnout is characterised by employees' withdrawal from organisational life, whereas in the case of organisational cynicism, employees may take a more defensive stance by verbally opposing actions (Dean et al., 1998). Furthermore, the effects associated with occupational burnout are usually detrimental, but organisational cynicism can have a positive effect on the employee.

Brandes and Das (2006) noted the non-linear nature of the relationship between cynicism and performance. Moderate levels of cynicism can improve performance because it serves as a coping mechanism and, despite disappointment and frustration, does not lead to behaviours that might reduce performance at work (Johnson, O'Leary-Kelly, 2003). In contrast, low and high levels of cynicism are negatively related to performance. According to Brandes and Das (2006), employee cynicism may be a result of their critical appraisal of their work and may be a force for change in the organisation (Brandes, Das, 2006).

A large body of research suggests that cynicism is negatively related to both job performance and prosocial behaviour (Bakker et al., 2004, Demerouti et al., 2005). Research by Leiter (1993), found that emotional exhaustion leads to a cynical attitude as a coping strategy. It was also found that professional ineffectiveness also triggered a cynical coping strategy. Therefore, cynicism may mediate between emotional exhaustion and job performance and prosocial behaviour. This was confirmed in research by Bang and Reio (2017). Their research showed that the three components of burnout were negatively related to task performance, contextual performance and prosocial behaviour. Cynicism was also found to mediate the relationship between emotional exhaustion, ineffectiveness and task performance, contextual performance and prosocial behaviour.

4. Conclusions

Research on organisational cynicism in relation to occupational burnout is complex, as it shows that cynicism can be captured as one of the factors of occupational burnout and is then also treated as a defence mechanism against occupational burnout. On the other hand, some researchers indicate that organisational cynicism has a significant impact on emotional exhaustion, one of the main elements of occupational burnout (Abraham, 2000.) A sense of organisational injustice also leads to an increase in cynicism that in turn influences a higher risk of occupational burnout (Chiaburu, Peng, Van Dyne, 2011).

Besides, it should be noted that research on organisational cynicism to date has been mainly on organisational predictors of its emergence. However, it is advisable to look for some individual dispositions that make certain working conditions in some individuals induce less

undesirable psychological consequences including the emergence of organisational cynicism. It is likely that employees' emotional reactions may play an important role in shaping high or low levels of employee cynicism. However, there are few reports on this topic. According to the affective event theory (AET) of Weiss and Cropanzano (1996) to which Cole et al. (2004) refer, emotional reactions are the channel through which conditions in the place of work, and even the dispositions of individuals, influence work attitudes (Weiss, Cropanzano, 1996). Research by Cole (2004) indicates that emotions are not the end result but serve as a generative mechanism for the relationship between supervisor support and toughness and employee cynicism. They indicate that, for example, anger, worry or frustration may contribute to increased levels of psychological withdrawal and cynicism (Perrewé, Zellars, 1999). Likewise, feelings of guilt may help explain why some downsizing survivors reported elevated levels of cynicism (Kalimo et al., 2003).

The presented review of research shows the spectrum of considerations and studies that have been conducted, but also allows us to notice many areas that require deepening. Organizational cynicism is a cognitive, emotional and behavioral construct. The most space was devoted to the study of cynicism in its cognitive and emotional dimensions. It is noted that also taking into account the behavioral level could allow for a better understanding of organizational cynicism. Also, taking into account the consequences of organizational cynicism, which Şen, C., & Basım, H.N. (2023) talk about, such as: fraud, decreased motivation, emotional burnout, a sense of ignorance, etc., it seems reasonable to look for the psychological determinants of these problems. It is noted that cognitive competences can protect against fraud, but also greater distrust, which characterizes a cynical attitude, can hinder the acquisition of knowledge. It is a paradox that cynicism goes hand in hand with intelligence, but such a relationship was not found in the research of Stavrova, O. and Ehlebracht, D. (2018).

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AI-BASED TOOLS' IMPACT ON UNIVERSITY EDUCATION

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Purpose: The main reason for writing the paper was to present the latest research studies on using AI in education and present the survey studies on students' opinions according to AI-based tools in learning process.

Design/methodology/approach: The theoretical part of the article presents research from the last 5 years on AI in education and higher education. The empirical part presents the results of surveys conducted among students of the University of Economics in Krakow on their opinions on the impact of AI-based tools on their learning process.

Findings: The research show that the vast majority (95.1%) of respondents see that tools based on AI facilitate the learning process and provide valuable didactic support. Despite positive assessments, respondents express concerns about credibility, privacy and potential addiction to technology.

Research limitations/implications: The results suggest the need for appropriate regulation and education regarding the use of AI-based tools. The study is limited by the too rapid development of AI in recent times and the ever-increasing number of new tools used in the student learning process.

Practical implications: The study revealed that 95.1% of students find AI tools like ChatGPT, Canva, and Quizlet beneficial for learning, although concerns about credibility, privacy, and dependency remain. It suggests universities should implement AI tools and train staff in their use while addressing risks and ensuring equal access for all students.

Social implications: By highlighting the benefits of AI in education, the study may foster more positive public attitudes towards technological integration in learning environments. With AI tools enhancing the learning experience and potentially improving educational outcomes, students may enjoy improved academic success and career prospects, ultimately contributing to a higher quality of life.

Originality/value: The study is notable for its focus on students and their subjective assessments of the opportunities and concerns related to the use of AI, especially in the context of tools such as ChatGPT, Canva, and Quizlet, which sheds light on their growing importance and challenges in higher education.

Keywords: artificial intelligence, AI, AI-based tools, university education.

Category of the paper: research paper.

1. Introduction

The concept of Artificial Intelligence (AI) was born in the 1950s. The original goal of AI research was to create a human-like robot capable of thinking analogous to human thinking. It is important to note that the goal was not a typical computer program. A computer is not capable of thinking, drawing conclusions, learning, or creating new ideas, operating only from a strict set of instructions programmed in languages such as C++, Java or Ruby. The foundation of AI, on the other hand, is the automation of thought processes that humans normally perform. AI, understood in this way, encompasses a broad field that includes machine learning and deep learning (Chollet, 2018).

At the beginning of its development, AI focused on solving tasks that were intellectually challenging for humans but relatively simple for computers, such as games that require formal description, such as chess. Today, the main challenge for AI has become tasks that humans perform intuitively and that are difficult to formalize, such as speech recognition or identifying faces in photos (Goodfellow et al., 2016).

Education is one field that is experiencing significant tensions due to increasing computerization and changes in the labor market. The 21st century brings challenges, such as ensuring equal access to modern technology for a wide range of students. In this context, AI is emerging as an opportunity to address educational barriers and accelerate learning processes. Despite positive expectations, there are concerns about the impact of technology on education, which highlight the difficulties of adapting to rapid technological change (Witek-Crabb, 2012).

The aim of the article is to present the latest research on the use of AI in education and to present surveys on students' opinions on AI-based tools in the learning process. The first part of the article presents an overview of the latest research on AI in education and higher education, as well as the characteristics of selected AI-based tools used for learning by students. Next, a description of the research method and the results of surveys conducted among students of the University of Economics in Krakow on their opinions on the impact of AI-based tools on their learning process are presented. The aim of the study was to explore students' opinions on the use of AI-based tools during learning and classes, as well as the opportunities and threats associated with their use.

The originality of the presented article consists in its focus on students' subjective assessments of the opportunities and challenges associated with the use of AI-based tools in higher education, such as ChatGPT, Canva, and Quizlet. The study highlights the growing importance of these tools and reveals both their positive impact on the learning process and concerns about credibility, privacy, and potential dependency on technology. The findings, emphasizing the need for regulation and education regarding the use of AI in education, contribute significantly to the evolving field of research on technology integration in academic environments.

2. Literature review

With the ever-increasing popularity of AI-based tools, a great deal of scientific research is being undertaken on this issue, both in Poland and abroad. Research indicates that AI is becoming more prevalent in education, offering numerous benefits, but also posing risks and challenges that must be consciously addressed. The researchers point to the need to adapt the curriculum for generative AI and raise the issue of combining deep learning with symbolic AI (Bajak, Spendel, 2024).

Furthermore, an extensive literature review was conducted on the impact of AI on education in 2020. The aim of the research was to assess how AI affects administrative management, teaching and learning processes in educational institutions. The authors focused on various forms of AI application, from initial implementations in computers to advanced web-based and intelligent educational systems. The results indicated that AI has significantly improved administrative efficiency, enhancing the quality of teaching by personalizing learning materials and improving the learning process by tailoring content to individual students' needs. The study also highlighted the need for further research into the use of AI in education to maximize its potential while minimizing privacy and ethical risks (Chen et al., 2020).

The AI research also addressed the issue on characterizing students' attitudes toward the use of ChatGPT in education. A diagnostic survey method was used for the study, and an online questionnaire was completed by 189 students between the ages of 17 and 52. The results of the survey showed varying attitudes toward ChatGPT among students, with science students showing more positive attitudes compared to social sciences and humanities students. The study also found that these differences manifested themselves in both beliefs about the tool's usefulness and emotional responses to it. The article's authors recommend that educators prepare for student use of ChatGPT and develop guidelines for its use in educational contexts (Franczyk, Rajchel, 2024).

Studies on how students use AI have found, among other things, that: Students most often use it several times a week; ChatGPT is the most popular AI tool among students; Teachers mostly do not encourage students to use AI tools in the learning process; The main purpose of using AI in education is to facilitate access to educational resources (Raszyd et al., 2024).

The results of a survey conducted among students at the University of Economics in Krakow were also published. The purpose of the research was to identify students' opinions on the possibility of using ChatGPT in solving specific decision-making problems. The surveys were conducted during classes in the summer semester of the 2022/23 academic year. The results of the survey indicate positive impressions of most students towards the use of ChatGPT in classes, although there were also concerns about laziness, plagiarism and loss of information-seeking skills (Cabała et al., 2023).

The challenges facing modern universities in the context of the development of AI were also analyzed. The author used a literature analysis method to identify key challenges and risks associated with the integration of AI into educational processes. The analysis showed that despite significant financial resources and research freedom, universities are still too slow to respond to dynamic changes in technology. Charchuła stressed that full adaptation of educational systems to the rapidly changing artificial intelligence environment is impossible due to the difficulty of predicting its development. Nevertheless, a partial lack of adaptation can be beneficial, as it allows for caution and avoids the potential negative effects of adopting new technologies too quickly. The article suggests that universities should seek a balance between adaptation and caution to maximize the potential of AI while minimizing risks (Charchuła, 2024).

In addition, the literature discusses the opportunities and risks of AI in education. The author emphasizes that AI is a technological revolution with potential in education and there is no uniform definition of it. According to her, AI offers individualization of the educational process, personalization of materials, support for students with special needs; supports students with disabilities, such as by translating speech into subtitles, and helps teachers with administrative tasks and assessment. On the other hand, the author points out, there are concerns about the security of student data and the biases of algorithms; It is necessary to maintain ethics, security and privacy when using AI, and AI affects social interactions and relationships between teachers and students (Więckiewicz-Modrzewska, 2024).

3. Selected AI-based tools

In recent years, (AI)-based tools have revolutionized various aspects of life, including education. Teachers and students are increasingly using these innovations to facilitate the teaching and learning process. This chapter will present a selection of AI-based tools that can be used in the educational process (Hadaacs, Schulcz, 2021).

ChatGPT (<https://chatgpt.com/>) is an advanced natural language model developed by OpenAI that can generate texts, answer questions, and assist learning through dialogue. Teachers can use ChatGPT to design teaching materials, create exam questions, or even as an assistant to communicate with students. Students, on the other hand, can use ChatGPT as a resource for helping with homework, getting clarification on difficult questions, or learning through interaction.

Grammarly (<https://www.grammarly.com/>) is a grammar and writing style improvement tool that uses AI to analyze text and suggest revisions. It is an invaluable resource for students working on essays and for teachers preparing teaching materials. Grammarly helps identify

grammatical and stylistic errors and ensure text consistency, which is crucial in the academic world.

Canva (https://www.canva.com/pl_pl/) uses AI to simplify the graphic design process. Teachers can use the tool to create visually appealing presentations, posters or educational materials. Students will find Canva an easy way to prepare designs and presentations that are aesthetically pleasing and easy to read, which can help improve content comprehension.

Duolingo (<https://www.duolingo.com/>) is a language learning application that uses AI techniques to personalize the learning process. The tool adapts tasks and exercises to the student's individual pace and skill level, making learning more effective. Teachers can recommend Duolingo as a complement to traditional language lessons, allowing students to practice language skills in a variety of contexts.

Quizlet (<https://quizlet.com/pl>) is a platform that enables the creation of sets of learning fiches and various educational games. Using AI, Quizlet can analyze learning progress and adjust materials to maximize memorization. This is particularly valuable for both teachers who want to monitor their students' progress and students who are looking for effective methods of acquiring knowledge.

Each of these tools, based on AI, brings significant facilitation to the world of education, enabling personalized learning, efficiency in teaching and an interactive approach to knowledge acquisition. Their adaptation in schooling and higher education is becoming more widespread, and their benefits are evident at both the individual and institutional levels.

4. Methods

The purpose of the survey was to find out students' opinions on the use of AI-based tools during learning, in classes, and the opportunities and risks that arise from their use. The study used a survey method to collect data. A research tool was developed in the form of an online survey questionnaire. The questionnaire consisted of 9 questions. The questions were of a closed nature with the possibility of entering one's own answer. The stages of the research process are presented in Figure 1.

The main sample group of the study was students of the University of Economics in Krakow. The survey sample consisted of 102 students, of which 77% were female and 23% were male. 65% of the respondents were undergraduate students, and 35% were graduate students. As for the mode of study, 69% were full-time students, and the remaining 31% studied part-time. Among the respondents, the most frequent were students of economic analytics (23%), accounting and controlling (19%), and management (15%). In addition, students of project management, human resource management, international logistics, spatial management, marketing and market communication, and business innovation responded.

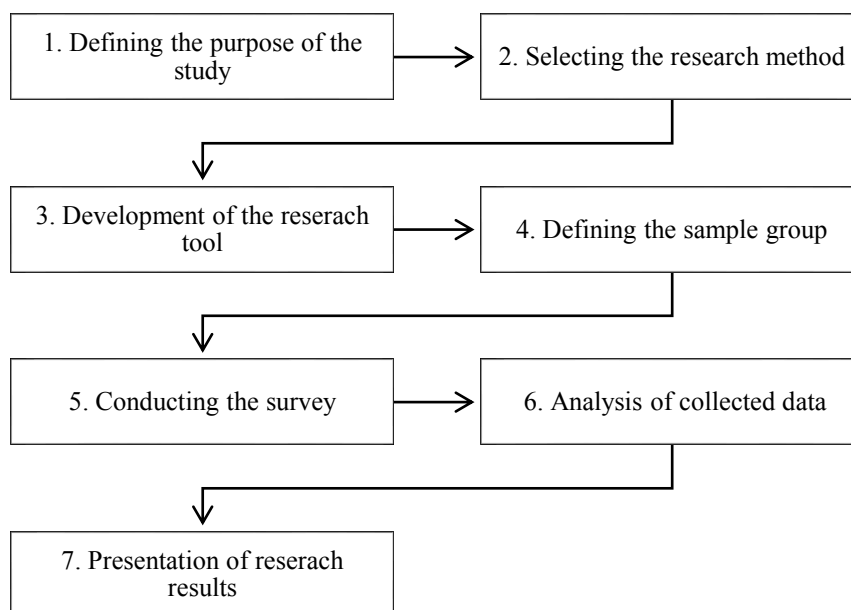


Figure 1. The research process stages.

Source: own elaboration.

The research was conducted in March/April 2024. The results of the study were presented in tables and charts, which included the percentage results of the questionnaire responses obtained. The results shown in the tables have been rounded to the nearest whole.

5. Results and discussion

The development of information technology, including tools based on AI, has revolutionized many aspects of daily life, including education. The article presents the results of a survey of university students to understand how AI-based tools are used by students and how they affect their educational process.

The results of the survey show that students at the University of Economics in Krakow are actively using various AI-based tools (Figure 2).

According to the results shown in Figure 2, ChatGPT is used by 86 respondents, accounting for 84% of the surveyed group. Grammarly, an aid for proofreading texts, is used by 23 students (23%), while Canva, a tool for creating graphics, is used by 58 people (57%). Duolingo, a language learning application, helps 47 respondents (46%), and Quizlet, a platform for creating educational fiches, is used by 63 students (62%).

Students at the University of Economics in Krakow perceive significant difficulties in learning without the support of AI-based tools (Table 1), with 76% stating that the lack of such tools would hinder their learning process. Only 24% see no significant impact of their absence on their educational experience. This underscores the growing dependence on technology in the educational world.

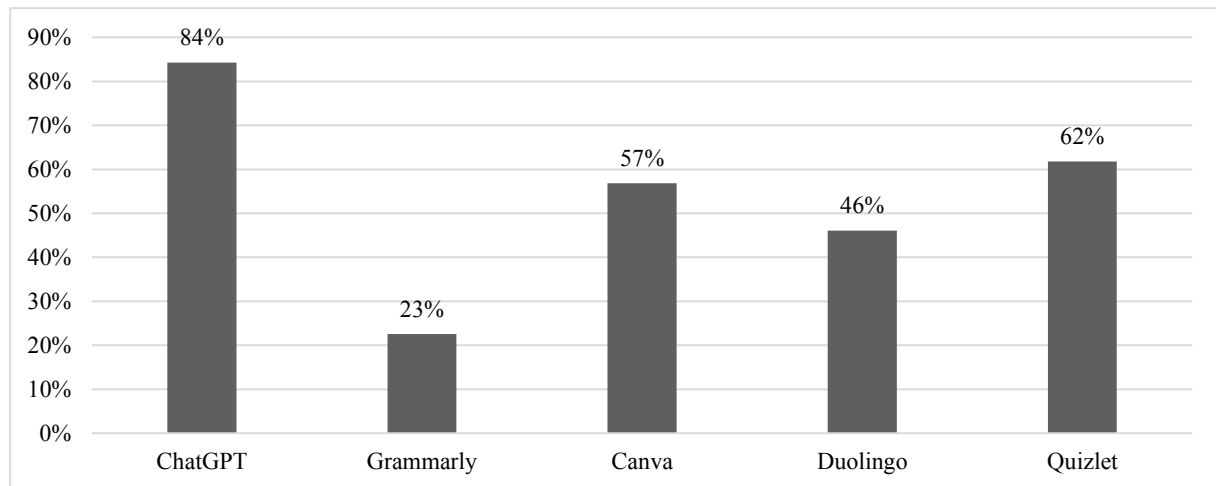


Figure 2. The use of AI tools by surveyed students.

Source: own elaboration.

The vast majority of respondents (95.1%) believe that the use of AI-based tools facilitates their learning process. Only 5% of surveyed students see no difference. These results indicate the important place AI-based tools can have in education, offering support in various aspects of learning.

Table 1.

The role of AI-based tools in learning by surveyed students

Student response	Learning difficulties without AI tools	Facilitating the learning process with AI tools
Yes	76%	95%
No	24%	5%

Source: own elaboration.

The majority of students (81%) are positive about the impact of these tools on the quality of their education (Figure 3). In addition, 14% consider this impact very positive, highlighting the significant role these technologies can play in improving the quality of learning.

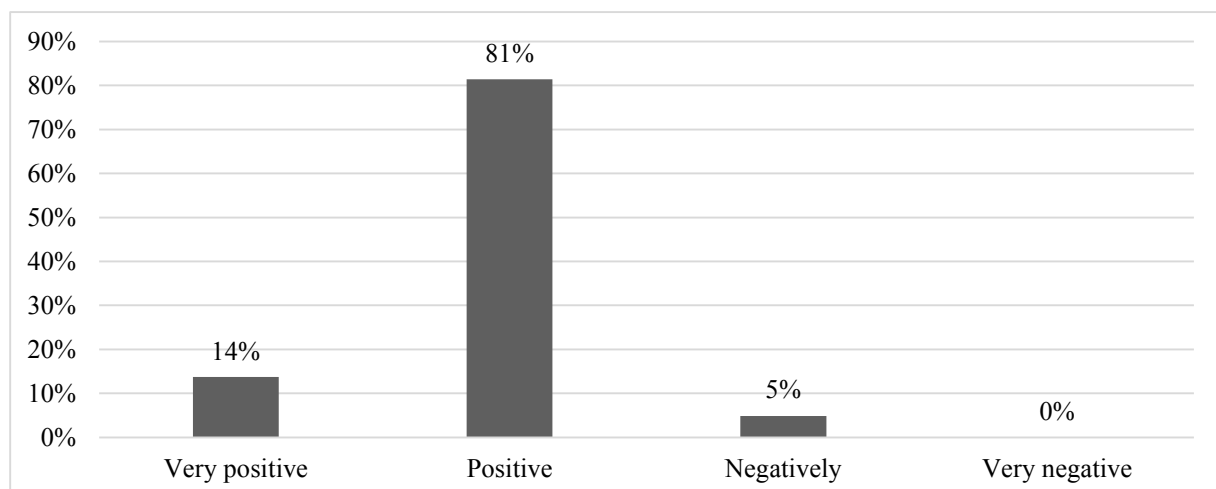


Figure 3. The impact of AI on the quality of education by surveyed students.

Source: own elaboration.

Respondents point to various opportunities associated with the use of AI. 66% of surveyed students point to improved learning efficiency, 40% point to opportunities to individualize learning, and 63% see the development of new teaching methods as an important asset (Table 2). These figures show the potential of AI to innovate in education.

Table 2.

Opportunities associated with the use of AI tools in the educational process

Opportunities	Percentage of student responses
Improving the efficiency of learning.	66%
Individualization of the learning process.	40%
Development of new teaching methods.	63%
Facilitating access to education for people with different needs.	60%
Adaptation of curricula to a rapidly changing world.	60%
I do not see opportunities.	0%

Source: own elaboration.

Despite the many opportunities, students also have concerns about using AI-based tools. The biggest of these are uncertainty about the reliability and integrity of the tools, expressed by 62%, and fear of becoming dependent on the technology and lowering critical competence, which concerns 67% of respondents (Table 3).

Table 3.

Concerns about the use of AI tools in the educational process

Concerns	Percentage of student responses
Concern about losing control over one's own learning process.	27%
Concern about data privacy, especially when collecting and analyzing personal data to tailor educational content to individual student needs.	41%
Uncertainty about credibility and integrity.	62%
Fear of becoming dependent on technology, lowering critical competence	67%
Anxiety about the social and economic consequences of possible exclusion of a group of people.	23%
I don't have any concerns.	2%

Source: own elaboration.

About half of the respondents (54%) indicate that only some teachers use these tools in their classes (Table 4). This may suggest the need for more widespread implementation of these technologies in the teaching process at the university, and, above all, training of lecturers in this area.

Table 4.

Use of AI tools in the classroom

Description of the phenomena	Percentage of student responses
Yes, most teachers use AI tools in the classroom.	0%
Yes, but only some teachers use AI tools in class.	54%
Teachers do not use AI tools in classes.	46%

Source: own elaboration.

Students' responses on the replacement of traditional teaching methods by modern ones (Figure 4) are divided. The majority, or 62%, express an opinion against the complete replacement of traditional methods by AI, emphasizing the value of conventional approaches

in education. However, 38% recognize that AI can fulfill the role of traditional methods, pointing to an evolution in the perception of teaching.

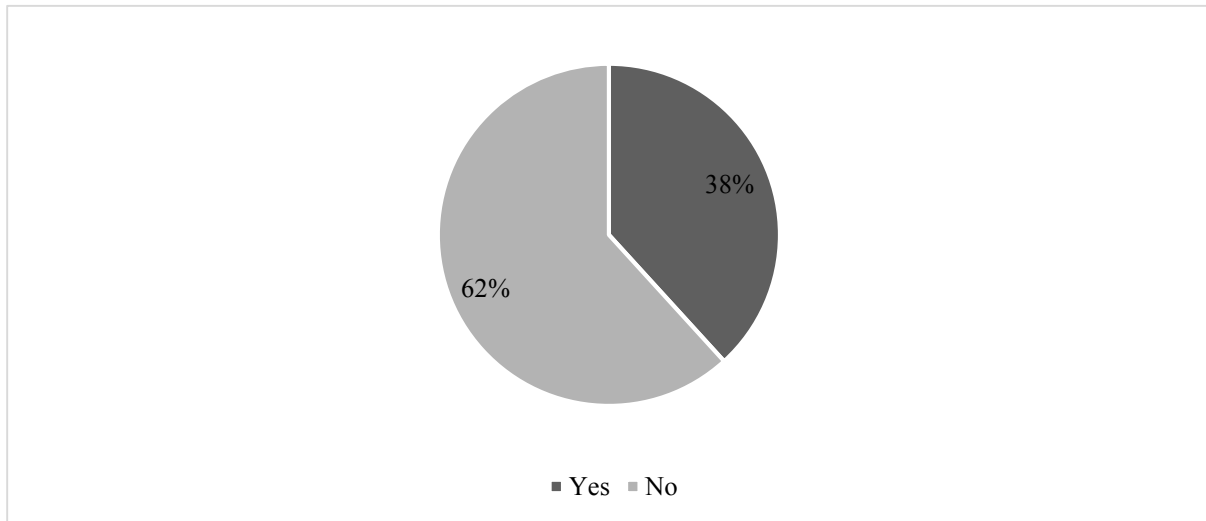


Figure 4. Replacing traditional learning methods with AI by surveyed students.

Source: own elaboration.

Table 4.

Students' opinion on full Introducing AI into the Educational Process

Description of the opinion	Percentage of student responses
Yes, completely.	8%
Yes, with some limitations.	81%
Rather not.	9%
Certainly not.	2%

Source: own elaboration.

Respondents are cautious about the idea of fully introducing AI into the educational process. As shown in Table 4, 81% are in favor of introducing them with some limitations, and only 8% support full introduction. About 12% are against any changes. These data illustrate that while students perceive potential, at the same time they are aware of the need to maintain control over the technological impact on their education.

6. Summary

The survey of students at the University of Economics in Krakow provides valuable insights into how AI-based tools are currently being used in education and the perceived opportunities and challenges of their use. The vast majority of respondents recognize that the use of AI tools facilitates the learning process, highlighting their value as a teaching support. These results clearly indicate a growing reliance on technology in the context of education, with an emphasis on tools such as ChatGPT, Canva and Quizlet, which provide significant assistance in a more effective and engaging educational process.

In addition, the majority of students are positive about the impact of AI on the quality of their education, which may suggest the significant potential of these technologies in raising standards and teaching efficiency. Nonetheless, concerns about credibility, privacy, and the fear of becoming dependent on the technology or lowering critical competence, which were expressed by a significant number of respondents, are a signal to consider the potential negative effects and the need for appropriate regulation and education on the use of these tools.

These findings suggest that universities should not only continue to implement modern AI tools in the teaching process, but also provide training for teaching staff in their effective use. This will allow for a fuller and more informed use of the potential offered by these technologies, while taking care to maintain a critical and ethical approach to education.

First of all, universities could create and implement policies on the transparency of the use of AI tools in education, taking into account the need to openly inform students about how data is collected, processed and used. In addition, universities should consider developing codes of ethics governing the use of AI, which would include rules on privacy and anti-dependency. It is also worthwhile for educational institutions to promote digital literacy courses and training to raise awareness among students and employees about the benefits and risks of AI. Regular audits of AI tools and collaboration with experts in technology law and ethics could ensure that the solutions being implemented comply with best practices and laws. In the context of this study's findings, universities and educational policy makers should also consider strategies to minimize the risks associated with over-reliance on technology and to guarantee equal access to AI-based educational tools for all students. Future research should focus on the long-term effects of integrating AI in education to ensure that its impact is positive for both current and future generations of students.

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LINKED OPEN DATA CONCEPT IN PUBLIC INSTITUTIONS – LOWER SILESIA (POLAND) CASE STUDY

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Purpose: The aim of the article is to review the level of advancement of linked open data (LOD) concept in public institutions, based on the example of Lower Silesia (Poland) organizations. Moreover, this paper considers the level of advancement of Lower Silesia institutions on the famous Tim Berners Lee's scale and compares the obtained results.

Design/methodology/approach: case study of important public institutions of Lower Silesia region, and the assessment of LOD concept advancement, based on 5-star Tim Berners Lee's scale and short expert interviews.

Findings: We can observe considerable interest and willingness to create a network of linked open data, which is visible in the growth of the number of data sets and the ever-expanding structure of the LOD cloud. Implementation of LOD in public institutions can be really helpful in management and decision-making processes. Public entities in Lower Silesia (Poland) should continue to develop their network to reach the highest level of advancement of LOD concept, especially in the context of integration with other data sets.

Research limitations/implications: The limitation of the research was the fact that not all public institutions are still familiar with the concept of linked open data, or do not use it to its full extent.

Practical implications: In the context of public institutions, LOD can play a key role in improving transparency, efficiency, and data-driven decision-making. Users can freely access information that is crucial to them and use it for interesting social or commercial projects, as well as individual ones.

Social implications: The practical implementation of LOD is also related to its social impact, everything depends on the type of data that is made available to users. Very often, they are related to administration, public transport, budget management of smaller and larger communities or health care, what can really contribute to improving the quality of life.

Originality/value: For the first time, the level of advancement of the linked open data concept in Polish public institutions was evaluated, which may improve the results in institutions already using this idea but also encourage them to develop the network of linked data resources.

Keywords: linked open data, management, decision making, big data, data analysis, public institutions, semantic web.

Category of the paper: research paper, case study.

1. Introduction

The concept of Linked Open Data (LOD) is one of the most practical and useful forms of organizing and publishing data. This approach consists in sharing data in an open and linked way, which allows them to be analyzed by public institutions, citizens, and the private sector. The practical implementation of LOD in public administration can lead to increased data credibility and transparency, support for the decision-making process, improvement of the quality of public services and better management of these entities, even in crisis situations.

The article covers key theoretical aspects and practical use of Linked Open Data in public institutions, especially on the example of Polish Lower Silesia region. Technological and organizational aspects will be considered, as well as an analysis of case studies from Poland, aimed at assessing the level of advancement in sharing data in an open and linked way. This study is based on rich literature on the subject, considering scientific research, government reports and legal regulations. The aim of the article is to review the level of advancement of linked open data (LOD) concept in public institutions, especially in the context of the possibility of using it in management and decision-making process based on the example of Lower Silesia (Poland) organizations. This research is also a case study of what kind of open data is available and what can be used by users: citizens, commercial companies, and public organizations. Moreover, this work places the level of advancement of Lower Silesia institutions on the famous Tim Berners Lee's scale and compares the obtained results. For the first time, the level of advancement of the linked open data concept in Polish public institutions was evaluated, which may improve the results in institutions already using this idea but also encourage them to develop the network of linked data resources.

According to the Ministry of Digital Affairs (Karpowicz, 2019), Polish government have set the directions for implementing the policy for opening data by 2027 and indicated the necessary actions to be taken. Within this framework "The Act on Open Data and Reuse of Public Sector Information and the Data Opening Program for 2021-2027" was established. The Program covers key issues in the field of sharing and managing data. It is addressed to government administration bodies, units subordinate to them or supervised by them, and the President of the Central Statistical Office. Additionally, it can also be implemented by other entities that create or store data, in particular local government units or private entities.

The specific objectives of the program are:

- increasing the availability of data on the Dane.gov.pl portal, including those made available via API,
- improving the interoperability and quality of data,
- increasing the use and exchange of data,
- stimulating the market for the reuse of cultural resources and scientific data,
- cooperation with national and international data stakeholders,

- raising the knowledge and skills of public administration employees in the area of opening and managing data and increasing public awareness of the potential of open data.

Unfortunately, on government websites and in case of commercial research it is difficult to find even the first attempts to assess the effectiveness of this program, in particular answers to questions what is the level of advancement of local public institutions in implementing the LOD concept? How is this data used – in what kind of projects or processes it can be helpful (especially is it similar like European or global examples of application)? Finally, what kind of barriers and challenges appear related to the implementation of the program? This knowledge gap motivated the author to undertake preliminary research on the example of Lower Silesia in order to assess the level of advancement in the use of the LOD concept in this region and to answer the research questions. In the future, comparisons with other entities from other regions and analysis of a larger number of nationwide projects should be planned, especially in 2027 to assess the effectiveness of this regulation.

The article consists of 5 chapters: introduction, literature review, where the current state of knowledge and key concepts are defined, examples of applications of European and global LOD concepts in decision-making and management, Lower Silesia (Poland) case study, where the research methods and results are presented, and the summary, where the research results and barriers, challenges and potential benefits of using LOD are discussed.

2. Literature review and basic terms related to Linked Open Data

The foundation of the Linked Open Data concept was presented in the publication of Sir Tim Berners-Lee (Berners-Lee, 2006), who proposed a completely innovative way of linking resources on the Internet - instead of a network of related documents (e.g. html files), he pointed to the need to create a semantic network of objects that, thanks to their connections, will give the user access to larger sets of information about the object of his investigations.

However, linked data term is different from linked open data, which is often confused and sometimes even unintentionally equivalently used. According to Ontotext analytic company (Yankulov, 2025) “Linked Data is one of the core pillars of the Semantic Web, also known as the Web of Data”. The Semantic Web should be not understandable only to humans, but also to machines, so data should be published in a unique way. Because of that, it is possible to create and continuously expand the network of connections between data on the Web of Data, as well as to create ontologies and semantic dictionaries of specific business sectors and industries.

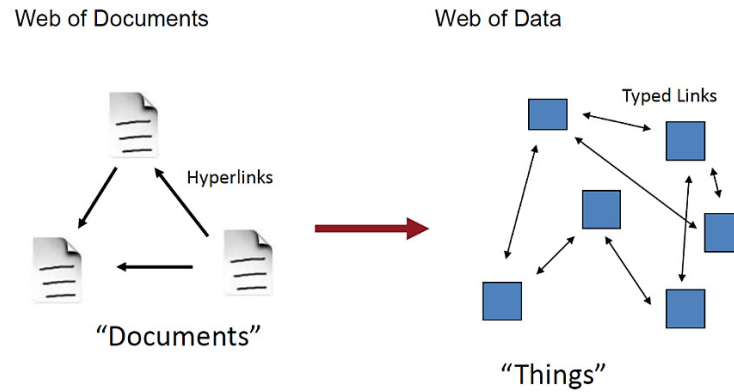


Figure 1. Semantic Web, transformation from web of documents to web of data.

Source: Fensel, 2013, slide 15.

In 2006, Tim Berners-Lee introduced four principles of creating linked data, which include:

1. using URIs (Uniform Resource Identifier) to identify resources on the Web,
2. sharing data in open formats such as RDF (Resource Description Framework), which allows us to describe a Web resource as a triplet: subject, predicate, and object. Moreover, because of the structure, it helps to create dictionaries and ontologies of Web resources,
3. using SPARQL standards for queries,
4. creating relationships between data sets to enrich informational context.

While in the case of open data, it's not necessary to link them for reuse, further distribution or any other business purpose, they can be just open and available to interested stakeholders. That's why linked open data is such a useful concept and very powerful combination of two approaches mentioned before, because it uses both open and linked sources at the same time and it's available under free licenses (e.g. Creative Commons).

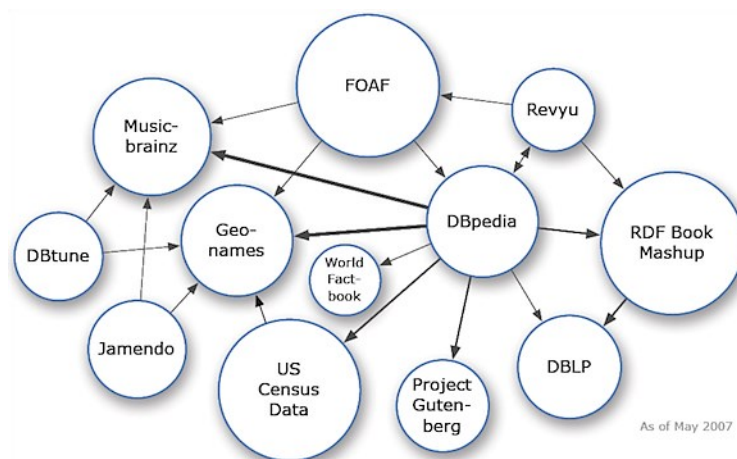


Figure 2. The linked open data cloud in May 2007 – very early stage of LOD concept.

Source: lod-cloud.net, 2025.

The most famous practical example of the LOD concept is DBpedia – a crowdsourcing database created in 2007 based on open, linked Wikipedia resources, allowing users to define queries and find connections between specific objects and other sources on the Web. The latest version of DBpedia (DBpedia, 2025):

- contains factual data from articles and infoboxes of the English Wikipedia Language Edition (WPLE),
- is enriched with labels and abstracts from the largest Wikipedia Language Editions,
- is enriched with rdf: type statements to several ontologies,
- contains approx. 900 million RDF triples (Jan 2021) but is steadily growing.

Almost at once, in 2010, after the success of DBpedia, this concept was adopted by other entities, e.g. Best Buy, BBC World Cup site, Google, Facebook and Flipboard. In 2011 Google, Microsoft, and Yahoo have even announced the joint vocabulary initiative for common meaning to data on the web which was called schema.org (Fox, 2011). In another publication (Bizer, Heath, Berners-Lee, 2009) the importance of linked open data in building interoperable information systems and it's growing role in public administration were strongly emphasized. In May 2012, Google's Knowledge Graphs were introduced – based on rooted in public sources such as Freebase, Wikipedia and the CIA World Factbook (Singhal, 2012) covering places, people, companies, businesses and more. By May 2020 Google has announced it contains approximately 5 billion objects, as well as more than 500 billion facts about and relationships between these different objects (Sullivan, 2020).

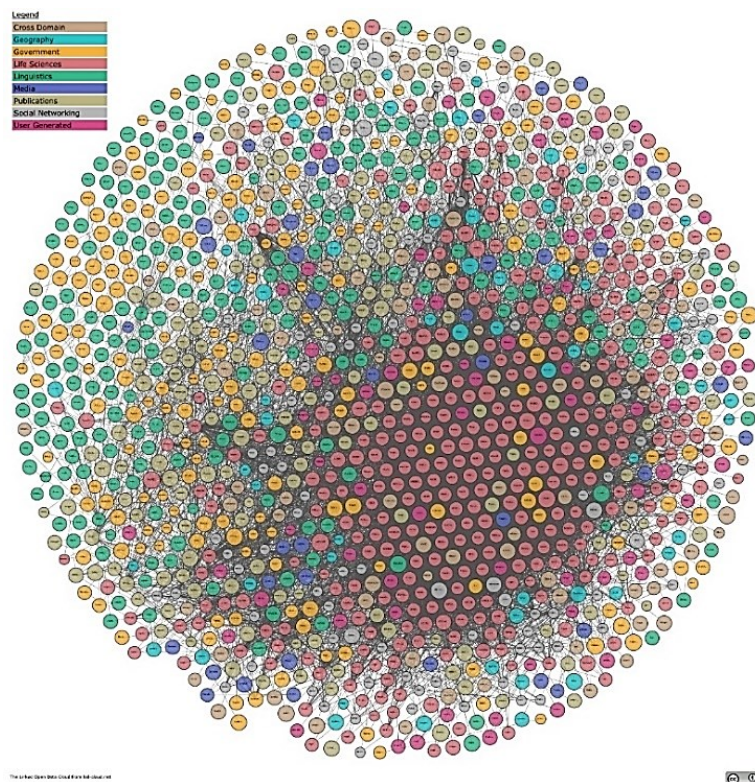


Figure 3. Current state of linked open data network.

Source: lod-cloud.net, 2025.

Today, there is still a need to take care of the form of sharing linked open data and its quality. This data should be free for users and made available in the form of linked, editable data sets that can be processed using open licenses. The number of such data sets, as shown in the figure below (Figure 4), is still growing, but these are often thematically related, hermetic graphs, often strongly related to the specifics of a given industry. On the one hand, this allows them to be used for research, strongly embedded in a given type of business, however, there is potential for further expansion of connections, so as to find integration points between different areas of business or science. As Hitzler mentioned (Hitzler, 2021) “recent activities around knowledge graphs are fueled by the strong industrial use cases and their demonstrated or perceived added value”.

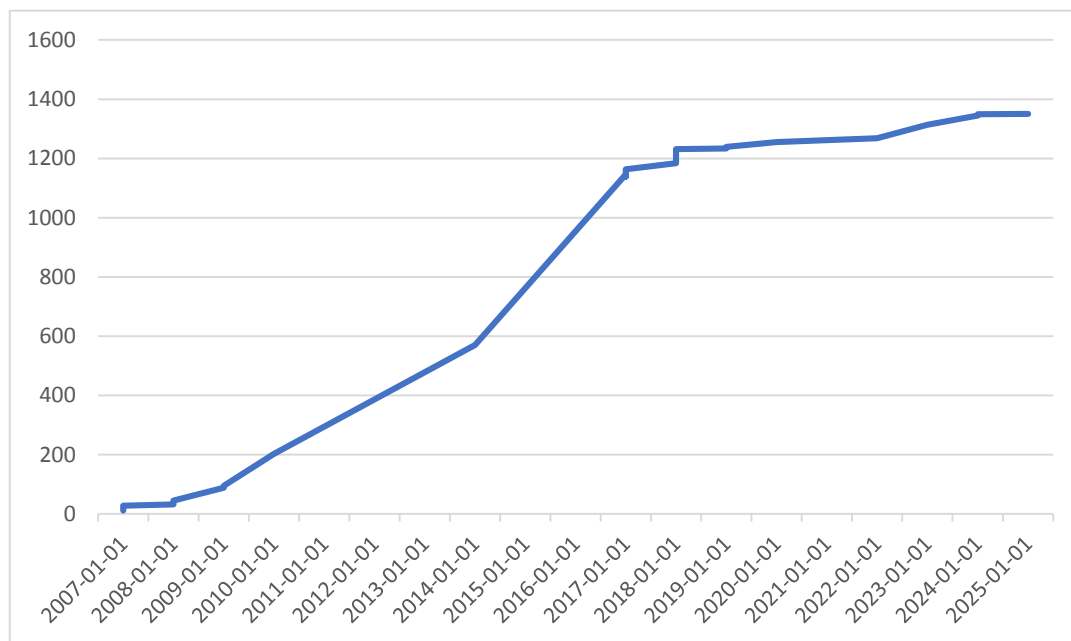


Figure 4. Number of datasets in the Linked Open Data Cloud over time.

Source: own elaboration, based on The Linked Open Data Cloud, (2025).

To sum up literature review, we can observe considerable interest and willingness to create a network of linked open data, which is visible in the growth of the number of data sets and the ever-expanding structure of the LOD cloud. However, there are not too many publications on how this data is published, whether it meets all the assumptions about its availability, and therefore how useful it is in the decision-making process and in the management of the indicated entities. It is also interesting to answer the question whether there are challenges and barriers in this area. In addition, the potential benefits of implementing a linked open data policy will also be discussed.

3. The usage of linked open data in public institutions – decision-making and management practices

The concept of linked open data in public institutions is widely used all over the world, both in local and global administrations. Publishing data in the form of LOD can improve the management of public resources, increase citizens' access to information, support the development of innovative services and, in general, improve the quality of life. Therefore, it is not surprising that there is a desire to use this idea, especially in the process of making key decisions for society and broadly understood resource and organizational management. The application can be very varied, starting from government administration and creating open data systems, through healthcare: epidemiological analysis and prediction of health threats or transport management - optimizing road traffic based on data generated in real time. The author would like to cite several selected examples of global applications of the LOD concept in public institutions supporting the management and decision-making process, although there are many more of them, and thanks to the constantly expanding network of dataset connections, new, interesting initiatives are constantly emerging.

Among the particularly interesting initiatives we can certainly mention:

- 1) **EU Open Data Portal** - provides information from different European Union agencies and Member States in a format compliant with the Linked Open Data principles. Recently The Open Data Maturity (ODM) 2024 report (Page et al., 2024) has been announced, which is an assessment of the progress of European countries in promoting and facilitating the availability and reuse of public sector information. The four dimensions of open data maturity were taken into consideration:
 - the level of development of national policies promoting open data,
 - the features and data made available on national data portals,
 - the quality of the metadata on national data portals, and
 - initiatives to monitor the reuse and impact of open data.

The following chart allows us to find out the composite linked open data maturity level, which countries are beginners, followers, fast-trackers and trend-setters in this field:

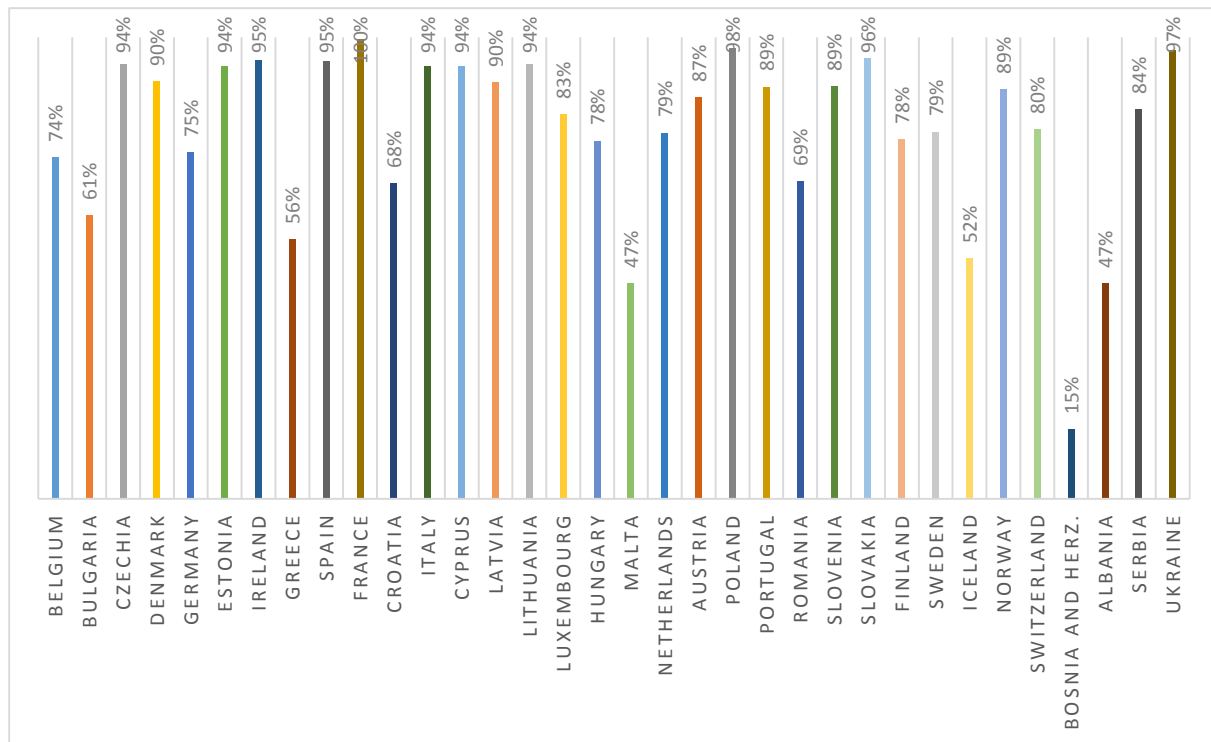


Figure 5. Composite open data maturity level among EU countries.

Source: own elaboration, based on Page et al., 2024.

Moreover, portal holds presents economic statistics, geographic data, and data related to environmental policies. It supports legislative processes by providing integrated information on the impact of regulations. Access to data by start-ups creating transport or environmental applications is also available to users.

- 2) **Data.gov in the USA and European countries releases** - Government Data.gov portals provide data from thousands of federal agencies in the United States and many regions/provinces in European countries. The data is published in open formats, which allows easy integration with other data sets. Resources include infrastructure and transportation data to optimize public transport routes, information to support public health decisions, such as analyzing epidemiological data during the COVID-19 pandemic, and advances in the development of tools for citizens to monitor budgets and the impact of government policies on local communities.
- 3) **World Bank – Atlas of Sustainable Development Goals (SDG)** - The World Bank provides LOD-compliant data to monitor progress towards the Sustainable Development Goals (SDGs). We can follow e.g. details about each country's poverty rate, health and well-being index, quality of life, economic growth, innovation, climate, and progress indicators, supporting decisions of on the allocation of development funds.
- 4) **INSPIRE – Infrastructure for Spatial Information in Europe** – an EU initiative aimed at making spatial data available in a LOD-compliant format. This data is used in environmental management and spatial planning. It enables monitoring of land use

changes to protect the environment and supports crisis response activities such as flood or forest fire rescue.

- 5) **OpenCorporates – Linked Open Company Data for Anti-Corruption Institutions**
- world's largest open database of company information. It is used by governments and public organizations to battle economic crimes. Useful tool to monitor public transactions and detect conflicts of interest but also analyze links between economic entities in money laundering investigations.
- 6) **FAO** – according to Food and Agriculture Organization of the United Nations (AGROVOC, 2025) it's "a Linked Open Data set about agriculture available for public use and facilitates access and visibility of data across domains and languages". It enables standardization of agricultural data, dictionaries and their integration with climate data. Moreover, it supports decisions in the field of food security and natural resources management.

These examples prove that Linked Open Data usage in public institutions can find application not only in administration and planning, but also in sustainable development, public health and environmental protection, supporting innovative decisions and the management of public services.

4. Lower Silesia (Poland) public institutions case study – research methods and the results

According to The Open Data Maturity (ODM) 2024 report (Page et al., 2024) Poland is one of the countries that is a trend-setter of European open data maturity level (Figure 5). The use of Linked Open Data (LOD) in Lower Silesia is an important element in the development of the information society and in sharing public data. The LOD initiative, widely promoted (as mentioned earlier) in Europe, combines open data with network technologies, enabling the creation of linked and easily accessible information resources. In 2012 (Klink et al., 2012), the "Strategy for the Development of the Information Society in Lower Silesia until 2020" was developed, the aim of which was, among others, to promote open standards and data interoperability. This document, prepared in cooperation between the Marshal's Office of the Lower Silesian Voivodeship and the Wrocław University of Science and Technology, emphasized the importance of open data in building a modern knowledge-based economy. An example of the practical use of LOD is a game project based on data on the Wrocław city budget, entitled "Media 3.0 SAP", which took third place in the first government hackathon competition in 2016, based on open linked data. It is worth mentioning that the first place was taken by the "Fingers" team for an application used to handle matters in public offices faster. The main objective of the research was to assess the level of advancement of websites

of public institutions in one of the dynamically developing regions of Poland – Lower Silesia – and in particular how they implement the concept of not only open data but also linked data. The research has a preliminary nature and lasts for two months from November to December 2024. The adopted methodology included case studies of important public institutions, and when the assessment was difficult due to technical reasons, it was decided to conduct short expert interviews with website administrators or representatives of the indicated entities. The choice of research methods was not accidental, both case study analysis and expert interviews are qualitative methods that allow for a detailed understanding of procedures and relationships within the studied object. These methods allow for taking into account the broad background of the studied phenomena, including social or organizational factors, and in the event of difficulties in assessment, they allow for asking questions that specify what a given phenomenon looks like in the research entity. These methods are also helpful to analyze unique use cases, if the studied phenomenon is unusual or exceptional, the case study allows for their thorough exploration, which is why they are often used, for example, in the analysis of entities implementing innovative technologies or technological concepts, as in the presented article. Moreover, the case study allows for the formulation of new hypotheses, especially in preliminary or pilot research, which can be verified in further extended studies on a larger number of entities. Unstructured interviews were used here, because it allowed for a short verification (when doubts appeared) whether the selected institutions meet the criteria of the LOD concept scale. Finally, the analysis of the content on the websites of selected public institutions in Lower Silesia will allow for the assessment of the level of advancement of the Linked Open Data idea. Several dozen examples were analyzed, but the article presents the most interesting ones, on which it was possible to collect and confirm the most reliable data. The need to conduct additional interviews only arose when the websites of selected institutions were very extensive and contained large data resources. The difficulty was mainly in assessing whether the website met the 5-star criteria on the Tim Berners-Lee scale. Website administrators or representatives of the indicated entities consisted of asking whether the posted data had links to other network resources, in other words whether they met the last criterion on the aforementioned scale. The answers placed the websites in the hierarchy of advancement in the application of the linked open data concept. In some cases, interviews were not necessary, because the structure of the website allowed us to assess the level of advancement of the entity's data publication. After selecting the examples, they were rated using the famous 5-star Tim Berners-Lee scale (Berners-Lee, 2006) which is as follows:

Table 1.*Tim Berners Lee's 5-star linked open data scale*

Scale	Explanation
1*	data should be accessible, in any form, under any open license, e.g. Creative Commons on the Web
2*	data should be accessible in a structured form, e.g. as a spreadsheet instead of its image or scan
3*	data should be accessible in an open format (e.g. CVS instead of Excel file), so data format is independent of the software vendor
4*	data should be marked with URIs and/or RDF description to facilitate identification and unambiguous reference to resources
5*	data should be linked to other data to provide context and enrich its value, creation of global network of information is possible

Source: Berners-Lee, 2006.

The assessment of websites of main public institutions in Lower Silesia in terms of Tim Berners-Lee's five-star scale requires an analysis of the availability and format of the data they provide. The higher the level on the scale, the more useful and easier the data is to reuse, also in the context of integration with other data sources. The results of the analysis and research are as follows:

- 1) **Wrocław City Office website (bip.um.wroc.pl)** – website of the capital of Lower Silesia region in Poland – Wrocław, provides a variety of public data, such as the city budget, spatial development plans, and demographic statistics. This data is often available in PDF or XLS formats, which ensures machine readability. However, there is no information about the use of open standards such as RDF or SPARQL, or about connections with other data sets. Additional interviews with experts did not confirm this information either. Therefore, this site can be rated 3 stars, as it provides data in a non-proprietary format, but does not meet the requirements of higher levels of scale.
- 2) **Marshal's Office of the Lower Silesian Voivodeship (bip.dolnyslask.pl)** – the official website of the Marshal's Office provides various documents and data on the region, such as development strategies, reports, and information on EU projects. This data is provided in formats such as PDF or DOC, which ensure machine readability. However, as in the previous case, there is no information on the use of open standards or on links to other data sets. Despite additional interviews, this information could not be confirmed. Therefore, this website can be rated 3 stars.
- 3) **Lower Silesia Geoportal (geoportal.dolnyslask.pl)** – portal provides geographic data in formats such as SHP or GML, which are machine-readable and non-proprietary. However, there is no information about the use of standards such as RDF or SPARQL and about connections with other data sets. Therefore, this portal can be rated 3 stars.
- 4) **Lower Silesian Voivodeship Office (www.gov.pl/web/dolnoslaski-uw)** – The website of the Lower Silesian Voivodeship Office provides various public data and information, such as press releases, statistics, and information on government programs implemented in Lower Silesia. This data is available in formats such as PDF or DOC, which ensures its machine readability. However, additional interviews did not confirm the use of open

standards and about connections to other data sets. Therefore, this site can be rated 3 stars.

- 5) **Wroclaw Open Data (www.wroclaw.pl/open-data)** – portal enables all interested stakeholders, including Wroclaw residents, to quickly and easily access public information collected by the Wroclaw City Office and other city units. The platform presents budget data, spatial, demographic, educational, cultural, environmental, social and communication data. Information is provided in formats such as WMS, GML, XLS, CSV, SHP, or DOC, which ensures machine readability. Portal uses standards such as RDF and provides links to other data sets or their graphical visualizations. Therefore, this site can be rated 5 stars. Unfortunately, the website is available only in Polish version.
- 6) **Bridge of knowledge (mostwiedzy.pl)** – the platform has been designed to meet all five levels of data openness. Resources about research infrastructure and scientific activity all over the country, also in Lower Silesia, are available to scientists, entrepreneurs and society in an open, simple and transparent form. It provides data in open, machine-readable formats, using standards such as RDF, and provides links to other data sets, allowing the full potential of Linked Open Data to be used. As such, the platform deserves a 5-star rating.
- 7) **Open Data Portal (dane.gov.pl)** – nationwide portal where institutions from Poland, including Lower Silesia region, share their data. The website provides access to data in open and machine-readable formats and also promotes their reuse (its marked by URIs). According to Data Governance Act (DGA) information point on the website – conditions of reuse of data are laid down individually in the course of processing a request and are adjusted to a given case, type of data requested, preferred way of accessing data, etc. However, there is no information about direct connections of data with other data sets via links. Therefore, this portal can be rated 4 stars.

Table 2.

Summary of research results

Name of website/Tim Berners Lee's scale	1*	2*	3*	4*	5*
Wroclaw City Office website	X	X	X		
Marshal's Office of the Lower Silesian Voivodeship	X	X	X		
Lower Silesia Geoportal	X	X	X		
Lower Silesian Voivodeship Office	X	X	X		
Wroclaw Open Data	X	X	X	X	X
Bridge of knowledge	X	X	X	X	X
Open Data Portal	X	X	X	X	
Average value:					3,71

Source: own elaboration.

5. Conclusions – potential benefits, challenges and barriers

The main aim of the article was to review the level of advancement in the use of linked open data (LOD) by public institutions, especially in the context of the possibility of using them in management and decision-making process based on the example of Lower Silesia (Poland) organizations. Thanks to the case study of selected institutions for which it was possible to verify the relevant data and conduct expert interviews, it turned out that the average level of advancement is equal to 3,71 on the 5-point Tim Berners-Lee scale. This proves a relatively high level of development of the linked open data concept of the websites of public institutions in Lower Silesia. However, it was noticed that in many cases there is still no visible connection between the data published on the websites of such organizations and other resources on the Web, which is why only 2 websites achieved the maximum score. Of course, this may be due to the fact that the research was preliminary. In the future, in order to deepen the analysis, a comparison of entities from different regions of Poland is planned, and perhaps also international research using surveys. On the other hand, the concept has been known for over 20 years now, and the sets of open linked data are still expanding (Figure 4). Moreover only 2 years left to the end of government “The Act on Open Data and Reuse of Public Sector Information and the Data Opening Program for 2021-2027”, so we should expect the first effects. Therefore, it can be concluded that some public institutions should consider how to achieve a better result, especially when it comes to data integration and its practical usage. Of course, this may involve numerous challenges and barriers that they will have to overcome. It seems crucial to increase the awareness of employees of public institutions of the benefits of the concept of linked open data. Even during short expert interviews, it was not so obvious to institutions’ representatives that LOD allows the use of data from various sources, building a network of related data, their integration and interoperability, as well as standardization of formats, which facilitates machine processing. Additionally, it can contribute to fulfilling the mission of such entities, as data becomes more accessible and transparent to citizens. Standardizing data, and therefore publishing it according to Tim Berner-Lee's principles mentioned earlier, allows for easier integration of data from different sources and ensures their semantic compatibility. Problems may arise from differences in data modeling, which require data mapping or the way ontologies are created. Another challenge is the fact that in many cases the data sets are very hermetic and thematically related, so the expansion of linked open data and integration of many sources can create more comprehensive, enriched resources. An additional argument is the flood of information on the Web – it’s obvious that we live in the era of big data, so linked open data concept is the chance to find interesting content more easily and apply an appropriate licensing policy, which can definitely improve the quality of scientific research, analytical, decision-making and management processes. LOD concept in the case of public institutions is also the chance to cooperate with business and jointly develop innovative

ideas. This is shown by the example of Hackathons. Companies can use public data under appropriate licenses (e.g. Creative Commons) to build applications such as semantic search engines, intelligent recommendation systems or data visualization platforms or new business models. Moreover, for organizations themselves, the use of linked open data can be crucial for organizing internal or external information and knowledge management. Technical limitations may be a significant barrier in the case of public institutions, especially in the context of preparing and sharing data in the right formats. Software supporting LOD must be compatible with semantic web technologies, enabling easy connection, processing and sharing of data. Interoperability between different systems may require support for different versions of standards and APIs. The software must support key LOD standards, such as RDF, SPARQL, OWL, JSON-LD. Not all systems support the full set of these standards, which can cause difficulties in data exchange. The software should be able to convert between different formats (e.g. RDF to CSV, XML, or JSON-LD) for integration with other applications. In addition, LOD standards evolve (e.g. new versions of OWL or SPARQL), so the software must be regularly updated. Older systems may not support newer features, which leads to compatibility issues in the LOD ecosystem. Small budgets allocated for such projects can be also quite problematic. Developing guidelines for the appropriate publication of data, especially in the context of protecting their privacy and security, may also be a challenge. Privacy protection, especially in the case of personal data, requires the use of anonymization and access control mechanisms and appropriate encryption. In each case, an individual decision should be made about the possibility of sharing, because once something is shared, it will remain so, which can significantly affect the reputation of the entity. Therefore, it seems necessary to invest time and financial resources in further training or workshops in public institutions to raise awareness of the benefits of LOD, to develop technical competences and consistent standards to facilitate the implementation of these practices. It is hoped that this research will help public organizations to assess their own level of advancement in implementing the linked open data concept and to take corrective actions if it's necessary.

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LABOR MIGRATION IN THE CONTEXT OF SUSTAINABLE REGIONAL DEVELOPMENT

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Purpose: Labor migration plays a crucial role in shaping regional economies and social structures, particularly in the context of sustainable development. Understanding the relationship between migration flows and regional sustainability is essential for addressing economic disparities, labor market dynamics, and environmental concerns. This paper examines how labor migration is explored in academic research within the framework of sustainable regional development.

Design/methodology/approach: The study employs bibliometric analysis to examine labor migration research within the framework of sustainable regional development. The analysis is based on data retrieved from the Web of Science and Scopus databases, without time restriction. A structured literature review was conducted, and quantitative results were visualized using bibliometric maps generated in VOSviewer. This approach enables the identification of key connections between labor migration and sustainable regional development research.

Findings: The study highlights the evolving research trends in labor migration and sustainable regional development. It identifies the most recent and influential areas explored by the academic community, shedding light on the dominant themes and gaps in the literature.

Originality/value: The article contributes to the understanding of how labor migration is studied in relation to sustainable regional development, offering a comprehensive bibliometric overview. The findings provide valuable insights for researchers, policymakers, and practitioners interested in migration policies and regional sustainability strategies.

Keywords: sustainable development, labor migration, regional development, economic integration.

Category of the paper: Literature review.

1. Introduction

Labor migration has long been a key factor in shaping regional economies and social structures, influencing both economic growth and demographic change (Castles, 2010; Martin,

2022). As globalization accelerates and economic disparities persist, the movement of workers across regions and borders plays a critical role in labor market dynamics, regional development, and socio-economic sustainability. The study of labor migration is particularly relevant in the face of contemporary challenges such as technological shifts, demographic aging, and policy transformations that affect both sending and receiving regions (Harris, Todaro, 1970; Massey et al., 1993). Understanding these dynamics is essential for designing policies that promote balanced regional development while addressing issues related to workforce shortages, integration, and economic resilience.

This study provides an overview of the literature on labor migration and regional development. Using a systematic review approach, it evaluates recent trends, key subject areas, and the most commonly used terms in research publications from Web of Science (WoS) and Scopus databases. The focus of this paper is to address research questions related to current academic discussions, emerging themes, and conceptual frameworks in labor migration and regional development. Furthermore, the study examines how migration patterns contribute to economic restructuring, employment distribution, and spatial inequalities within regions.

The primary aim of this study is to map out the growing body of literature on labor migration and regional development by analyzing research within commercial databases of texts described as high quality. By doing so, this study identifies the key topics and geographical regions that have been central to scholarly discussions in recent decades. The increasing attention to labor migration has been shaped by major global events, such as the European Union's labor mobility policies, the impact of automation on employment structures, and the post-pandemic recovery of labor markets. Additionally, the paper explores how labor migration has been influenced by geopolitical shifts, including Brexit, the expansion of international trade agreements, and regional labor shortages.

This systematic review aims to assess the key trends in academic literature on these interconnected topics and to identify gaps in research, particularly regarding the long-term impacts of labor migration on regional development. While research on labor mobility has expanded, certain critical aspects—such as the effects of labor outflows on sending regions, the sustainability of remittance-dependent economies, and the integration of migrant workers into host communities—remain underexplored. The study also highlights the shifting focus of migration studies, with increasing attention to themes such as "circular migration", "brain drain", and "regional labor market mismatches" in response to contemporary labor mobility challenges.

Several scholars have examined the complex relationship between labor migration and regional development. Piore (1979) and Sassen (2013) explored the role of migration in dual labor markets, emphasizing how migrant workers often fill low-wage and temporary positions in host economies. More recent works Van Hear, N., Bakewell, O., & Long, K. (2020), Lagakos (2020), de Haas (2021), Tipayalai (2020) and Fu & Gabriel (2012) have analyzed migration as part of broader global economic structures, showing its influence on economic inequality, labor

policies, and regional sustainability. These studies suggest that labor migration presents both opportunities and challenges for host regions, depending on economic policies, labor demand, and social integration mechanisms.

Despite the growing body of literature on labor migration and regional development, research gaps remain, particularly regarding the long-term sustainability of migration-driven regional economies. Scholars such as Rodríguez-Pose (2018) and Kone & Özden (2017) have argued that while migration can enhance regional economic performance, these benefits are often contingent on governance frameworks and local institutional capacities. Moreover, while much research has focused on European and North American labor migration, emerging patterns in Africa, Latin America, and Southeast Asia remain underrepresented in academic discourse.

In addition to addressing these gaps, this paper builds on recent discussions by scholars such as Anderson et al. (2021), Khanna (2020), Newland, K. (2020), McAuliffe & Triandafyllidou (2021), who highlighted how the COVID-19 pandemic reshaped labor mobility patterns and introduced new challenges related to remote work, digital migration governance, and health security in labor markets. The research further explores how economic crises, automation, and climate change are shaping contemporary labor migration trends, leading to shifts in regional development strategies.

Using WoS and Scopus data, this paper examines key research questions related to the evolving discourse on labor migration and regional development. It highlights how global economic changes, labor market restructuring, and policy interventions influence migration flows, workforce distribution, and regional growth patterns. The findings of this study contribute to the growing body of literature on labor migration by providing a comprehensive bibliometric analysis of the field. Moreover, the study offers valuable insights for policymakers, labor market analysts, and regional development practitioners seeking to align migration policies with sustainable development goals. By synthesizing current research and identifying gaps in the literature, this paper aims to provide a foundation for future studies and policy recommendations that enhance the positive impacts of labor migration on regional economies.

2. Material and methods

The topic of migration has been analyzed by the authors from three perspectives: crisis, sustainable development, and resilience. This paper is the second of three parts that delve deeper into the issue of migration, exploring its complexities and multifaceted nature. Together, these perspectives offer a holistic view of migration as a dynamic and evolving phenomenon. By examining migration through these lenses, the authors aim to provide a comprehensive understanding of its causes, consequences, and potential solutions. The crisis perspective

highlights the urgent challenges and humanitarian aspects like refugee migration, the sustainable development approach focuses on long-term strategies for integration and economic impact, while the resilience framework examines how individuals and societies adapt to migration-related changes.

A systematic literature review (SLR) is using systematic and transparent procedures to identify, select and critically appraise research that meets explicit prespecified eligibility (Villar, 2022). The study involves conducting a bibliometric analysis, treated as popular and rigorous method for exploring and analyzing large volumes of scientific data (Donthu et al., 2021). It is a method of quantitative research based on academic publications as a data source. Its application is the better understanding of how research is produced, organized, and interrelated (UCSF Library, 2023). Using the VOSviewer, link analysis was worked on. It enabled the presentation of a visual network of connected entities as nodes and links (Cambridge Intelligence, 2023).

The study consisted of three stages. The first was related to the preparation of a group of inquiries regarding the issues of labor migration and sustainable regional development, such as: „wage migration” AND „regional development”, „wage migration” AND „sustainable development”, „wage migration” AND „economic growth”, „wage migration” AND „socio-economic development”, “economic migration” AND „regional development”, “economic migration” AND „sustainable development”, “economic migration” AND „economic growth”, “economic migration” AND „socio-economic development”, “labor migration” AND „regional development”, “labor migration” AND „sustainable development”, “labor migration” AND „economic growth”, “labor migration” AND „socio-economic development”, “labour migration” AND „regional development”, “labour migration” AND „sustainable development”, “labour migration” AND „economic growth”, “labour migration” AND „socio-economic development”. These queries were entered separately into the Web of Science (WoS) and Scopus databases. Files in Tab-delimited format were downloaded from WoS, and in CSV (Excel) format from Scopus. As a result, a total number of 1,161 documents was obtained (338 for WoS and 823 for Scopus, respectively). No time limit was applied under the inclusion and exclusion criteria.

As part of the WoS database - 1/3 of the texts were open access. Among the Web of Sciences categories dominated: economics, business, management, demography, and environmental studies. The texts came mostly from China, the USA, and Russia. More than 8 out of 10 indexed texts were written in English. As part of the Scopus database, over 2/3 of the texts were open access. The main subject areas include social sciences; economics, econometrics and finance; environmental science, and arts and humanities. The documents most often came from the USA, United Kingdom, China and Russian Federation and, as in the case of WoS, the dominant language of publication was English (9 out of 10 texts).

In the second stage, duplicate documents were removed in each database separately, resulting in a total number of 717 documents through negative selection (314 for WoS and 403

for Scopus, respectively). The structured literature review process and the quantitative results obtained after two stages of selection are presented in Figure 1.

In the third stage, the analysis of these texts was undertaken separately for each database, using the software tool for constructing and visualizing bibliometric networks - the VOSviewer program. The visualizing Network identified the key threads in the documents developed so far within the selected issue and is useful, among others, to determine directions for further research (Hamidah et al., 2020).

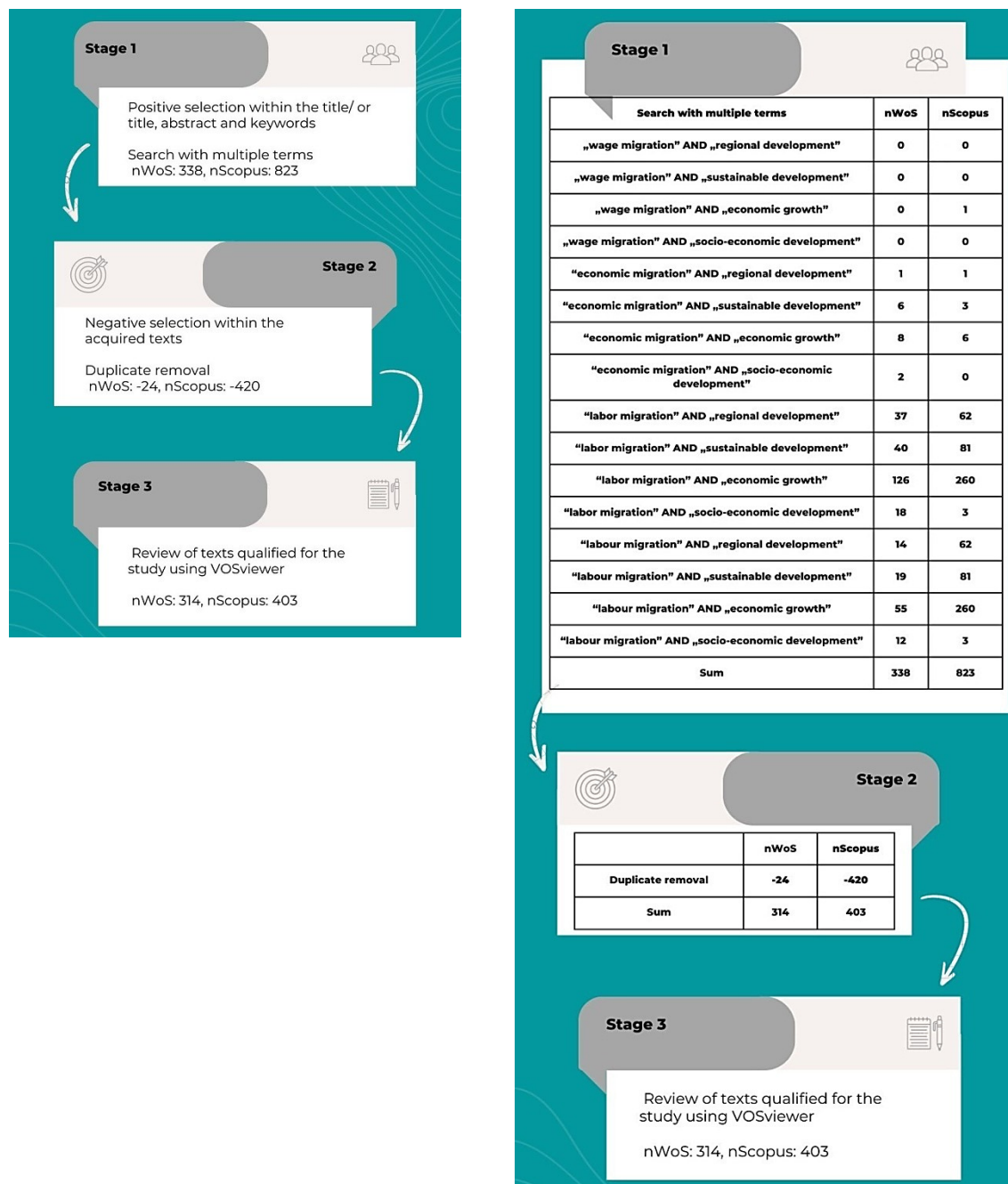


Figure 1. A structured literature review process and quantitative SLR results.

Source: own elaboration.

In summary, by using the watchwords listed above, 338 texts were obtained from the WoS database and 823 from Scopus. A total of 24 duplicates from WoS and 420 from Scopus were removed, resulting in 314 texts in the WoS database and 403 in the Scopus database.

3. Results

3.1. Web of Science

Among the 314 publications meeting our criteria, materials devoted to the researched topic appeared in print in the years 1966-2022. Among them, articles in journals (260 texts) and articles presented at scientific conferences (48 texts) prevailed. In addition, 4 books and 2 book series were indexed. During this period, the number of publications indexed in WoS increased. In 1966, 3 documents were published, in 2008 - 8 documents, in 2021 - 36 texts. In 2022, less materials were indexed than in 2021, however, compared to 1966, the publication increase was still significant. Detailed data is presented in Figure 2.

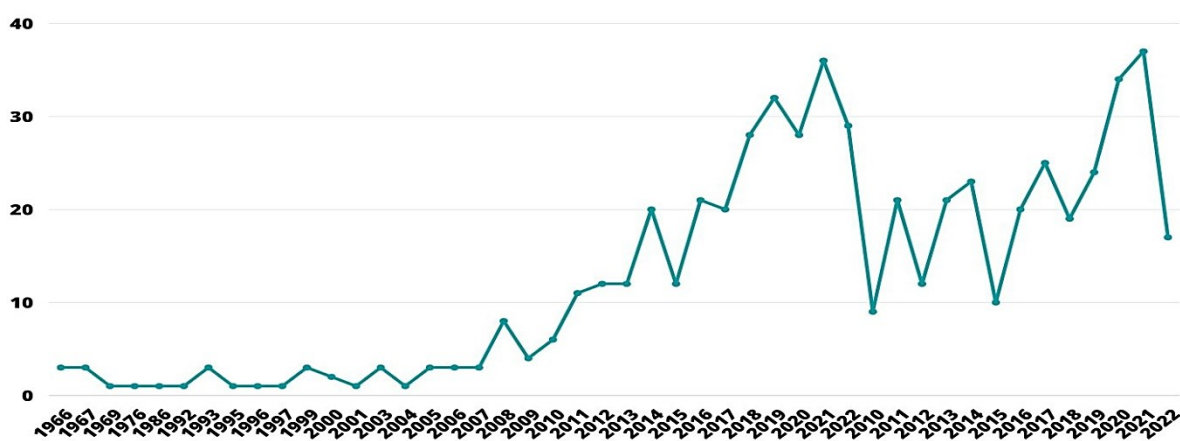


Figure 2. Number of publications indexed in WoS within the researched area (1966-2022).

Source: own elaboration.

As part of the WoS database, in VOSviewer it is possible to analyze data obtained from publication titles. The full counting method was specified and the maximum number 3 of occurrence of a term was marked. Of the 949 terms, 70 met the threshold. As a result, 7 sets of closely related nodes were created - thematic clusters: 1 – red, containing 17 items (in which the most common are: *migration*, *change*, *region*, *implication*, *policy*, and *international migration*); 2 – green with 12 items (respectively: *impact*, *labour migration*, *factor*, *regional development*, and *European Union*); 3 – dark blue with 11 items (among others: *country*, *economy*, and *context*); 4 – yellow with 10 items (among others: *China*, *effect*, *evidence*, and *labour*); 5 – purple with 8 items (among others: *development*, *case*, *education*,

and *economic development*); 6 – light blue with 6 items (among others: *labor migration*, *economic growth*, *Friedlander* - topic of *Puerto Rico labor migration* by Stanley L. Friedlander, and *case study*); and 7 – orange with 5 items (among others: *immigration*, *growth*, and *migration policy*). Each node represents an entity – a watchword. Its size indicates the occurrence of the watchword – the multiple occurrence. Within a given cluster there is a close relationship between items. Whereas the link between two nodes represents the co-occurrence between keywords (Donthu et al., 2021). Figure 3 shows clusters in each of the topic areas studied.

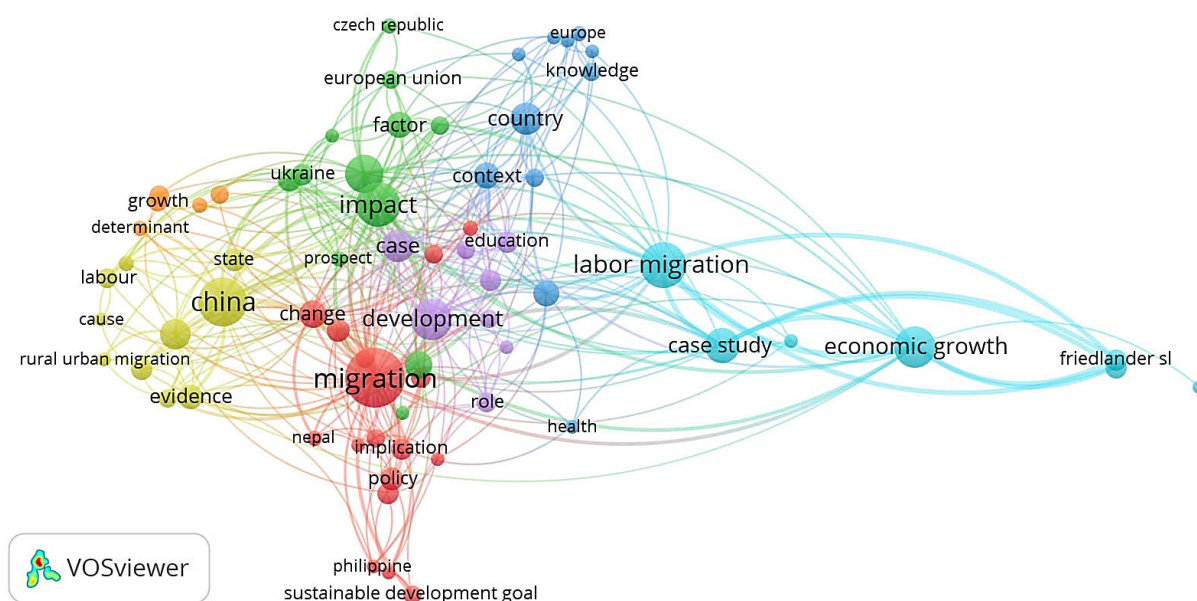


Figure 3. Network visualization based on WoS data.

Source: own elaboration.

The most frequently mentioned countries include: China, Czech Republic, Philippines, Austria, Nepal, Russia; among parts of the continent - Sub Saharian Africa; among the continents – Europe, and among the economic and political unions - the European Union. Within them, the most frequently discussed issues are those related to China and: *labor/labour migration*, *economic development*, *economic growth*, *consequences*, *determinant*, *policy*, and *rural-urban migration*, elements belonging to different clusters (Figure 4a-d).

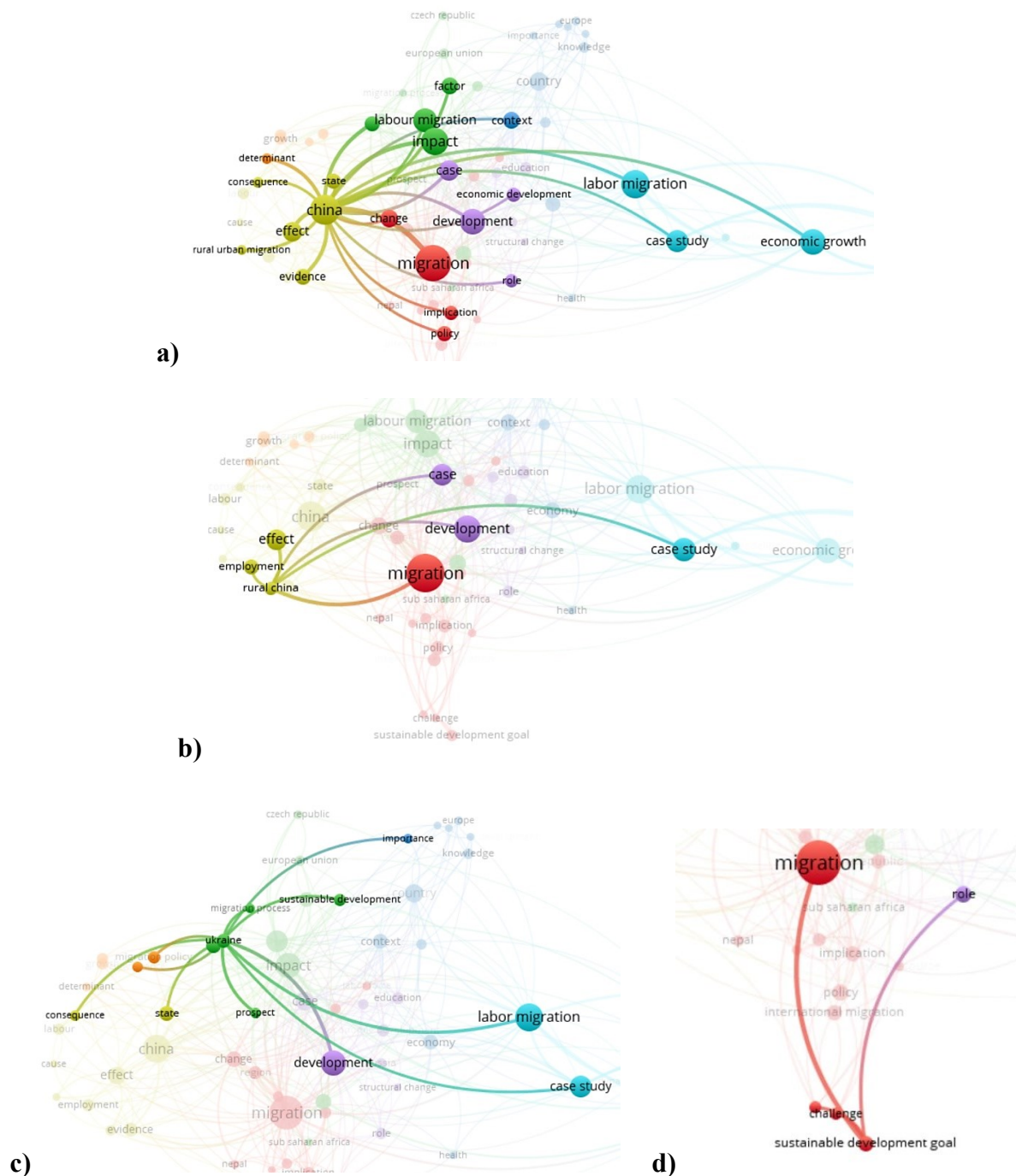


Figure 4a-d. Relationships between items: 4a. *China*, and 4b. *rural China* 4c. *Ukraine*, 4d. *sustainable development goals*, and other items selected for the study based on WoS.

Source: own elaboration in VOSviewer program.

The latest publications, i.e. those appearing in print after 2020, include those containing the following items in their titles: *Ukraine* and *sustainable development goal* (marked in yellow in Figure 5). The first one is described in relation with items such as: *labor migration*, *consequences*, *importance*, *migration process*, *prospects*, and *migration policy* (Figure 4c). Sustainable development goals in the publication are considered, among others, with *challenge* and *role* (Figure 4d). The oldest publications, appearing in print around 2010, are related to the items: *international labor migration*, *economic growth*, *regional development*, *convergence*,

and *Friedlander*. They are marked in purple in Figure 5, which shows the developments over time. Among the issues best researched are the following items: *China*, *impact*, *migration*, *labour migration*, *economic growth*, and *development*, which in Figure 6 having the highest density. The more concentrated the colors are, the brighter they are, the more research is devoted to the item.

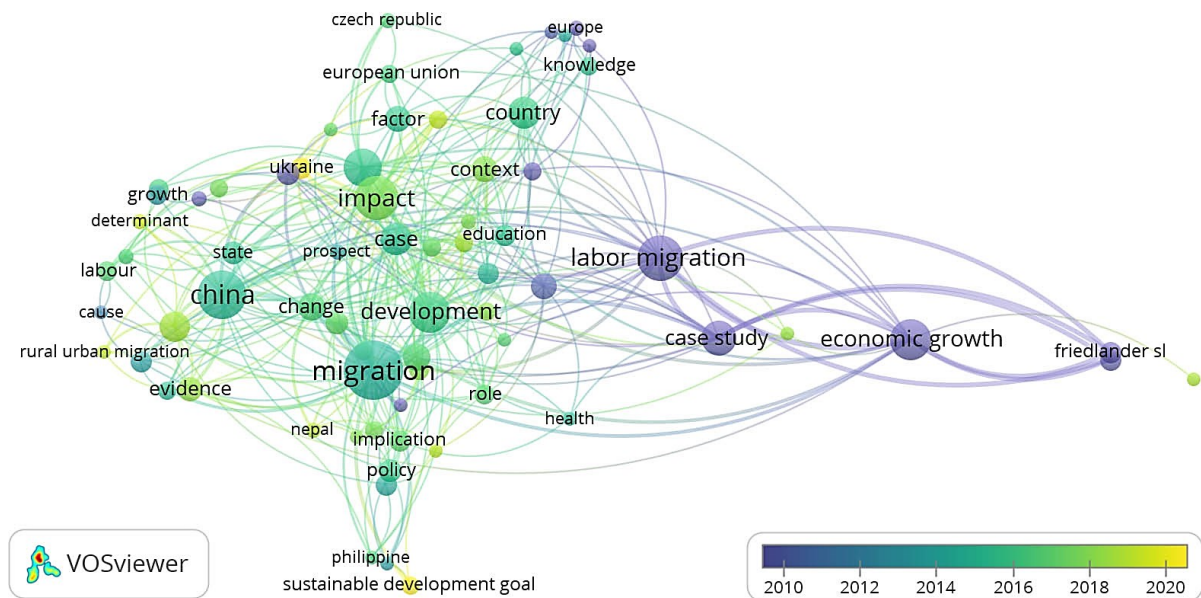


Figure 5. Overlay visualization based on WoS data.

Source: own elaboration.

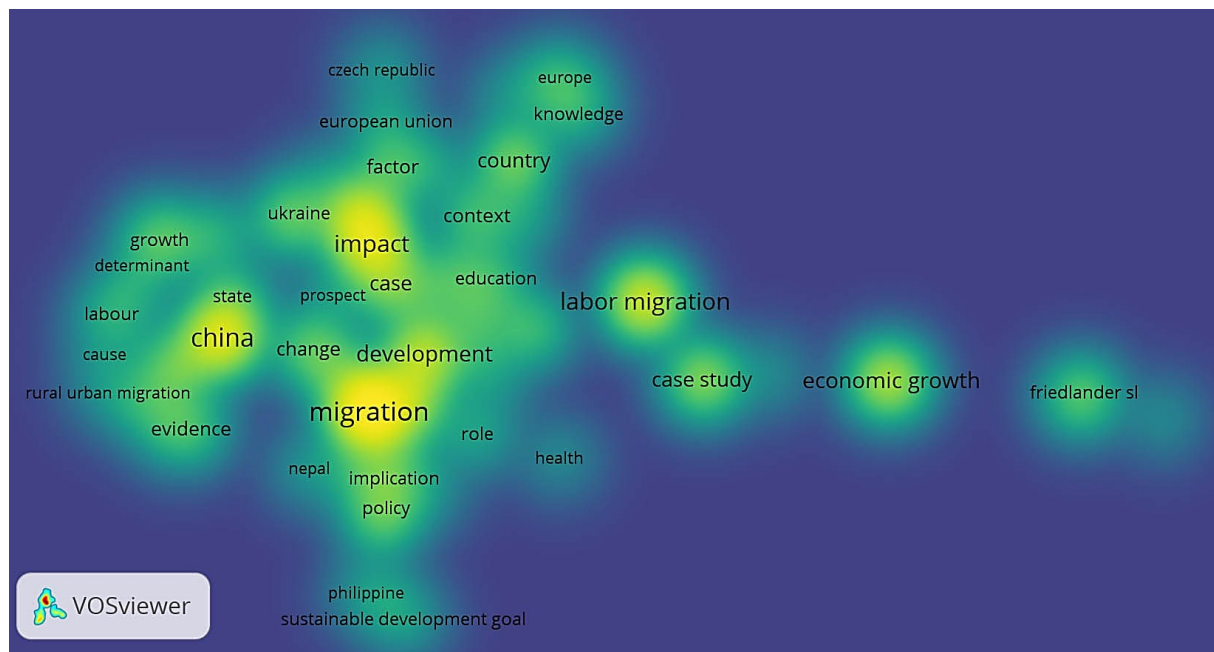


Figure 6. Density visualization based on WoS data.

Source: own elaboration.

3.2. Scopus

Among the 403 publications meeting our criteria, the indexed documents come from the years 1964-2023 (January). Most of them were indexed as journal articles - 328, book chapters - 31, conference papers - 24, and books - 5, the remaining 15 included among others reviews.

As in the case of the WoS database, the number of publications indexed in Scopus devoted to the researched issues increases over time. One publication from 1964 was indexed, in 2008 - 13, and in 2021 - 37 documents. In 2022, fewer publications were indexed than the year before, but compared to 1964, the increase in publications is still significant. Detailed data is presented in Figure 7.

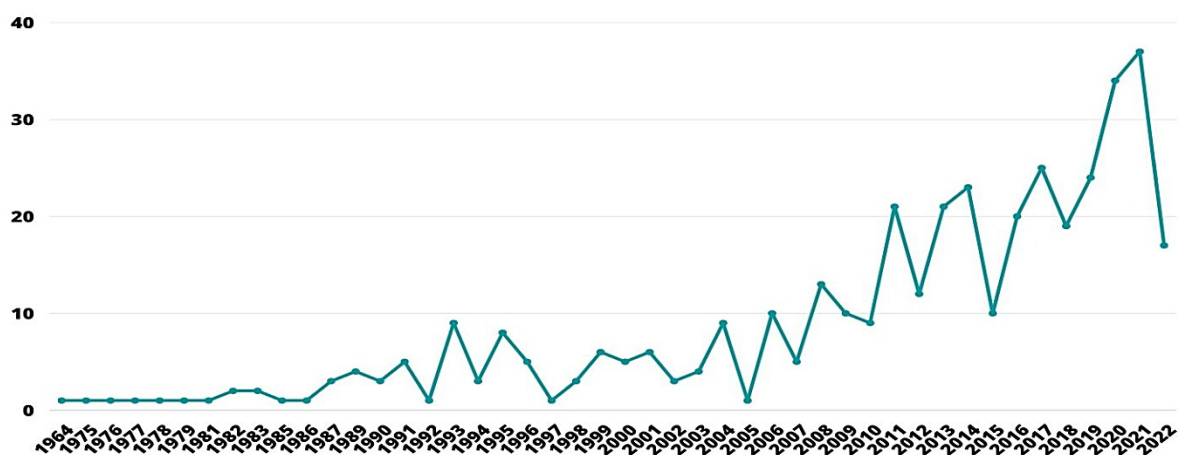


Figure 7. Number of publications indexed in Scopus within the researched area (1964-2022).

Source: own elaboration¹.

As part of the data obtained from this database, in VOSviewer it was also possible to check the co-authorship. The minimum number of document of an author has been marked as 3. Of the 750 authors, 9 meet the thresholds. Among them, Aderanti Adepoju was the most often quoted. Among the people who most often cooperate with each other are: Liu Jianguo, Yang Hongbo and Zhang Jindong, as indicated by a total link strength of 6 (Table 1).

¹ For the clarity of the figure, the data from January 2003, which at the time of the study was 1 document, was omitted.

Table 1.*Co-authorship within the scope of the Scopus database*

Author	Documents	Citations	Total link strength
Adepoju A	3	117	0
Chiu M.M.	3	6	0
Claeyssen J.C.R.	3	20	3
Holliday J.	3	33	0
Juchem Neto J.P.	3	20	3
Liu J.	3	25	6
Martin P.	3	92	0
Yang H.	3	25	6
Zhang J.	3	25	6

Source: own elaboration.

As part of the Scopus database, in VOSviewer it is possible to analyze the titles, abstracts and keywords of documents. The method of full counting was specified and the maximum number of occurrence of a term as 15 was marked. Of the 9960 terms, 196 met the threshold. As a result of the study, 8 clusters were created: 1 – red with 57 items (in which the most common are: *impact*, *study*, *worker*, and *labour migration*); 2 – green with 39 items (respectively: *country*, *region*, *development*, and *labor migration*); 3 – dark blue with 26 items (among others: *migration*, *policy*, *migrant*, and *population*); 4 – yellow with 20 items (among others: *China*, *economic growth*, *change*, and *city*); 5 – purple with 18 items (among others: *economy*, *growth*, and *factor*); 6 – light blue with 17 items (among others: *remittance*, *income*, and *Mexico*); 7 – orange with 12 items (among others: *immigration*, *effect*, *state*, and *labour market*); and 8 – light pink with 7 items (among others: *model*, *system*, *strategy*, and *analysis*). They are presented in Figure 8. The most frequently raised issues include: *migration*, *country*, *labour migration*, *region*, *development*, *economy*, and *China*. The most frequently mentioned countries include: China, Japan, Thailand, Indonesia, Nepal, Philippine, Sinagapore, Canada, Mexico, Turkey, Russia, Germany, Ireland, United Kingdom; among the continents - Asia (and within its framework Southeast Asia), Europe, Africa; and among international integration groups - European Union.

The density map (Figure 10) shows that the best explored areas are those related to items: *migration*, *country*, *region*, *development*, *economic growth*, and *China*. Less marked items indicate less researched areas, and thus directions for further research conducted in this topic.

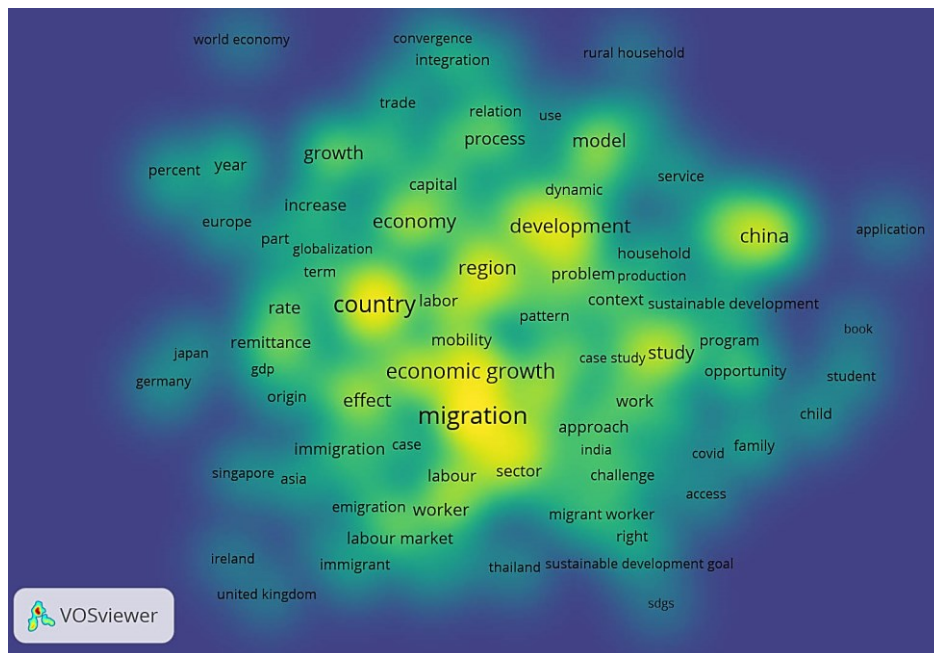
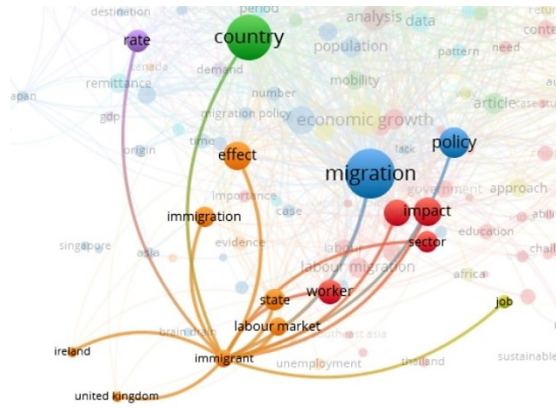


Figure 10. Density visualization based on Scopus data.

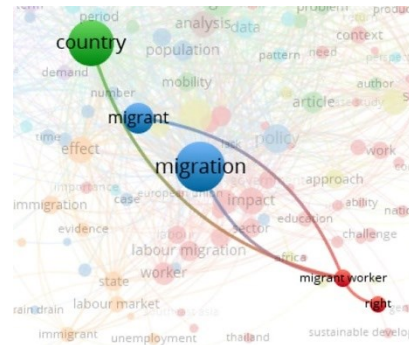
Source: own elaboration.

Among such watchwords that are intuitively associated with the subject of migration, like:

- people that changing their place of residence, items: *immigrant*, *migrant worker*, *labor migrant*,
- financial aspects, items: *income* and *remittance*,
- knowledge-learning aspects, items: *education* and *student*,
- general migration-related aspects, items: *change*, *mobility*, and *integration*, *change* and *remittance* have the widest network of connections with other items (Figure 11a-j).



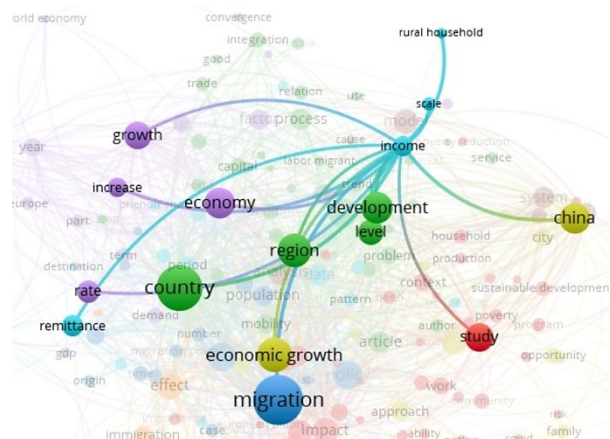
a)



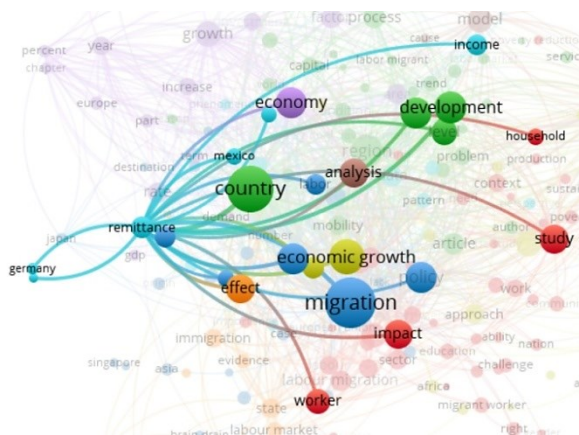
b)



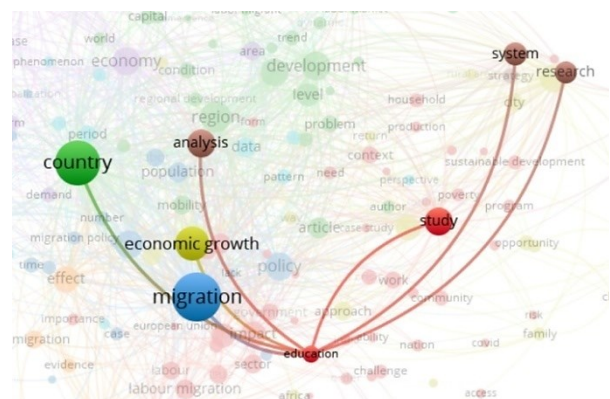
c)



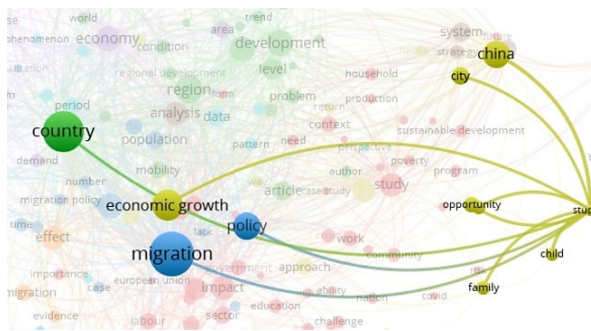
d)



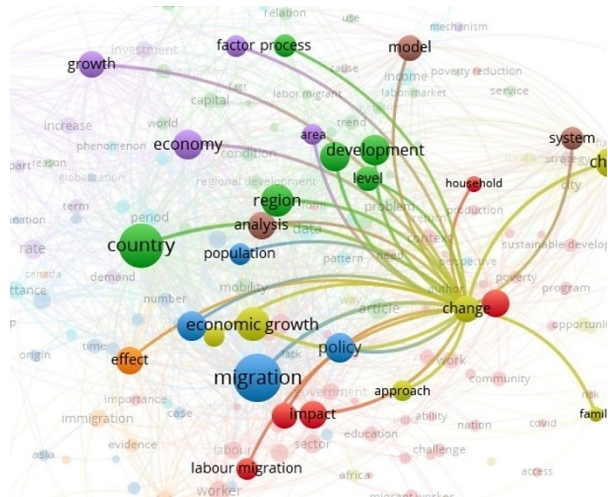
e)



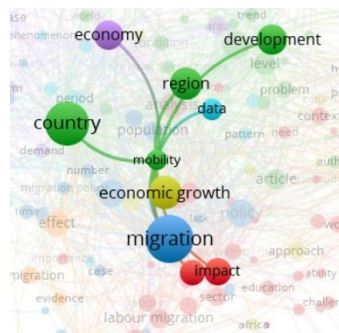
f)



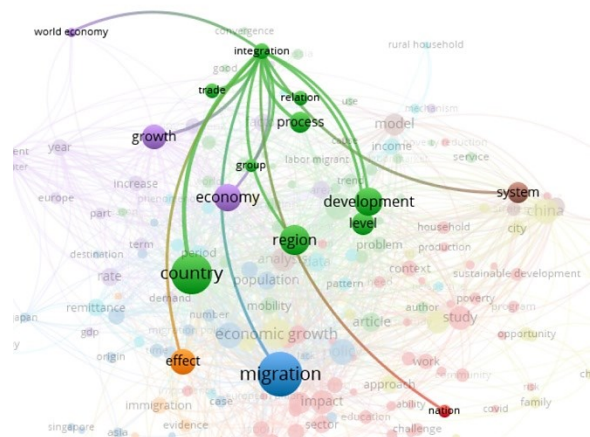
g)



h)



i)



j)

Figure 11a-j. Relationships between items: 11a. *integration*, 11b. *change*, 11c. *education*, 11d. *student*, 11e. *income*, 11f. *remittance*, 11g. *immigrant*, and other items selected for the study based on Scopus.

Source: own elaboration in VOSviewer program.

4. Discussion

The findings of this study highlight a significant and sustained increase in research on labor migration and regional development. This trend underscores the growing recognition of labor migration as a fundamental driver of regional economic dynamics, social transformations, and policy considerations. Scholars such as Castles (2010) Ratha et al. (2011) and de Haas (2021) have long emphasized the complex interplay between migration and economic development, with labor mobility shaping and being shaped by structural economic conditions, policy frameworks, and regional inequalities. The rising volume of research suggests that labor

migration remains central to global economic and social policy discussions, particularly in light of changing labor market demands and geopolitical shifts.

A regional analysis of labor migration studies reveals that China, the Czech Republic, the Philippines, Austria, Nepal, and Russia are among the most frequently researched countries. Additionally, Sub-Saharan Africa (Adepoju, 2003, 1995; Akanbi, 2017) and the European Union emerge as key areas of focus. These findings align with broader migration trends, where labor mobility plays a crucial role in economic restructuring, workforce redistribution, and regional development (Rodríguez-Pose, 2018). Adepoju et al. (2010) investigated Europe's migration agreements with migrant- sending countries in the global south.

China, in particular, has been extensively studied due to its large-scale internal migration, rural-urban labor shifts, and policies governing migrant workers (Xu, Li, 2008; Walmsley et al., 2013; Harris, Todaro, 1970; Chan, Yang, 2020, Chan, 2018). Research on China primarily focuses on themes such as economic development, labor migration policy, and the consequences of migration on urbanization and regional inequalities. Similarly, European labor migration studies often examine intra-EU mobility, economic integration, and the impact of migration policies on regional labor markets (McAuliffe, Triandafyllidou, 2021).

An analysis of publication trends over time indicates that early studies, particularly those published around 2010, concentrated on fundamental economic aspects of labor migration, such as international labor flows, economic growth, and regional development (Piore, 1979; Massey et al., 1993). These studies laid the theoretical groundwork for understanding how migration contributes to labor market efficiency and economic convergence.

More recent research, particularly after 2020, has expanded to include emerging themes such as sustainable development and migration governance. Studies focusing on Ukraine, for example, link labor migration to issues such as migration policy, economic resilience, and workforce mobility in times of crisis (Górny, Kaczmarczyk, 2020; Maruszewski, Kaczmarczyk, 2020; Kone, Özden, 2017). Meanwhile, discussions on the Sustainable Development Goals (SDGs) highlight the role of migration in achieving global development objectives, emphasizing challenges such as equitable labor market integration and policy coherence (OECD, 2020).

Density mapping of academic literature suggests that the most intensively studied themes in labor migration research include economic growth, migration impacts, and regional development (Hugo, 2008; Bauer et al., 2004; Brunow et al., 2015). These topics reflect long-standing concerns regarding the contribution of labor mobility to productivity, innovation, and regional economic restructuring (Sassen, 2013; Rodríguez-Pose, 2018).

However, certain areas remain underexplored. For instance, while financial aspects of migration, such as remittances and income redistribution, are well-documented, less attention has been given to their long-term effects on regional economic disparities (Betts, 2011). Similarly, issues related to knowledge transfer, education, and skills development in labor

migration remain fragmented, despite their significance for human capital accumulation and workforce adaptability (Zetter, 2018).

Furthermore, the social dimensions of labor migration, including migrant integration, social mobility, and community cohesion, warrant further exploration. While terms such as mobility, change, and integration are frequently mentioned in migration studies, their broader social and cultural implications require deeper interdisciplinary investigation (Hynie, 2018).

The findings of this study highlight significant trends in the literature on labor migration and regional development, emphasizing the growing academic interest in the economic, social, and policy-related dimensions of migration. Over the years, research on labor migration has evolved, focusing on its role in shaping economic structures, influencing regional disparities, and contributing to sustainable development (Grau, Aide, 2007; Hermele, 2021; Van Hear et al., 2020; Lagakos, 2020; de Haas, 2021; Tipayalai, 2020; Fu, Gabriel, 2012).

A key insight from the study is the prominence of economic considerations in labor migration research, particularly regarding its effects on labor markets, wage dynamics, and overall economic growth (Castles, 2010; de Haas, 2021). The connection between labor migration and regional development is well established, with studies frequently analyzing rural-to-urban migration patterns and their impact on urbanization, employment opportunities, and regional inequalities (Harris, Todaro, 1970; Chan, 2018). The financial aspects of migration, such as remittances and their role in income redistribution, remain a widely explored topic, particularly in relation to developing economies (Betts, 2011; Zetter, 2018).

Another critical area of focus is migration policy and governance, where scholars examine the role of national policies, international agreements, and institutional frameworks in shaping labor migration trends (McAuliffe, Triandafyllidou, 2021). Studies suggest that effective migration governance can maximize the benefits of labor mobility while mitigating associated challenges, such as exploitation and labor market segmentation (OECD, 2020). Additionally, social and cultural dimensions of migration, including migrant integration, discrimination, and community cohesion, have gained increasing attention, particularly in the context of host societies (Hynie, 2018; Scholten, Penninx, 2016).

One of the most emerging areas in migration studies is knowledge transfer and skills development, focusing on brain drain, brain gain, and the role of education in shaping labor migration flows (Liu-Farrer, Docquier, Rapoport, 2012; Kone, Özden, 2017). This research is particularly relevant in the context of high-skilled migration and its implications for both sending and receiving regions. Furthermore, sustainability and migration have become a growing field of interest (Hermele, 2021; Pécoud, 2014; Martin, 2022; Castles, 2009; Al-Husban, Adams, 2016; Holliday et al., 2019; Adger et al., 2019), particularly regarding the alignment of labor migration policies with the United Nations' Sustainable Development Goals (SDGs) (OECD, 2020).

These key research trends, summarized in Table 2, illustrate the diverse themes within the field of labor migration and regional development. The density map analysis confirms that well-researched areas include migration's economic impact, regional disparities, and policy frameworks, while less explored areas, such as the role of labor migration in environmental sustainability, present opportunities for future studies. As migration continues to shape regional and global development trajectories, further research is needed to address emerging challenges, particularly in relation to geopolitical shifts and labor market transformations.

Table 2.

Key research trends in labor migration and regional development

Key research area	Main themes	Key references
Economic impact of labor migration	<ul style="list-style-type: none"> - Labor migration as a driver of economic growth. - Productivity and wage effects. - Impact on labor markets and employment structures. 	Castles (2010), de Haas (2010), Piore (1979), Stark, Bloom (1985), Rajan (2004)
Migration policy and governance	<ul style="list-style-type: none"> - National and regional migration policies. - Labor rights and protections. - The role of international organizations. 	McAuliffe, Triandafyllidou (2021), OECD (2020)
Urbanization and regional disparities	<ul style="list-style-type: none"> - Rural-urban migration and regional inequalities. - Urban labor market integration. - Infrastructure and housing challenges. 	Harris, Todaro (1970), Chan (2018), Rodríguez-Pose (2018)
Financial aspects of migration	<ul style="list-style-type: none"> - Remittances and income redistribution. - Migration and financial inclusion. - Effects on sending and receiving regions. 	Betts (2011), Zetter (2018), OECD (2020)
Social and cultural dimensions	<ul style="list-style-type: none"> - Social integration of migrant workers. - Discrimination and labor market segmentation. - Community cohesion and identity. 	Hynie (2018), Scholten, Penninx (2016), Chen (2005)
Knowledge transfer and skills development, brain drain	<ul style="list-style-type: none"> - Brain drain vs. brain gain. - Education and skill acquisition of migrant workers. - Migration and innovation. 	Kone, Özden (2017), Massey et al. (1993), Liu-Farrer (2009), Docquier, Rapoport (2012)
Sustainability and migration	<ul style="list-style-type: none"> - Migration's role in achieving Sustainable Development Goals (SDGs). - Circular migration and environmental sustainability. - Policy coherence for sustainable labor mobility. 	OECD (2020), McAuliffe, Triandafyllidou (2021), Hermele (2021), Pécoud (2014), Martin (2022), Castles (2009), Al-Husban, Adams (2016), Holliday, et al. (2019), Adger et al. (2019)

Source: own elaboration.

The findings of this study underscore the critical role of labor migration in shaping sustainable regional development. While much of the existing research has focused on the economic factors and impacts of migration, the emergence of new topics, such as migration governance, workforce digitalization, and climate-driven labor mobility, indicates promising avenues for future exploration (McAuliffe, Triandafyllidou, 2021).

The impact of migration on both source and destination areas depends on factors such as migration flow size, composition, context, and timing. Migrants' interaction with new environments influences their consumption, behavior, and engagement with local

socioeconomic systems, all of which affect sustainability. Migration can drive both positive and negative outcomes, leading to an overall ambiguous effect. While migration offers individual benefits, it also brings complex challenges, including labor market shifts, brain drain or gain, resource demands, and the impact of remittances (Skeldon, 2009). The relationship between migration and development remains contentious, shaped by varying analytical approaches and political perspectives (Castles, 2011).

The connection between migration and sustainability outcomes in both source and destination areas, particularly through remittances, is well-documented (de Haas, 2020; Levitt, 1998). Migration is also associated with increased social mobility at destination (Lyu, 2019). Previous studies indicate that emigration reduces the overall labor supply, particularly in specific sectors (Skeldon, 2009). As a result, if migrants are more likely to come from unemployed populations, migration can ease unemployment pressures and decrease the demand for social security programs in source areas (Lyu, 2019).

The relationship between migration and sustainability is shaped by changes in physical capital, human capital, and labor resources. In the short term, migration can influence these factors in various ways (Gavonel et al., 2021). Firstly, a sustained increase in migration flows may lead to a decline in income per capita due to the dilution of physical capital. This occurs when rapid population growth results in available capital being distributed across a larger number of people, reducing per capita resources. Secondly, migration can impact human capital levels, depending on the educational background of migrants and the extent to which migration is selective based on skill levels. Thirdly, the effect of migration on the labor force is less definitive, as it depends on the demographic composition of migrants (Boubtane, et al., 2016) and the degree of substitutability between migrant and native workers, among other factors. These three dynamics collectively shape income per capita, which is typically represented in economic models through a standard aggregate production function.

Researchers point out that migrant communities contribute valuable knowledge, perspectives, and experiences related to sustainability (Gavonel et al., 2021). However, their voices are frequently overlooked in policy discussions and formal sustainability planning (Siddiqui et al., 2021). Research increasingly shows that incorporating diverse viewpoints into inclusive knowledge systems leads to more effective and transformative actions (Scoones et al., 2020). Migrant social networks, both in their countries of origin and destination, influence the outcomes of migration management policies (Sørensen, 2012). Additionally, the strictness of entry and integration policies plays a crucial role in shaping migrants' ability to contribute to sustainability transitions (de Haas, 2010; Bakewell et al., 2016). This ability is closely tied to migration infrastructure, which refers to the interconnected technologies, institutions, and actors that support mobility (Xiang, Lindquist, 2018).

Scholars indicate that migration impacts community resilience and resource sustainability (Adger et al., 2002; Tebboth et al., 2019). Population growth affects resource demand, while migration redistributes residents, influencing density and land use (Gray, Bilsborrow, 2014).

Migration-sustainability dynamics have been analyzed through ecological, cultural, and policy perspectives (Rees, 2006). New migration patterns shape social, economic, and environmental sustainability, as seen in Amsterdam, where migrants perceive sustainability as integrating social goals, economic opportunities, and urban livability.

On the other hand, Gavonel et al. (2021) suggest the existence of a migration-sustainability paradox, where migration simultaneously contributes to economic globalization, exacerbating the sustainability crisis, while also serving as a catalyst for positive social and environmental transformation. In other words, migration exerts both beneficial and detrimental influences on sustainability, resulting in an overall impact that remains uncertain. This paradox can be explored through hypotheses and empirical data across various spatial and temporal scales. For instance, some evidence indicates that migration may drive an increase in global CO₂ emissions. Liang et al. (2020) identify a positive correlation between international migration and CO₂ emissions, although no direct causal relationship is established. Likewise, Shi et al. (2020) observe a link between internal migration in China and the emission of air pollutants. However, migration also has the potential to foster sustainable development in both origin and destination regions, highlighting its complex and multifaceted role in sustainability dynamics.

From a policy perspective, labor migration management must evolve to address contemporary challenges, including demographic shifts, labor market mismatches, and geopolitical uncertainties. Governments and international organizations must develop policies that balance labor market flexibility with migrant rights protection, ensuring that migration contributes positively to both sending and receiving regions (OECD, 2020).

Governance at all levels often overlooks migration in sustainability policies and, even more so, sustainability in migration policies. The Millennium Development Goals ignored migration entirely (Fukuda-Parr, 2016), while the SDGs made limited progress by incorporating it into a few targets (Piper, 2017). The International Organization for Migration (IOM) advocates for sustainable reintegration pathways for returning migrants (IOM, 2019). However, migration and sustainability planning remain largely fragmented across policy domains, despite their strong interconnections.

Future research should also expand beyond economic analyses to consider broader socio-political and environmental dimensions of labor migration. For instance, exploring the intersections between migration, sustainability, and technological change could provide valuable insights into the future of work and regional development in a rapidly evolving global economy (Scholten, Penninx, 2016).

By identifying well-researched areas and gaps in the literature, this study provides valuable guidance for academics, policymakers, and development practitioners seeking to leverage labor migration for sustainable regional development.

The analysis of migration from the perspectives of crisis (see: Łukaniszyn-Domaszewska, Mazur-Włodarczyk, 2025a), sustainable development, and resilience (see: Łukaniszyn-Domaszewska, Mazur-Włodarczyk, 2025b) opens the door for further debate on the complexity

of this phenomenon. It raises important questions about how societies, governments, and international organizations can balance short-term humanitarian responses with long-term strategies for integration and stability. Additionally, the resilience perspective invites discussion on the agency of migrants themselves - how they adapt, contribute, and shape their new environments. Future research and policy discussions should focus on the interplay between these perspectives to develop more comprehensive and effective migration policies.

5. Summary

This study provides a comprehensive analysis of the literature on labor migration and regional development, highlighting key research trends, geographical focus areas, and evolving scholarly discussions. The findings indicate that labor migration is a crucial factor shaping regional economies, influencing employment patterns, wage structures, and economic growth (Castles, 2010; de Haas, 2010). A significant body of research underscores the economic consequences of migration, with particular attention to remittances, labor market integration, and rural-urban mobility (Harris, Todaro, 1970; Betts, 2011).

Additionally, the policy and governance aspects of migration have received substantial attention, as scholars explore the impact of national and international policies on labor mobility and workforce regulation (McAuliffe, Triandafyllidou, 2021; OECD, 2020). Migration governance is particularly relevant in the context of economic unions such as the European Union, where labor mobility plays a critical role in regional integration and economic convergence (Scholten, Penninx, 2016). However, research gaps remain, particularly concerning the long-term effects of migration on regional sustainability and the role of labor migration in mitigating demographic challenges such as aging populations and labor shortages (Zetter, 2018; Kone, Özden, 2017).

The table 3 summarizes key policy recommendations that can enhance labor migration governance by incorporating sustainability, digital transformation, inclusivity, public-private collaboration, and resilience. These strategies provide a holistic framework for policymakers to address both current and emerging challenges in migration management.

By integrating sustainability principles, governments can create fairer and more inclusive migration policies that align with global development goals. Digital technologies, when effectively implemented, can streamline migration processes and enhance security, while addressing linguistic and regional biases in research ensures that migration policies reflect diverse perspectives. Furthermore, fostering collaboration between public and private sectors can drive economic opportunities for migrants and host communities alike. Finally, building resilience into migration systems will help mitigate the impact of crises and ensure long-term

stability. These recommendations serve as a foundation for further discussion and policy development, emphasizing the need for evidence-based and adaptive migration governance.

Table 3.

Policy implications and recommendations according labor migration management

Policy area	Recommendation
Integrating sustainability into migration policies	Adopt long-term, sustainability-driven migration policies, promote fair labor conditions, ensure social protection, and align policies with SDGs. Encourage ethical recruitment and migrant integration programs.
Leveraging digital technologies for migration governance	Implement digital tools such as blockchain for secure documentation, AI-driven skills matching, and online platforms for migration processes. Ensure digital inclusion for migrants.
Addressing language and regional biases in migration research	Support multilingual and regionally diverse research through funding translations, collaborations with non-English institutions, and integrating diverse perspectives into migration policies.
Enhancing public-private partnerships	Foster collaboration between governments, businesses, and civil society for skills development, labor market integration, and migrant entrepreneurship. Provide incentives and regulatory support.
Strengthening resilience in migration systems	Develop contingency plans for crisis-driven migration (e.g., pandemics, climate change, political instability). Support displaced workers and promote adaptability strategies.

Source: own elaboration.

Migration serves as a driver of development, yet it is governed by nation-states through policies that shape regional dynamics within countries and regulate the movement of people across borders. The sustainability and transformative potential of migration should be integrated into policymaking and public decision-making processes. When migration enhances overall well-being, reduces inequalities between regions and societal sectors, and minimizes environmental impacts, it can play a crucial role in advancing sustainability transitions (Gavonel et al., 2021).

A notable emerging trend is the interaction between labor migration and sustainable development, particularly in relation to the United Nations' Sustainable Development Goals (SDGs) (OECD, 2020). While migration is often framed as a challenge, recent literature suggests that well-managed labor migration can contribute to economic resilience, innovation, and knowledge transfer, particularly in the context of high-skilled migration (Pécoud, 2014; Hynie, 2018). However, concerns persist about social cohesion, migrant rights, and integration policies, highlighting the need for further interdisciplinary research in this field.

Overall, this study confirms that labor migration is an essential driver of regional development, yet its effects are highly context-dependent. Future research should focus on underexplored dimensions, such as the impact of climate change on labor migration patterns, the role of digitalization in shaping new migration flows, and the long-term sustainability of migration-driven economic growth. Addressing these research gaps will be critical in ensuring that migration policies align with broader development objectives and contribute to both economic and social stability.

In conclusion, by exploring migration through the lenses of crisis, sustainable development, and resilience, this analysis provides a well-rounded perspective on its challenges and opportunities. Each approach sheds light on different aspects of migration, from immediate humanitarian concerns to long-term societal adaptation. Understanding these dimensions is crucial for developing effective policies and strategies that address migration in a balanced and sustainable way.

The limitations of this research include those related to the specificity of the SLR, e.g. detailed queries and a narrow selection of data sources. These studies were based on only two databases, in which mostly English-language documents are indexed. The above excludes many scientific texts published in other languages and devoted to the researched area. These databases have their characteristics and limitations, visible e.g. in that the same inquiries resulted in obtaining a different number of documents in WoS and Scopus. However, they are not the only databases of scientific documents. In the future, it is worth carrying out SLR also based on other databases that enable downloading files in formats compatible with VOSviewer (or other software), as well as databases previously incompatible with VOSviewer, such as Google Scholar or Research Gate.

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THE ROLE OF GOODWILL AS A KEY FACTOR IN BUILDING THE DEVELOPMENT OF A SMALL BUSINESS

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Purpose: The aim of this article was to present the analytical results of an evaluation of the English-language research literature on the important concept of goodwill as building blocks for the intangible aspects of corporate value added. The study took into account the results of research published in the English-language literature and the preliminary results of the author's own research on accounting offices. The topic was taken up by the Author due to the lack of sufficient analyses concerning the quantitative significance of the goodwill concept and its specific role in the creation of company value.

Design/methodology/approach: The listed research results provide a basis for conducting in-depth analyses in the undertaken scope concerning the determination of the essence of individual factors creating the company's value. At present, in both Polish and English-language literature, there are no specific results relating to the quantitative assessment of the essence of goodwill. It is necessary to clarify the differences in its role in various aspects concerning the functioning of the liberal professions and to indicate the role of trust in the area of this concept, which constitutes its key element and points to the essence of the role of intangible factors boiling down to the value of capital and the human potential of an individual.

Findings: The research carried out showed that the value of goodwill in relation to the three selected professions varies. With regard to the value of law practices, the key element is the role of the practitioner. With regard to accountancy firms, the key element also shaping the value of each practice is the ability to generate income, taking into account aspects related to the partner's transition in and out of the partnership and the experience of the employer running the practice. In the case of medical services, it is not possible to assign a uniform goodwill value to a single business given its diversity and the type of services offered.

Originality/value: The topic addressed is new on the quantitative side. At present, the author has carried out a preliminary survey of accounting offices. In addition, the English-language literature presented has made it possible to prepare a key summary to assess their value. The topic fills an important research gap.

Keywords: małe przedsiębiorstwo, goodwill, wolne zawody, zaufanie, wartości niematerialne.

Category of the paper: Scientific paper.

1. Introduction

The application of Rules-of-Thumb shows the development of the relationship between the market value of a business in practice and the specific business parameters of the companies being valued. Despite the fact that the adopted multiplier methods are in practice simplified methods of determining the value of a business, in theory they provide many difficulties related to their actual valuation. In practice, we now know of many multipliers involving the determination of a company's value using multiplier methods. While the application of these methods is important from the perspective of enterprise valuation, it also provides an opportunity not only to determine the value of the actual purchase price of an enterprise, but also to value it rationally. In the practice of business valuation - this is not only a financial possibility but also the only way to determine the price of a small and specific business. The value of each business is estimated as the sum of the net assets and the value of the goodwill. When analysing issues related to factors shaping the market value of small businesses in Poland, attention should also be paid to the issue of trust influencing the advantage of a specific business over its competitors. The market value assessed by consumers, indicating the position of a particular business and its owner at the same time, becomes crucial.

These valuations combine both economic, financial and governance issues, indicating the high interdisciplinary nature of the Rules-of-Thumb. On the one hand, goodwill is the identification and determination of the impact of defined financial and non-financial factors on the market value of a company, while on the other hand, it is the impact of factors determining the growth of trust in the entrepreneur and the evaluation of segments determining the choice of services by specific often regular customers.

Goodwill is a combination of quantitative as well as qualitative aspects. For the assessment of the level of goodwill aimed at all professions, the following evaluation criteria are established:

- the area of financial internal factors (investment in working capital, investment in fixed assets, financing of activities from own financial resources, financing of activities from external sources, level of operating costs of activities carried out, operating profit margin, tangible fixed assets held)
- the area of external financial factors (structure of achieved revenues, convenient forms and principles of payment for services, high income of customers in the region where the services are provided, level of service prices, prices of materials, tax strategies),
- the area of internal factors on the market and marketing (easy way to reach clients, convenient hours when services are provided, certificates held, licences held, ownership of premises where services are provided, length of cooperation with clients, type of cooperation - individual and corporate clients, good relations with clients, low staff turnover,

- the area of external factors on the market and marketing (whisper marketing, age distribution of clients, size of the enterprise, owned trademark, favourable legal-administrative regulations, access to natural resources, labour market, low level of market saturation, length of enterprise on the market)
- the area of management-related factors (innovative technologies and solutions used, software used, good relations with employees, work schedule in force, clear and comprehensible procedures adopted and established, independence in decision-making, involvement of employees in deciding on the future of the company, effective logistics),
- the area of factors covering human capital and potential (creativity, practical experience of the freelancer, education and qualifications of the freelancer, titles and degrees of the professional, additional qualifications, specialisations of the freelancer, interpersonal skills including ease of establishing contacts, managerial skills in managing people and organising working time).

2. Research findings to date

The research conducted to date indicates the great importance of intangible factors in shaping the value of an organisation, the market value of which is determined by the level of human capital, both in relation to the owner and subordinates. The role of human capital acquires particular importance in the case of companies employing people in the so-called liberal professions. 'From the point of view of the usefulness of human capital for the organisation, two possibilities for increasing the return on capital are distinguished by raising the level of skills of individual employees and by managing human capital effectively in a broader sense (Maciąg, 2011). In turn, B. Pfau and I. Key, on the basis of their research among 750 large companies, found that human capital is a leading indicator of corporate financial performance, and that investing in employee development provides shareholders with three times the returns compared to other companies.

Human capital, which is one of the areas assessed during the implementation of research tasks, is one of the most important factors determining the future economic results of an organization. According to research conducted by B. Hansson, the basic organizational factors influencing the value of human capital on the example of management staff are leadership (communication, efficiency, qualifications, organizational values, charisma skills), commitment (time management skills, working conditions), knowledge (creativity, inventiveness, access to knowledge), efficiency (good working conditions, delegation of authority, motivation) and development (innovations, improvement, training) (Hansson, 2009). As it results from the research, human capital should be treated as one of the factors building the reputation of a small enterprise and at the same time creating its added value in economic

terms. "The essence of reputation is the value of the organization for the environment in which it operates, the assessment of its previous activities in terms of the goals it has formulated. From the perspective of the company's ability to maintain its development on the market, reputation is shaped mainly by intangible assets, which include: credibility, responsibility and trust" (Maciąg, 2013).

According to H. Keh and Y. Xie, 'a good reputation among stakeholders can influence delaying effects related to competitors' activities, obtaining higher selling prices in uncertain markets, attracting better quality investment capital or raising more capital from the stock market, maintaining high employee morale, obtaining better efficiency from business activities'(Keh, Xie, 2009). The impact of reputation on a company's financial health has been the subject of research for many years. In 2000, based on their research, R. Dunbar and J. Schwalbach found both the existence of an impact of financial performance on reputation and the impact of reputation on financial performance (Dunabr, Schwalbach, 2000). R.A. Srivastav, T.H. McInish, R.A. Wood A.J. Capraro have shown that for companies with better reputations, investors subjectively assess the risk of an investment as significantly lower and therefore approve of a lower rate of return (Srivastav, McInish, Wood, Capraro, 1997). Research conducted indicates that intangible factors, including reputation is increasingly becoming a determinant of investment decisions (Helm, 2007).

Thus, as can be seen from the research conducted so far, corporate reputation reflects a company's ability to meet the needs and demands of different stakeholder groups. It is an element of a company's intangible assets and influences its value measured in financial terms. As practice indicates, the valuation of a small business boils down to the assessment of resources of a financial, tangible and intangible nature. A specific group are intangible resources, which are not always fully reflected in the balance sheet. One of the elements determining the value of intangible factors shaping a company's goodwill is trust. This trust has a pragmatic value. Trust is the associated loyalty and truthfulness that represents real, practical economic value that increases the efficiency of the system and allows more goods to be produced (Arrow, 1974). In the practice of small business, it is assumed that it is the quality of capital and human potential that builds relationships and enhances trust at the enterprise-client level.

3. Multiplier methods from the perspective of assessing the intangible value of an enterprise

The entire value of an enterprise and, at the same time, its valuation possibilities are based on the application of multiplier methods. These methods are used in the case of determining the value of partnerships and thus freelancers. According to Article 88 of the Companies Act,

partners in a partnership may be: Group I (advocate, legal adviser, notary, tax adviser), Group II (patent agent, sworn translator, property expert), Group III (accountant, chartered accountant, insurance broker, stockbroker, investment adviser), Group IV (architect, construction engineer), Group V (nurse, midwife, physiotherapist, laboratory diagnostician), Group VI (doctors), Group VII (dentist, veterinarian), Group VIII (pharmacists). The division of the groups was taken into account on the basis of the degree of connection between the different professions, taking also into account the needs of the individual clients and the level of trust required.

Analysis of the liberal professions has shown that they cannot be assigned to a specific group, so for the purpose of this analysis groups of professions have been created, taking into account a similar range. Currently used multiplier methods refer only to certain liberal professions enjoying the highest level of trust, taking into account customer feedback and value for the owner. To date, individual valuation mechanisms have not been identified for specific industries. The valuation standards used to date include commonly used professions such as the legal, medical and accounting professions. No less, all the considerations undertaken relate only to discussion taking into account the specifics of these professions.

In practice, taking into account all liberal professions each has different valuation mechanisms, assuming the influence of various factors (both tangible and intangible) on their value. In the Polish and Anglo-Saxon literature, there is a well-established consideration of the applicable standards taken into account in valuation by multiplier methods, which in effect include a qualitative analysis of the experience accumulated to date. As indicated in the applicable definitions, 'The methodology requires that gross revenues are averaged over the last 5 years to compensate for any unusual increases or decreases in the revenue stream. Gross revenues for that year are then multiplied by a factor. The factor or multiplier varies depending on the industry and even geographical location. Some accounting firms are valued at 1.0 to 1.5 times annual gross revenues, while medical practices may be valued at 0.4 to 1.0 (40 to 100 per cent) of annual gross revenues' (Brown, 2020) The literature indicates that a standard for law firms has not yet been developed, no less as the available data indicates that the value of the multiplier can be determined based on the data conditioning it. Among other authors, it is indicated that an analysis of aspects such as:

- the market in which the local practice operates (a factor similar to other small businesses),
- stability of clients (similar factor to other sectors),
- sources of reference for all factors identical in all sectors),
- type of client relationships,
- the ability of lawyers in the firm to maintain the business (factor not included in the situation of sole practitioners),
- the payment arrangements for law firm services (fixed amount, one-off),

- the degree of concentration of income (variation from year to year - we take 5 years into account for the analysis),
- the level of profitability of the practice in relation to competitors (differentiation in relation to other practices),
- the size of the law firm (level of employment, stability of employment, scope of services),
- stability of counterparties (partners)-level of stability of employment.

Central to the valuation of small business practices is the position and independence of the owner.

The factors adopted for valuation taking into account the high level of autonomy of the owner and the lack of dependence on the performance of others leads to a professional valuation of the profession by taking into account the following values usually taken into account, among others: the age and health of the professional, the possibility of obtaining lucrative contracts in advance, the reputation of the professional in the environment in which he or she operates (in terms of knowledge and skills, the extent of the professional's professional success, the nature and duration of the professional practice taking into account the way the business is conducted in the form of a partner in a partnership or professional corporation (Trugman, 2018). The idea of professionalism is that clients, when choosing an attorney, come to a professional, not to the firm itself. Related to this are skills, knowledge, reputation and personality. In the case of legal services, changing the place of service does not have the effect of reducing the number of clients. Revenue-generating opportunities are attributed directly to the practitioner, including the legal profession.

In lawyers' assessments, goodwill in the case of a goodwill valuation is primarily intrinsic value, so it comes down to the value of the owner, regardless of its marketability. Despite the determination of intrinsic value, the sale of such services is not possible given the strictly professional nature of the business and the economic nature of its non-transferability. It is currently difficult to establish a reasonable remuneration. Also, in subsequent cases decided by the Courts, age, experience, education, expertise, the effort of locating the practice - and therefore the high individualism of the activity performed - have all proved relevant in determining the value of the practice (Fishman, Pratt, Morrison, 2013). The court stated that the value of this type of practice cannot be equated solely with its economic value because it is primarily intangible factors that determine its value. Therefore, the ultimate value of a practice lies in the assessment of its consumers. From an economic perspective, the question of continuity of value is crucial. Taking into account Polish regulations on the division of assets, it is assumed that an enterprise is an organised set of intangible and tangible components designed to conduct business activity.

It includes in particular: signs identifying the business or its separate parts, ownership of immovable or movable property, including equipment, materials, goods and wares and they rights in rem in immovable or movable property, rights arising from contracts of lease and hire

of immovable or movable property and rights to use immovable or movable property arising from other legal relationships, receivables, rights in securities and cash, concessions licences and permits, patents and other copyrights and property related rights, business secrets, books and documents relating to the conduct of the business not extending beyond the period of the business.

All assets must be valued at the date of distribution of the estate, so the issue of continuity of value is not taken into account. All subsequent gains are not taken into account at the time of distribution. This approach distinguishes Polish laws from US solutions. Legal professions are considered to be most attributable to the position and reputation of the owner. The valuation of a law practice is particularly complicated because of the type of business and its structure, attributed to the reputation and skills of the owner.

‘While in many cases the personal efforts of the individual owner are analysed, in few cases is the applicability of an appropriate methodology for valuing the personal efforts and the business itself considered’ (Hitchner, 2006). In practice, the value of an enterprise carried out by a freelancer is nothing more than the reputation, prestige, brand, repute or image of the enterprise therefore the non-financial aspects affecting its economic value. A company's reputation is an attribute that increases the value of a company over and above the carrying value of its physical assets and has a strong impact on the company's market position. Another author takes the view that the individual value of a professional practice can be defined as the reputation of a company, the main purpose of which is to express the value of the company's market position.

In relation to business reputation, it is an economic term in which reputation is the overall result of a company's long-term presence in the market and which includes the impact of the costs of marketing activities and also other activities and opportunities that can lead to the creation of a better overall awareness of the company and its activities (Palazzo, Foroudi, 2021).

The long-term presence of the company in the market is characterised by the value of the medical practice, which relates more to the work and opinions of doctors. The value is less attributed to the person of the owner. Most professional practices are run by individuals associated with the practice being valued. As with law firms in relation to medical practices, the valued intangible assets include several key issues that affect the value of a medical practice, such as the reputation of the doctors, the location of the practice, the loyalty and number of high-paying patients, and the management systems in place (Hekman, 2008).

A greater role is attributed to external factors from the perspective of company value creation. With regard to the value of medical practices, examples of factors that can be classified as key factors include: local competition, partners and key employees, medical equipment, planned investments (share of existing investments in the company's assets, structure of achieved revenues). In the case of health care, the criterion of trust relates to several levels, including a person who has already had contact and experience with a health care professional, a person who believes in the effectiveness of a health care system that is trustworthy.

Ideally, it should be based on the care as well as the attitude of health care professionals towards the patient. With regard to medicine, we distinguish between several types of multipliers due to the size of the practice and the loyalty as well as the treatment process of the patient. With regard to patients using the specialist on a continuous basis for a longer period of time, the goodwill value is higher.

In relation to the final aspects, from specialist, in a continuous manner, the value of the goodwill is higher. In practice, the upper limits of the multipliers for assessing the goodwill, apply to those practitioners whose key intangible assets are loyal members. The higher the value of the intangibles, the lower the goodwill. From the other perspective, we have those values, whose contact with the patient is ad hoc and resulting from his temporary needs, e.g. surgery or other fields not related to pathological changes. In the case of such groups of patients, the multiplier is relatively low. No less likely is the existence of a problem. Because there are many complications as the so-called ad hoc has many patients, which can be, because the value of goodwill has an impact on other people associated with the doctor. You can even use practices that can be applied in the case of many schemes, and thus obtain different values of the goodwill. To a large extent, the value of the goodwill is connected with the role of the professional in relation to the values of the accounting office. In the case of accounting offices, its greater value, not only the intangible aspects, but also elements of the element of the activity. Office access height usually comes from two sources.

As in the case of the medical industry, these are regular clients with whom the office has signed an agreement for accounting and tax services and serves large companies, as well as occasional users of the office's services for often one-off needs. It should be noted that accounting offices are currently focused on serving regular clients, who to the greatest extent determine revenues from regular contracts with clients. Signed contracts with clients have shown that the goodwill of this type of enterprise is set high, taking into account other forms of activity. The pilot studies conducted have initially shown which intangible and tangible factors shape the value of the office to the greatest extent and determine the amount of goodwill. The value of an accounting office is estimated at a level closer to other classic types of enterprises. The value of an accounting office, regardless of its size, is influenced by the sum of net assets and goodwill values, as well as the deducted value of liabilities shown on the valuation date.

The pilot study carried out showed that in relation to accounting offices, the key factor shaping the value of a small enterprise is the stability of clients, segmentation of revenues and local competition. Most of the companies had been operating on the market for over 15 years, which allowed them to accumulate goodwill. Most of the companies were sole proprietorships. Despite the fact that accounting firms have relatively stable goodwill considering their level of revenues, they are usually small companies. Research shows that in terms of the factors creating their value, the share of assets physically creating the value of the enterprise is small. To a large extent, these are companies; the type of business conducted is also of little importance

considering its size, which indicates a high demand for this type of service. In terms of the essence of goodwill, the respondents were asked about the value of capital and human potential from the perspective of shaping the economic value of the enterprise. The practical experience of a person performing a freelance profession, creativity and interpersonal skills had the greatest impact on the value of the concept of goodwill. To a lesser extent, the managerial skills and qualifications of a person performing a freelance profession were of lesser importance. This thesis confirms much earlier assumptions according to which in the case of persons practicing the accounting profession, practical experience is more important than the qualifications held and constitutes the main goodwill value (Maciąg, 2013).

The conducted research confirmed the importance of goodwill understood on the one hand as the value of intangible factors in the role of owned assets and on the other hand showed how important its role is in shaping the value of the company. Taking into account only three professions performed, it can be seen that its role is very diverse considering the size of its share in shaping assets and depends to a large extent on the competence and trust in the person conducting this type of activity. It should be noted that only one profession in the form of legal practice had the greatest impact on creating the value of the company. The remaining professions to a greater extent reflected a value similar to other companies, including other more general professions. A key element also shaping the value of each practice is the ability to generate income, taking into account aspects related to the transfer and departure of a partner from the Company.

4. Conclusions from the conducted research

In practice, in the valuation of an enterprise, we encounter two types of enterprise value. One aspect is the external value established by the adopted methods, and on the other hand, we are dealing with the valuation of goodwill, which is an element of intangible value, in that it is the result of trust in the owner. Intangible value is also an internal element, i.e. related to the professional, assigned to non-financial elements. At present, too many studies focus only on mathematical elements that can be calculated relatively easily. At present, in Poland, there are no regulated uniform valuation standards in relation to specialist industries, which are the subject of many analyses and valuations. The very approach to the concept of "trust" in relation to the valuation of enterprises is an element proving the role of intangible assets. Although the approach to valuation using the goodwill method is known in the subject literature, there are currently no methods enabling its valuation in the case of specialist practices represented by freelancers.

In the context of Polish realities, there are no developed Polish multipliers that take into account intangible assets related to Polish economic realities and reflect the value of goodwill taking into account its global dimension. Currently prepared indicators do not include research results containing the specific role of intangible factors in shaping the value of an enterprise. In relation to selected categories of freelance professions, for example in relation to legal professions, the adopted valuation methods are based on common, often qualitative findings without referring to the specificity of a specific undertaking. It should be noted that the valuation of an enterprise is not only a quantitative aspect but also a qualitative one, which can be determined using appropriate research methods. Currently, all previously developed multipliers also based on intangible elements (knowledge, human capital) refer to the results of American research based on transaction values, having no major impact on the Polish market. Taking into account the value of intangible assets, it should be remembered that in the field of similar professions, the same valuation pattern cannot be used because all valued practices have different criteria related to determining the factors shaping the value of goodwill.

5. Summary

The main objective of the prepared article was to highlight the factors determining the value of businesses run by freelancers. The key aspect was to analyze the value of each practice from the perspective of the issue of trust in the professional and increasing the value of intangible factors.

The achievements of English-language literature and the results of own research relating to the specifics of running accounting offices were assessed. The conducted research showed that not all businesses run by freelancers have the same level of trust and not all activities can be treated in a uniform way. The greatest increase in trust in shaping intangible assets was observed in law firms, while it was least visible in relation to accounting offices, where the key factor was the experience, not the education of the person providing the services.

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INTERNAL COMMUNICATION MANAGEMENT AS A TOOL FOR EMPLOYEE ENGAGEMENT AND ENTERPRISE QUALITY POLICY ENHANCEMENT

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Purpose: the purpose of this study is to analyze the impact of internal communication management on employee engagement and the implementation of quality policy by tailoring communication strategies to demographic differences, industry characteristics, and communication barriers.

Design/methodology/approach: the study utilized a survey conducted among 374 employees and managers from various industries. Statistical methods, such as Chi-square tests, Spearman's correlation, and linear regression, were applied to analyze relationships and verify hypotheses. The approach integrates communication theories with practical insights into quality policy and employee engagement.

Findings: the study found that communication errors, such as lack of feedback and inconsistent messages, reduce employee engagement and hinder quality policy implementation. Older employees identified these issues more frequently, while tailored communication strategies improved engagement and acceptance of policies. Statistical analysis confirmed that fewer communication errors lead to higher engagement.

Research limitations/implications: if research is reported on in the paper, this section must be completed and should include suggestions for future research and any identified limitations in the research process.

Practical implications: the study's sample was limited to 374 respondents from specific industries, which may not represent all sectors. Future research should expand to diverse industries and cultural contexts to validate findings and explore long-term trends.

Social implications: effective internal communication enhances employee engagement, improves service quality, and fosters better workplace cultures. These practices can influence corporate social responsibility and inform policies promoting transparency and efficiency.

Originality/value: the study highlights how tailored communication strategies enhance employee engagement and quality policy implementation, offering practical insights for managers and HR specialists.

Keywords: Internal communication management, employee engagement, quality policy, communication barriers, organizational performance.

Category of the paper: Research paper.

1. Introduction

Internal communication serves as the foundation of modern management, playing a pivotal role in supporting organizational processes at both micro and macro levels. Efficient information exchange shapes organizational culture and facilitates the achievement of strategic goals within enterprises. Consistent, clear, and targeted messages contribute to increased employee engagement and improved operational efficiency. Conversely, inconsistent messaging, lack of feedback, or unclear communication can lead to significant challenges, such as a decline in decision-making quality, an increase in operational errors, and diminished trust among employees and clients.

As a result, managing internal communication has become a critical area of research, particularly for organizations striving to build sustainable competitive advantages. This highlights the importance of well-structured communication strategies that align with organizational objectives and foster resilience in a rapidly evolving business landscape.

The originality of this study lies in the comprehensive analysis of the impact of internal communication on the implementation of quality policy, taking into account both organizational factors and individual employee preferences. Most previous research has focused on general aspects of corporate communication, neglecting a detailed examination of its influence on key organizational processes, such as the implementation and maintenance of quality standards. This study fills that gap by providing new empirical evidence and practical recommendations that can be applied both in academic research and business practice.

Research on internal communication unequivocally highlights its fundamental importance in building effective organizations. Smolağ and Łusarczyk (2018) emphasize that effective communication not only fosters innovation but also impacts employee engagement, which translates into achieving the strategic goals of an enterprise. Similarly, Rogala and Białowas (2014) underline the significance of reliability and clarity in conveyed information as key elements for organizational functioning. Dębowski (2001), in his studies, analyzes the role of internal communication as a factor supporting a company's development strategy, emphasizing its importance in building a positive corporate image and strengthening employee loyalty. Insights from the literature reveal that communication management is one of the critical areas influencing operational efficiency and long-term organizational success.

Gregor and Kalińska-Kula (2014) highlight the importance of marketing research methodology, including internal communication, as a tool enabling a detailed analysis of the effectiveness of communication processes. Contemporary publications, such as "The 5 Key Trends in Internal Communication Technologies" and "Internal Communication in Companies – Examples and Best Practices" (EY Insights, 2024), point to significant development directions in the field of communication, including the integration of AI-based technologies and the use of innovative tools to enhance employee engagement.

The literature also highlights Kania's (2013) research, which focuses on the audit of communication systems, emphasizing the necessity of their systematic evaluation in the context of project management. The findings stress the importance of regularly assessing communication processes and their impact on achieving organizational goals. These conclusions indicate that effective internal communication is not only a critical operational factor but also a strategic element in building sustainable organizational efficiency.

There is a notable lack of research focusing on managing improper communication as a key factor in ensuring the attainment of an adequate level of service quality. The word “communication” originates from the Latin term *communicare*, meaning “to be in relation with someone”, and refers to the exchange of information between individuals (Maliszewski, Czerwiński, Paluch, 2012). In the communication process, not only the content of the information but also the way it is presented holds significant importance. Peter Drucker emphasized that “the most important thing in communication is hearing what isn’t said” (Drucker, 1999).

Effective communication requires the development and implementation of procedures that encompass both formal and informal channels of information exchange across all levels of an organization (Robbins, Coulter, 2020). Paweł Argenti emphasizes that communication is a key factor in work efficiency, manifesting through the coordinated flow of information between departments and management levels, which directly supports the achievement of an organization’s strategic goals (Argenti, 2015). This approach underscores the importance of structural coherence and transparency in communication processes for improving service quality.

Effective internal communication plays a crucial role in engaging employees in the achievement of an organization’s strategic goals. Grunig and Grunig (2011) emphasize that effective management of communication processes supports the realization of an organization’s strategic objectives by fostering coherence and commitment among employees. This not only facilitates the smooth flow of information but also strengthens the integration of activities across different management levels.

The literature on the subject discusses various aspects of this issue, such as managing multi-generational teams, implementing a consistent quality policy, automating communication processes, and the impact of digital leadership on team motivation.

Górecka (2021) analyzes the challenges associated with communication in multi-generational teams. Research shows that differences in communication preferences across generations can lead to misunderstandings, negatively impacting engagement. Multi-generational teams require a diversified approach to communication, which helps reduce tensions and improve collaboration efficiency.

Mazurwska and Płoska (2022) emphasize the importance of a transparent quality policy in internal communication. Organizations that clearly communicate quality objectives and regularly report results build trust among employees. This approach enables employees to better

understand their role in the implementation of organizational strategies, thereby increasing their engagement.

Similarly, Stefańska and Grabowski (2023) highlight the significance of communication quality in remote teams. In a remote work setting, regular contact with team leaders and systematic communication of organizational goals help maintain high levels of engagement. The absence of these elements results in decreased job satisfaction and efficiency.

Stor and Domaradzka (2020) highlight the benefits of automating communication processes in the context of quality management. Automation not only enables faster identification of communication issues but also enhances process transparency, which translates into increased employee motivation. The implementation of quality management systems, such as TQM, allows for real-time progress reporting, positively impacting team engagement.

Korzyński (2018) analyzes the role of digital leadership in managing communication challenges. Leaders who effectively use digital tools to communicate with their teams achieve better results in fostering engagement. Digital leadership is particularly important in technology companies, where fast and precise communication plays a critical role.

To achieve these objectives, communication—often interchangeably referred to in the literature as "communicating"—is crucial. In their research, Górski, Gros, Kassay, and Stankiewicz emphasize the importance of communication as a factor supporting both the social and strategic aspects of management. Górski (2006) and Kassay (2015) note that strategic communication plays a significant role in building a sustainable competitive advantage for enterprises, while Stankiewicz (2006) suggests the necessity of developing communication structures that support the implementation of quality policies in companies.

The literature highlights that effective communication not only facilitates the achievement of strategic goals but also contributes to greater coherence and efficiency in organizational activities.

While available research addresses many aspects of communication within organizations, there is a lack of detailed analyses focusing on managing communication issues as a dedicated tool for enhancing employee engagement. Further research in this area is needed to identify best practices and strategies for effectively leveraging communication to foster long-term employee engagement.

2. Description of the communication process

Communication is a process of transmitting information between parties through specific entities or tools to maintain or improve the desired level of production quality. In the context of enterprises, intermediaries in this process may include HR departments, team leaders, training specialists, external companies, or electronic communication systems. Their primary

role is to support the effective flow of information and enhance employee qualifications, which directly impacts the implementation of organizational strategies. Consequently, the activities of intermediaries contribute to maintaining or improving the quality of services provided by the company (Figure 1).

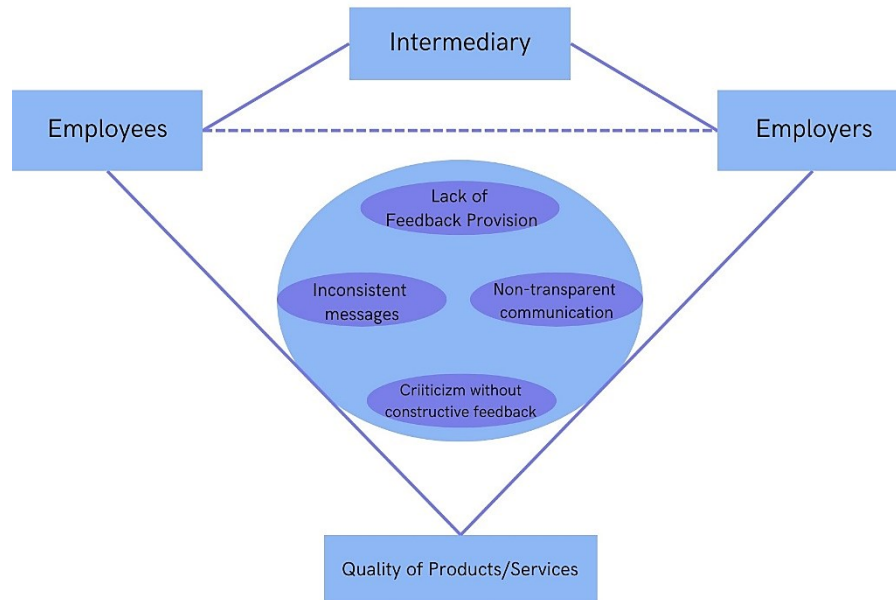


Figure 1. Internal communication framework in a company.

Source: Own elaboration.

Figure 1 illustrates the internal communication framework within a company, presenting the key components of this process and potential barriers. Information flows from employers to employees through specific intermediaries, such as team leaders, HR departments, training specialists, or electronic communication systems. Intermediaries play a crucial role in ensuring effective message delivery and supporting the achievement of the organization's strategic goals.

The figure highlights factors that may disrupt effective communication, such as the lack of feedback provision, inconsistent or imprecise messages, and criticism without constructive feedback. The impact of these factors on the quality of products or services underscores the importance of a well-organized internal communication system in an organization.

Disruptions and errors in the internal communication process

The dotted line in the presented diagram (Figure 1) highlights disruptions occurring in the process of information transmission within an organization. These disruptions can stem from several key factors: the lack of feedback provision, the delivery of improper or inconsistent messages, and the use of criticism without constructive feedback. Each of these elements negatively impacts communication effectiveness, which can result in reduced quality of services or products and diminished employee engagement. Understanding these communication barriers is crucial for developing strategies to eliminate disruptions in the flow of information.

The lack of feedback provision, imprecise and inconsistent messages, and criticism devoid of constructive feedback are among the most common errors in team communication, often leading to employee frustration and reduced organizational efficiency. Improper and inconsistent messages generate serious issues, such as misunderstandings, decreased work efficiency, and a deterioration of team morale. Furthermore, a lack of consistency between verbal and nonverbal messages can cause confusion among employees, negatively affecting their engagement and motivation (Szkola Męskiego Stylu, 2024).

To counteract these issues, it is essential to use clear and precise messages while avoiding contradictory signals during the communication process (EY Insights, 2024). Regular and constructive feedback is a crucial element in supporting employee development and fostering a positive workplace atmosphere (Staszewska, 2024). Understanding and eliminating these errors in internal communication form the foundation for effective team management and the achievement of an organization's strategic goals.

3. Methods

The study employed a custom-designed survey directed at employees and managers across various industries, including education, IT, hairdressing, and other service sectors. The sample size was calculated using formulas commonly applied in the literature, based on the works of Babbie (2014), Cochran (1977), and Matuszak and Matuszak (2011).

These formulas allowed for the precise determination of the sample size, taking into account the assumptions regarding the target population, the expected size of the estimated fraction, and the acceptable margin of error. Referring to established methodological sources (Babbie, 2014; Cochran, 1977; Matuszak, Matuszak, 2011) ensured scientific rigor and the correctness of the sampling procedures, thereby enhancing the reliability of the results obtained.

Formula (1) allows for the calculation of the minimum sample size for a finite population, assuming a specific confidence level and margin of error. It is widely used in social and educational research to ensure the representativeness of results.

$$nb = \frac{N}{\frac{1 + d^2(N - 1)}{\alpha^2 pq}} \quad (1)$$

where:

N – population size,

p – expected proportion of the estimated fraction,

$q = 1 - p$,

α^2 – critical value corresponding to the confidence level:

1.64 for $\alpha = 0.10$,
1.96 for $\alpha = 0.05$,
2.58 for $\alpha = 0.01$.

According to the presented formula, the minimum required sample size was estimated at 371 respondents, ensuring the representativeness of the findings. During the study, 374 responses were collected from participants with diverse levels of professional experience and years of service, further confirming the representativeness of the research.

The survey was developed using Google Forms, and its content was available at: <https://docs.google.com/forms/d/e/1FAIpQLScyY0oSYPePmM3h6lmQWLw-WgVoVsvupZFUBeh94V7iHiT5KQ/viewform>.

Such organization of the research process enabled the effective collection of data and analysis on a group consistent with the methodological assumptions.

3.1. Age profile of respondents

The most active respondent groups in the study were individuals in two age brackets: 35-44 years and 45-54 years, which constituted the largest percentage of participants. A significant proportion of respondents was also observed in the 25-34 age group. On the other hand, the least represented groups were respondents aged 18-24 and 55-64.

Data analysis reveals that the majority of respondents (46.52%) have over 10 years of work experience, while 39.84% have between 4 and 10 years of professional experience. This distribution of professional tenure confirms the respondents' work experience and their competence in evaluating the topics under study.

It is worth noting the 18-24 age group. Despite their limited practical experience, younger individuals demonstrated initiative and a willingness to share their insights, which may indicate their engagement in processes of introducing changes within organizations. This approach highlights the potential of younger employees in shaping innovative solutions within the organizational structures of enterprises (Figure 2).

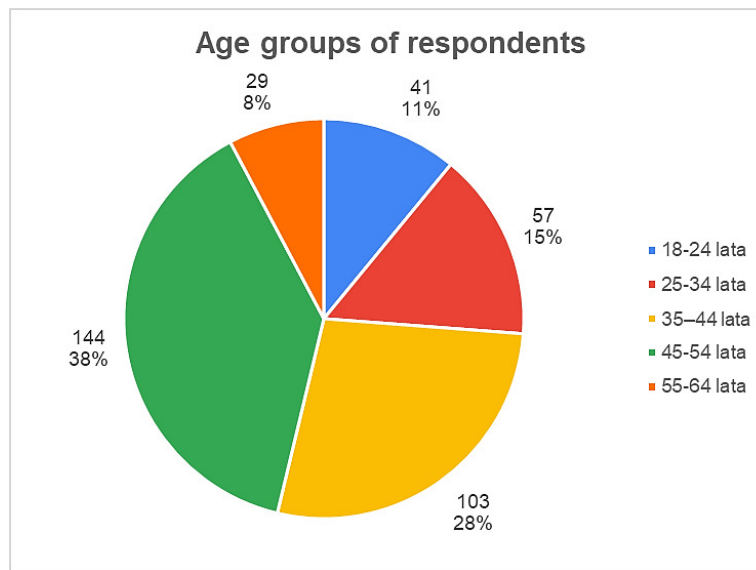


Figure 2. Age structure of respondent.

Source: Own elaboration.

3.2. Industry and gender profile of respondents

The gender distribution of respondents in the study was nearly balanced, with a slight predominance of men (51.07%) over women (48.93%). This distribution reflects the representation of respondents from various industries, including trade (69 participants), freight forwarding and logistics (60 participants), transport (52 participants), as well as the hospitality, gastronomy, and tourism sector (43 participants).

Industries with lower representation, accounting for less than 8%, were categorized as "other" (22% of respondents). This wide spectrum of sectors employing the respondents highlights the diversity of the sample and confirms the representativeness of the conducted research (Figure 3).

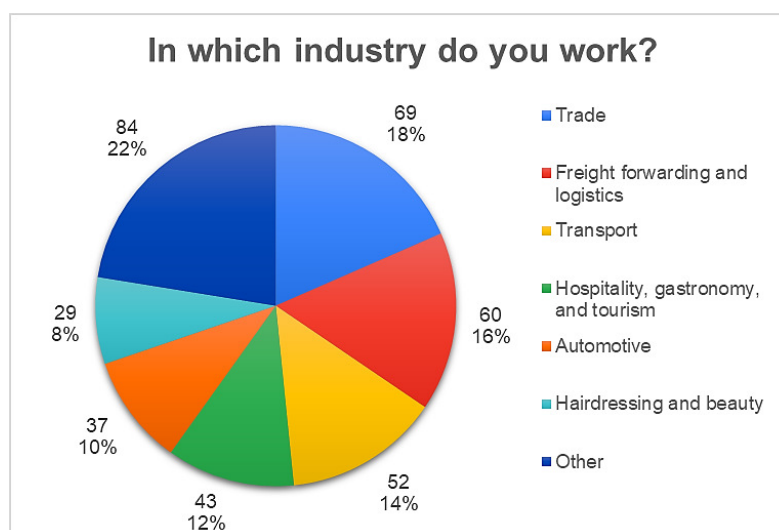


Figure 3. Industry and gender profile of respondents.

Source: Own elaboration.

3.3. Research Design and Methodology

The aim of the study is to identify the main communication barriers and their impact on the implementation of quality policy, as well as to develop practical strategies for optimizing communication processes. Specifically, the analysis includes an assessment of the effectiveness of various communication methods in the context of increasing employee engagement and minimizing communication errors. The findings of this study may serve as a reference point for future research and for organizations seeking effective solutions in the field of internal communication management.

The subject of the study is the analysis of the influence of internal communication processes on the implementation of quality policy and employee engagement in enterprises, with consideration given to communication barriers, demographic variables, and the use of modern technologies.

Research hypotheses

The following hypotheses were formulated as part of the study:

- H1. The number of communication errors is a significant factor negatively affecting the level of employee engagement. Correcting these errors can lead to increased engagement.
- H2. The perception of communication issues is not unequivocally related to the hierarchy of positions but may result from other factors such as organizational culture, access to information, or employees' personal experiences.
- H3. The acceptance of quality policy within the organization varies between age groups, and tailoring the policy to the specific needs of these groups increases the level of acceptance.

The presented hypotheses form the basis for verifying assumptions regarding the effectiveness of internal communication in enterprises and its impact on the implementation of quality policy. The study's findings will enable the development of recommendations for communication management to support service quality.

Methods and tools for statistical analysis

The study employed various statistical methods to analyze data and verify the research hypotheses. Below is a detailed description of the tools used:

- Cross-tabulation with Chi-square test: This tool was used to determine the potential existence of relationships between qualitative variables. The Chi-square test allowed for the assessment of the statistical significance of relationships between categories within the studied groups.

- Spearman's correlation analysis: This method was used to evaluate the strength and direction of relationships between qualitative variables. Its selection was based on its suitability for identifying correlations when the data does not follow a normal distribution. Spearman's analysis also served as the basis for the preliminary verification of research hypothesis H2.
- Linear regression analysis: This method was designed to verify hypothesis H1, which concerns the impact of regular meetings on improving the quality of management processes. This analysis allows for determining the direction and strength of the influence of independent variables on the dependent variable, enabling more detailed conclusions.

The selection of these methods enables a comprehensive analysis of the data while allowing for the assessment of relationships between variables and a detailed verification of the proposed hypotheses.

4. Results

The implementation of statistical research in this study followed a defined sequence of steps, which included the following stages:

- Coding of Survey Data: The data obtained from the survey was coded using ordinal numbers, enabling its transformation into a quantitative format. The coding process was a key step in preparing the data for statistical analysis, ensuring its operationalization and facilitating the quantitative representation of variables.
- Construction of Cross-tabulation Tables: Using IBM SPSS Statistics software, cross-tabulation tables were constructed. The Chi-square test was then applied to determine the existence of statistically significant relationships between qualitative variables.

Construction of the correlation matrix: A correlation matrix was developed, containing Spearman's correlation coefficients and levels of statistical significance. This matrix enabled the identification of the strength and direction of relationships between the analyzed variables.

Preliminary hypothesis verification: Based on the results obtained from cross-tabulation tables and the correlation matrix, preliminary verification of the research hypotheses was conducted.

Final hypothesis verification: Advanced statistical methods, such as regression analysis, were employed for the final verification of hypotheses, allowing for detailed conclusions about the relationships between the analyzed variables.

Preliminary analysis using the Chi-square Test. The preliminary analysis confirmed a relationship between the following questions (Table 1).

The table 1 confirms statistically significant relationships between the analyzed qualitative variables within the study, which allows for the formulation of several key conclusions:

1. Relationship between variables

High values of Pearson's Chi-square statistic and low asymptotic significance levels ($p < 0.05$) indicate statistically significant relationships between variables, such as:

- Industry and gender, as well as length of employment.
- Position and age, overall work experience, and length of employment in the current company.
- Quality policy goals and age, as well as overall work experience.
- Communication problems and the effectiveness of the quality policy with demographic variables (age, work experience).

2. Representativeness of the sample

The relationships between variables confirm that the diversity of respondent groups (industry, work experience, age, position) was effectively captured, which enhances the representativeness of the conducted research.

3. The role of demographic variables in communication

The results indicate that demographic variables, such as age and work experience, are associated with:

- The perception of communication problems.
- The evaluation of quality policy goals and their implementation.
- The perception of benefits resulting from the implementation of the quality policy.

4. Variation in the perception of communication and quality

The analysis of results indicates differences in the perception of communication and its impact on quality policy, depending on respondents' characteristics such as industry, age, and work experience. This confirms the need to adapt communication strategies to the specific traits of target groups.

Table 1.
Results of cross-tabulation analysis

No.	Dependent variables (question No.)	Independent variables (question No.)	Pearson Chi-square	Asymptotic significance
1	3. In which industry do you work?	14. Gender	167.163	< 0.001
2	3. In which industry do you work?	2. How long have you worked in your current company?	124.644	0.005
3	4. What is your current position?	14. Gender	57.609	0.004
4	4. What is your current position?	15. Age	245.021	< 0.001
5	4. What is your current position?	1. Overall work experience	200.841	< 0.001
6	4. What is your current position?	2. How long have you worked in your current company?	152.622	< 0.001
7	5. What are the main goals of the quality policy in your company?	15. Age	69.022	< 0.001
8	5. What are the main goals of the quality policy in your company?	1. Overall work experience	64.040	< 0.001

Cont. table 1.

9	5. What are the main goals of the quality policy in your company?	2. How long have you worked in your current company?	71.609	< 0.001
10	6. What are the benefits of implementing the quality policy in your company?	15. Age	53.275	< 0.001
11	6. What are the benefits of implementing the quality policy in your company?	1. Overall work experience	83.879	< 0.001
12	6. What are the benefits of implementing the quality policy in your company?	2. How long have you worked in your current company?	77.473	< 0.001
13	8. Have there been situations where improper communication negatively impacted the determination of quality policy goals?	15. Age	29.104	< 0.001
14	8. Have there been situations where improper communication negatively impacted the determination of quality policy goals?	1. Overall work experience	19.139	0.004
15	9. What are the most common communication problems that impact the implementation of the quality policy?	15. Age	59.421	< 0.001
16	9. What are the most common communication problems that impact the implementation of the quality policy?	1. Overall work experience	40.493	0.002
17	12. Do you think these actions are effective?	15. Age	16.072	0.041
18	13. What additional steps could be taken to improve communication and better achieve quality policy goals?	2. How long have you worked in your current company?	11.212	0.011
19	13. What additional steps could be taken to improve communication and better achieve quality policy goals?	1. Overall work experience	14.819	0.002

Source: Own elaboration.

Further analysis, with results presented in Table 2, extends these findings through the application of Spearman's correlation coefficient. The inclusion of this indicator allows for a detailed assessment of the strength and direction of relationships between variables, providing a valuable complement to the obtained results. This enables not only the identification of statistically significant relationships but also a deeper understanding of these relationships in the context of the studied issues.

Table 2 presents both Pearson's Chi-square values and Spearman's correlation coefficients, allowing for a more comprehensive interpretation of the results.

Table 2.

Results of cross-tabulation and Spearman's correlation analysis

No.	Dependent variables (question No.)	Independent variables (question No.)	Pearson Chi-square / Asymptotic significance	Spearman's correlation Coefficient / two-tailed significance
1	4. What is your current position?	15. Age	245.021 / < 0.001	-0.219 / <0.001
2	4. What is your current position?	1. Overall work experience	200.841 / < 0.001	0.178 / 0.001

Cont. table 2.

3	4. What is your current position?	2. How long have you worked in your current company?	152.622 / < 0.001	0.103 / 0.047
4	5. What are the main goals of the quality policy in your company?	15. Age	69.022 / < 0.001	0.199 / <0.001
5	5. What are the main goals of the quality policy in your company?	1. Overall work experience	64.040 / < 0.001	-0.224 / <0.001
6	5. What are the main goals of the quality policy in your company?	2. How long have you worked in your current company?	71.609 / < 0.001	-0.11 / 0.033
7	6. What are the benefits of implementing the quality policy in your company?	15. Age	53.275 / < 0.001	0.191 / <0.001
8	6. What are the benefits of implementing the quality policy in your company?	1. Overall work experience	83.879 / <0.001	-0.263 / <0.001
9	6. What are the benefits of implementing the quality policy in your company?	2. How long have you worked in your current company?	77.473 / < 0.001	-0.159 / 0.002
10	8. Have there been situations where improper communication negatively impacted the determination of quality policy goals?	1. Overall work experience	19.139 / 0.004	0.157 / 0.002
11	9. What are the most common communication problems that impact the implementation of	15. Age	59.421 / < 0.001	0.248 / <0.001

Source: Own elaboration.

Table 2 presents the results of the analysis of relationships between variables using both Pearson's Chi-square test and Spearman's correlation coefficient. Below are the key conclusions derived from the analysis:

1. Relationships related to job position

- Position and age (Chi-square: 245.021, $p < 0.001$; Spearman's rho: -0.219, $p < 0.001$):

The results indicate a significant relationship between age and job position. The negative correlation suggests that higher positions are more frequently occupied by older individuals.

- Position and overall work experience (Chi-square: 200.841, $p < 0.001$; Spearman's rho: 0.178, $p = 0.001$).

The positive correlation suggests that individuals with longer work experience are more likely to hold higher positions.

2. Quality policy goals and demographic characteristics and experience

- Quality policy goals and age (Chi-square: 69.022, $p < 0.001$; Spearman's rho: 0.199, $p < 0.001$).

There is a positive relationship between age and the perception of quality policy goals, suggesting that older employees better understand or more readily accept these goals.

- Quality policy goals and work experience (Chi-square: 64.040, $p < 0.001$; Spearman's rho: -0.224, $p < 0.001$).

The negative correlation indicates that employees with longer work experience show less acceptance of quality policy goals, possibly due to greater skepticism toward changes.

3. Benefits of the quality policy

- Benefits and age (Chi-square: 53.275, $p < 0.001$; Spearman's rho: 0.191, $p < 0.001$).

The results suggest that older employees are more likely to recognize the benefits of the quality policy.

- Benefits and overall work experience (Chi-square: 83.879, $p < 0.001$; Spearman's rho: -0.263, $p < 0.001$).

The negative correlation indicates greater skepticism toward the benefits of the quality policy among employees with longer work experience.

4. Communication problems

Communication problems and age (Chi-square: 59.421, $p < 0.001$; Spearman's rho: 0.248, $p < 0.001$).

The high positive correlation suggests that older employees are more likely to identify communication problems as obstacles to the implementation of the quality policy.

These results highlight the need to consider demographic factors and professional experience when designing quality policies and communication strategies within organizations.

5. Discussion

The results of the conducted research enabled the verification of three key hypotheses regarding the importance of communication and the adaptation of the quality policy to the specific needs of employees.

- H1. The number of communication errors is a significant factor negatively affecting the level of employee engagement. Correcting these errors can lead to increased engagement.

The analysis confirmed that the identification and correction of communication errors are significant factors in increasing employee engagement. Older employees more frequently identify communication problems as critical barriers to achieving organizational goals (Spearman's rho: 0.248, $p < 0.001$). These results suggest that correcting communication errors within this group can yield significant effects, such as greater engagement and improved work efficiency.

Similarly, employees with longer work experience also identify communication errors as a key factor affecting the implementation of the quality policy (Spearman's rho: 0.157, $p = 0.002$). This indicates the need to develop clearer and more personalized communication strategies, particularly for groups with longer professional experience.

- H2. The perception of communication problems is not unequivocally related to the hierarchy of positions but may result from other factors, such as organizational culture, access to information, or employees' personal experiences.

The preliminary analysis of hypothesis 2 was conducted using the Chi-square test to examine whether the perception of communication problems is related to the hierarchy of positions. The test results indicated no statistically significant differences between positions in the number of reported communication problems ($p = 0.089$). At the same time, the analysis revealed that other variables, such as length of service ($p < 0.05$), have a significant impact on the perception of communication problems.

Employees with shorter work experience more frequently reported communication difficulties compared to those with longer professional experience. Additionally, the analysis of cross-tabulations indicates that the perception of communication problems varies across industries and age groups, suggesting a potential influence of contextual factors such as organizational culture or access to information.

- H3. The acceptance of quality policy within the organization varies between age groups, and tailoring the policy to the specific needs of these groups increases the level of acceptance.

The results clearly indicate differences in the perception of the quality policy among age groups. Older employees are more likely to accept the goals of the quality policy and recognize the benefits of its implementation (Spearman's rho: 0.199, $p < 0.001$ for goals, and 0.191, $p < 0.001$ for benefits). Younger employees, on the other hand, demonstrate greater hesitation toward the quality policy, which may stem from less professional experience or a lack of understanding of its long-term benefits.

Although the preliminary results suggested the existence of relationships supporting hypotheses H1 and H3, and partially H2, their limitation lay in the use of methods that assessed only general connections between variables. To confirm these relationships and determine whether they are statistically significant in the context of dependent variables, a final verification was conducted using advanced statistical methods, such as linear regression and ANOVA analysis.

Verification of hypothesis H1

H1: The number of communication errors is a significant factor negatively affecting the level of employee engagement. Correcting these errors can lead to increased engagement.

To verify this hypothesis, linear regression was applied, with employee engagement as the dependent variable and the number of communication errors as the independent variable. The linear regression analysis confirmed that communication errors have a significant negative impact on employee engagement ($p < 0.001$), indicating that the greater the number of errors, the lower the engagement. These findings support hypothesis H1.

Verification of hypothesis H2

H2: The perception of communication problems is not unequivocally related to the hierarchy of positions but may result from other factors, such as organizational culture, access to information, or employees' personal experiences.

The verification of Hypothesis H2 was conducted using ANOVA analysis and Tukey's post hoc test to evaluate the relationship between the hierarchy of positions and the perception of communication problems. The results of the ANOVA analysis indicated no statistically significant differences in the perception of communication problems between position groups ($F = 1.432$, $p = 0.152$). Tukey's post hoc test confirmed that the mean ratings of the perception of communication problems do not significantly differ among the various position groups within the organizational structure.

The lack of significant differences suggests that the hierarchy of positions does not unequivocally influence the perception of communication problems. The results of the analysis indicate that this perception may be more dependent on other factors, such as access to information, organizational culture, or individual professional experiences. Therefore, the hypothesis that the perception of communication problems is not unequivocally related to the hierarchy of positions has been confirmed based on the conducted analyses.

Verification of hypothesis H3

H3: Tailoring the quality policy to age groups increases its acceptance within the organization.

The ANOVA analysis confirmed statistically significant differences in the acceptance of the quality policy among age groups ($F = 2.689$, $p = 0.035$), indicating that older age groups (35-44 and 45-54) exhibited higher levels of acceptance compared to younger groups (18-24 and 25-34). Tukey's post hoc test revealed that these differences are particularly pronounced between the youngest and oldest groups.

The results suggest that older employees, due to their greater professional experience, better understand the objectives of the quality policy, whereas younger employees may require more dynamic and engaging forms of communication. As hypothesized, tailoring the quality policy strategies and communication methods to the needs of different age groups can significantly enhance acceptance levels within the organization.

6. Summary

The results of the conducted research confirmed the critical role of effective internal communication in the implementation of quality policy and in increasing employee engagement. The conclusions presented below are based on statistical analysis, including Chi-square tests, ANOVA, and post hoc tests.

The findings of the study clearly indicate that effective internal communication plays a crucial role in increasing employee engagement and supporting the implementation of quality policies. Identified issues, such as inconsistencies in messaging, insufficient feedback, and differences in communication preferences among various employee groups, highlight the need for improvements in this area. Therefore, based on the obtained results and literature analysis, specific recommendations have been formulated to enhance communication processes within organizations, improve collaboration efficiency, and adapt communication strategies to the dynamically evolving needs of employees:

1. Reducing communication errors and improving message consistency

Basis in the article: Linear regression analysis demonstrated that the number of communication errors has a significantly negative impact on employee engagement ($p < 0.001$).

Recommendations

Develop and implement communication standards (e.g., standardized email templates, instructions, and reports) to prevent inconsistencies in messaging.

Conduct regular training sessions on effective communication, targeting both managerial staff and frontline employees.

Establish a two-way feedback mechanism, allowing employees to report communication issues and suggest improvements.

Introduce periodic reviews and updates of communication procedures within the organization.

2. Implementing Modern Technologies to Improve Communication

Basis in the article: Automation of communication processes and digital platforms enhance the effectiveness of information exchange, especially in multigenerational teams.

Recommendations

Implement digital communication platforms (e.g., Slack, Microsoft Teams, Asana) to streamline work organization and facilitate real-time information exchange.

Utilize artificial intelligence for communication quality analysis, such as chatbots for automating FAQs and tools for sentiment analysis of messages.

Create intranet knowledge bases where employees can easily access key documents, guidelines, procedures, and company updates.

Systematically monitor communication (e.g., analyzing trends in reports from communication systems) to identify potential issues proactively.

3. Adapting Communication Strategies to Different Age Groups and Levels of Professional Experience

Basis in the article: Older employees are more likely to accept quality policies, while younger employees prefer dynamic and engaging forms of communication.

Recommendations

Adjust the style and form of communication to different employee groups:

Older employees (35–54 years) – Prefer clear, formal messages and detailed reports.

Younger employees (18-34 years) – Favor short, dynamic messages, often delivered in video or graphic formats.

Introduce intergenerational mentoring, where older employees share their knowledge, while younger ones assist in adapting to digital communication tools.

Utilize diverse communication channels:

Emails for formal communication.

Online meetings for remote teams.

Chat platforms for quick information exchange.

4. Support for New Employees and Elimination of Communication Barriers

Basis in the article: New employees report communication issues more frequently than those with longer tenure.

Recommendations

Implement an onboarding program that includes training on company communication principles and an introduction to key contacts.

Establish a "buddy system", where new employees are paired with experienced mentors to help them better understand the organizational structure and communication channels.

Organize regular adaptation meetings for new employees, allowing them to share their experiences and challenges.

5. Transparency and Regular Communication on Quality Policy

Basis in the article: Clear communication of quality policy builds trust and employee engagement.

Recommendations

Introduce monthly reports on quality goals progress, presented in a clear and understandable format for employees.

Conduct quarterly meetings, where management shares updates on quality policy implementation and addresses employee questions.

Encourage employees to submit initiatives and improvement ideas through anonymous surveys or dedicated team meetings.

6. Strengthening the Role of Leaders and Managers in Communication Management

Basis in the article: Effective leaders utilize digital tools to enhance team engagement.

Recommendations

Provide training for managers on effective communication and team management, especially in the context of remote and hybrid work.

Implement 360° feedback, regularly collecting employee opinions on their supervisors' communication styles to drive continuous improvements.

Ensure leadership transparency by sharing the company's vision and strategy in a clear and accessible manner for all organizational levels.

Conduct regular one-on-one meetings between employees and managers to personalize communication and address potential issues.

7. Promoting a Culture of Open Communication and Feedback

Basis in the article: Lack of consistency and unclear messages can lead to frustration and decreased work efficiency.

Recommendations

- Implement regular employee satisfaction surveys regarding internal communication quality to adjust strategies according to employee needs.
- Organize workshops and open meetings, where employees can share their ideas and concerns about communication.
- Create an internal newsletter summarizing key updates and organizational changes in an accessible and engaging format.
- Improving internal communication in an organization requires a comprehensive approach, encompassing error reduction, the implementation of modern technologies, adaptation of strategies to different employee groups, and increased transparency and feedback. Implementing these measures will not only enhance work efficiency but also boost team engagement and motivation, directly contributing to the achievement of the company's strategic goals.

6.1. Perspectives for further research based on the article

This study focused on analyzing the internal communication process within organizations, examining its impact on employee engagement and the implementation of quality policy. However, due to limitations in the research sample, which did not include representatives from all industries and did not fully consider cultural and structural variables, there is a need to expand future research to additional aspects.

The analysis conducted in the article demonstrated that effective internal communication is crucial for increasing organizational efficiency and improving employee engagement. Identified limitations, such as the lack of a comprehensive analysis across different economic sectors and insufficient consideration of cultural and technological influences, indicate the necessity of further research. Therefore, future studies should focus on the following directions:

1. Expanding research across different economic sectors

The study suggests that organizational structure and workplace culture significantly influence the perception of internal communication. Conducting research across various industries, such as manufacturing, retail, services, and public administration, will help verify the universality of the findings and account for industry-specific characteristics. This could help identify unique communication challenges that were not addressed in this study

2. Analyzing the influence of cultural context on organizational communication

Cultural differences may affect how employees perceive communication and engage in quality policy implementation. Research conducted in different countries or regions could reveal how local cultural norms, management styles, and organizational trust levels influence the perception of communication issues.

3. Long-term effects of implementing communication strategies

The article suggests that improving internal communication positively impacts employee engagement and quality policy implementation. However, there is a lack of data on the long-term effects of these strategies. Future research should focus on analyzing the sustainability of communication improvements and their impact on organizational efficiency and employee retention.

4. The role of technology in internal communication

The study highlights the benefits of automating communication processes and using digital platforms. However, the rapid development of technologies such as artificial intelligence, chatbots, and sentiment analysis tools requires further research into their effectiveness and impact on communication quality and employee engagement.

5. The influence of leadership styles on communication effectiveness

The study underscores the importance of leaders in managing communication but does not specifically analyze how different leadership styles impact communication effectiveness. Future research should investigate how transformational, transactional, or servant leadership can enhance communication efficiency and team engagement.

6. The relationship between communication quality and business performance

The article suggests that effective communication positively influences employee engagement, but it does not directly analyze its impact on financial and operational performance. Future studies could focus on measuring the correlation between improved communication and key business performance indicators, such as revenue growth, customer satisfaction, and innovation.

Further research should broaden the scope of internal communication analysis within organizations, considering the diversity of economic sectors, cultural context, and emerging technologies. This approach will enable a more comprehensive understanding of the role of internal communication in enhancing employee engagement and achieving strategic business objectives.

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SUCCESSION PROCESS IN LISTED FAMILY COMPANIES – CURRENT STATUS AND FURTHER RESEARCH DIRECTIONS

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Purpose: The author of this publication tried to verify the advancement of the management and ownership process of succession in family companies listed on the Warsaw Stock Exchange (WSE). Especially knowing that the first succession process is the most difficult and most of listed family companies should be in period of planning or implementing it.

Design/methodology/approach: The presented conclusions from the empirical analyses are to be used to estimate the level of advancement of the succession process in family companies listed on the WSE in accordance with the theoretical basis presenting succession through the prism of the process.

Findings: The verification of the research projects showed that the vast majority of family companies listed on the WSE have not completed the succession process. Companies that have completed the management succession are rare, however no company has been identified that has completed the succession of ownership. Additionally, a quite significant level of generality was indicated in relation to the presented research work in the indicated area.

Research limitations/implications: The presented research results are based on different definitions of family companies, which results in a different number of entities covered by the empirical analysis and makes it difficult to draw overall conclusions. Despite that none of the presented research results verified the announcement of the succession plan in the corporate documents. It should also be noted that all the presented results of the conducted empirical analyzes focused on the verification of the intra-family succession.

Practical implications: Referring to the presented data it can be noticed that despite the passage of time, there is no significant progress in the succession process in family companies listed on the WSE. The people holding management control and ownership are still senior males. Therefore these data seem to be alarming.

Originality/value: To the best of the author's knowledge, this is the first scientific study presenting in one place the aggregated results of research which show the level of advancement of the succession process in family companies listed on the WSE from 2017 to 2024, taking into account the theoretical foundations presenting succession through the prism of the process.

Keywords: family companies, succession process, Warsaw Stock Exchange, management, ownership.

Category of the paper: Conceptual paper.

1. Introduction

According to the results of international research projects only 30% of family businesses are able to pass on the company to the second generation, while less than 14% of family businesses pass on to the third generation (Bjuggren, Sund, 2001; Fleming, 1997). As indicated by the scientists one of the key reasons, if not the most important one, behind such a high percentage of failures revealed at the stage of passing on the company to the next generations is the lack of skills to manage the complicated process of succession. It is also burdened with a significant emotional charge. The influence of the above-mentioned emotional factors is particularly visible when planning and implementing the succession process from the generation of founders and their successors (Venter, Boshoff, Maas, 2003).

In order to make it possible to conduct the succession process, it seems necessary to recognize and understand the variables influencing the transfer of management control and ownership in family businesses. This action should be the first step, which could also encourage family entrepreneurs to plan early and effectively manage the succession process. The greater its recognition, the easier it will be to think about the future of the enterprise in the context of the transfer of management control and ownership. As consequence it may contribute to an increase in the chances of growing the number of family businesses that will last despite the generational change. Understanding highlighted process and early decision-making within the family businesses may also contribute to the selection of the best candidate for successor and have a positive impact on a smooth change in the leadership position (Neubauer, Lank, 1998).

Despite this knowledge, recent times have been full of information presenting the indicated difficulties in the process of planning and implementing the succession process in Poland, which is confirmed by experiences concerning such family companies as Comarch S.A.¹ and Cyfrowy Polsat S.A. The highlighted situation prompted the author of this article to verify the existing state of knowledge about the advancement of the management and ownership succession process in family companies listed on the Warsaw Stock Exchange (WSE). Especially knowing that the first succession process is the most difficult and most of listed family companies should be in period of planning or implementing it. What is more this type of companies are liable to more rigorous information obligations than private companies and this is why should apply the principles of corporate governance. With such a goal set, the author of this article in the first part presented the definitions of the succession process existing in both international and Polish literature, in order to highlight the multitude of variables influencing the indicated process. The second part refers to the models of the succession process existing in the national literature and compared with international conclusions in order to indicate differences and similarities that may result from different conditions of the political and

¹ It should be noted that from December 2024 Comarch is no longer listed company and from 2025 it does not meet the definitional requirements of a family company.

economic system of a given country. The next part presents the results of research on the level of advancement of the management and ownership process of succession in relation only to family companies whose shares are listed on the WSE since 2017 until 2024, in order to show the conclusions in the last part and indicate further directions of research projects on the outlined process. To the best of the author's knowledge, this is the first scientific study presenting in one place the aggregated results of research which show the level of advancement of the succession process in family companies listed on the WSE in analyzed period, taking into account the theoretical foundations presenting succession through the prism of the process.

2. Literature review – the succession process

In order to describe the phenomenon of succession process in family businesses, the author of the paper would like to draw attention to how this concept is defined both by international and Polish scientists.

In international terms succession means the transfer of the leadership role from one family member to another as a key objective of the process that demonstrates its achievement - this is a common goal for most companies (Arthur Andersen/Mass Mutual, 1997). According to the work of P. Sharma, J.J. Chrisman, A.L. Pablo, and J.H. Chua, succession in family businesses refers to actions and events undertaken aiming to transfer managerial control from one family member to another (2001). On the other hand L. Cadieux with co-workers define succession as a dynamic process which primary goal is to transfer managerial control and ownership to the next generation. The responsibilities and roles of the most important groups in the process (senior and successor) interpenetrate during this process (Cadieux, Lorrain, Hurgon, 2002). The above presented definition can be considered complementary to the one proposed by C.E. Aronoff, S.L. McClure and J.L. Ward, according to which succession is a lifelong planning and management process, encompassing a wide range of stages, which are to ensure intergenerational business continuity. The factors that fall within the scope of the discussed cycle are diverse and include: introducing potential successors to the business from an early age (1), developing teamwork skills in sibling successors (2), ensuring financial security by the senior during retirement (3), drawing up an inheritance plan (4) (2011).

In reference to the definitions of succession process functioning in Polish literature, it seems worth renewing those presented by Ł. Sułkowski and A. Marjański, who perceive it as a specific problem of a family business that is to last despite the changing generations and concerns the transfer of ownership and management of the business (2009). According to A. Surdej and K. Wach succession is the transfer of management of the company from the founder-owner to the successor, who may be either a family member or someone from outside the family (2010). On the other hand, according to K. Safin, J. Pluta, B. Pabjan, succession should be treated as

a special type of change and the succession process as a type of change management process that will be able to ensure (after transforming the existing system) the continuation and development of the family enterprise in accordance with the established strategy (2014). Based on the work under the direction of J. Jeřak, it can be seen that the phenomenon of succession is understood as a three-element process consisting of the transfer of knowledge, management and ownership (2014). This seems to be a similar approach to A. Lewandowska, who in addition to the above-mentioned variables like knowledge, management and ownership also added value² (2015).

Looking at the highlighted definitions, both of those were used in empirical research conducted in Poland and around the world, one can see a significant common part. Especially in the matter of the essence of the succession process, however there are noticeable differences. What seems to be particularly worth addressing is the understanding of the person of the successor, because if the succession process in family businesses has generational continuity inscribed at its foundations, then the potential group of successors refers only to family members (intra-family succession). However, according to some scientists, considering succession solely through the prism of intergenerational transfer within the family is a manifestation of nepotism and putting the good of the entire system in favor of the family (Pollak, 1985). The research work of J.A. Barach, J.B. Gantisky, J.A. Carlson, B.A. Doochin showed that choosing a successor solely from among family members may be perceived from a strategic point of view as acting against the interests of the shareholders of the family enterprise (1988). Also A. De Massis, J.H. Chua, J.J. Chrisman in their publication presented a model with a number of situations in which a family enterprise should not decide on intergenerational transfer. If its aim is to take care of the future of company and family (2008). On the other hand, S. Klein in her work emphasized the necessity of analyzing the scope of succession based on the industry in which the company operates (2000). According to this point of view, there are sectors in which having capital to start a business does not mean skillfully managing the company or a situation in which the development of the company requires professionalization of the management structure and/or opening of ownership.

However there is a consensus that during the succession process there is a high probability of making a mistake. Numerous empirical analyses confirmed that issues such as planning and implementing the outlined process are the leading motive in research that explores succession through that prism (Bigliardi, Dormio, 2009; Motwani et al., 2006; Sharma et al., 2001). The fundamental conclusion drawn from the highlighted trend is the importance of planning in advance the succession process in the context of successfully completing the entire cycle and continuing the functioning of the company (Lee, Lim, Lim, 2003; Miller, Steier, Le Breton-Miller, 2003).

² In Polish, the words knowledge, management control, property and values start with the letter w, hence in Polish literature on the subject, this definition was used to create a model known as the 4 Ws.

In reference to the studies in a field of succession focusing on understanding it through the prism of the process, two key approaches functioning in the world of science can be noticed³. The first one focuses on a tangible event, which is the successor taking over management control in the company (CEO succession) (Miller, Steier, Le Breton-Miller, 2003) or so called passing the baton (Mitchel et al., 2009; Dyck et al., 2002) as an event requiring research. The development of the succession process understood in this way is based on the research work of B. Dyck and co-workers, which showed that the real succession process begins when the successor takes over the real management control. The reasons for the failure of the succession process can be identified with the lack of experience in the field of business management (Dyck et al., 2002). The scientists compared the succession process to a relay race (4*100), distinguishing such variables as: sequences, time, communication model and the technique of transferring management control (baton passing technique). The advantage and contribution to the development of theory resulting from the work of those scientists is certainly the presentation of variables resulting from the role of the senior and the successor in the succession process. On the other hand they omitted other stakeholders treated as secondary during the planning and implementation of the discussed process. The weaknesses of the presented study, according to its critics, include the use of the baton-passing analogy in the model, which assumes that the essence of succession is a tangible single event - the moment of transferring management control to the successor.

Despite this fact, these views are questioned by researchers who perceive succession as a gradual, social process containing individual stages, including the moment of transferring management control, as one of the components, but not as a key pillar of the discussed process (Murray, 2003; Handler, 1994; Handler, 1990). This is the second approach present in the literature, which describes succession through the prism of the process. In accordance with this approach, J. Lambrecht claims that succession should be perceived as a continuous process lasting a whole life, which consists of individual phases and in the course of which the senior and the next generation fulfill specific tasks and roles that overlap each other - mutual role adjustment (2005). Such argumentation is consistent with the vision of W.C. Handler, who perceives this overlap of specific tasks and roles on the side of the senior and the successor, as a phenomenon requiring a lot of time and delicacy (W.C. Handler compared the discussed phenomenon to a dance and called it succession dance). The key tasks reflecting the progress in the presented process focus on: gaining experience, building the role of a leader and having authority, transferring decision-making and capital. According to that statement the mentioned issues constitute a priority in the succession process and determine the effects (Handler, 1994;

³ It should be noted that focusing on understanding succession strategies through the prism of the process is one of the possible options functioning in the literature on the subject, alongside issues such as socio-emotional wealth and corporate governance, leadership and inter-generational conflicts and succession planning drivers, most closely related to the research trend described in this work. More information on the mentioned topic can be found in the article A review of succession strategies in family business: content analysis and future research directions (Nave et al., 2022).

Handler, 1990). It can be seen that this process is characterized by an ongoing social exchange, during which the successor and the founder/senior as well as other stakeholders take on different roles at individual stages of the succession cycle. The diversity of the roles together with the diversity of individuals who may be guided by different needs, means that a family business may be exposed to additional dangers during the implementation of the succession (Watson, 2009; Le Breton-Miller, Miller, Steier, 2004). In accordance with understanding of the succession process as multistep perspective the models of succession need to be presented. What has been done in the next section of this article.

3. Literature review – succession models

While describing the succession models, the author of this article focuses only on those that are used in the Polish literature. This approach results primarily from the relatively young free market economy in Poland. This factor means that the oldest enterprises in Poland are about 35 years old, and therefore should be at the stage of planning, if not implementing, the first succession plan.

In chronological order, the first model was proposed by Ł. Sułkowski and A. Marjański (2009), it includes:

1. Planning succession.
2. Establishing the stages of succession.
3. Selecting the successor (selecting alternative candidates).
4. Defining the time frame for succession.
5. Taking action to prepare for the successor role.
6. Carrying out the transfer of management and ownership.

Next, it is worth referring to the 4W model created by A. Lewandowska (2009), already mentioned in the paper. This model refers to the transfer from the senior to the next generation of:

1. Knowledge (the history of the company, the context of its establishment, indicating the path and support for the successor).
2. Management control (gradually transferred, giving the successor the opportunity to test themselves in various roles; gradually increasing the scope of responsibility).
3. Ownership (due to the emotional aspect, it is particularly recommended to gradually, yet successively transfer ownership to the next generation; this action is intended to increase the sense of responsibility in the successor).
4. Values (the transfer of values begins at the first stage and continues until full ownership is transferred).

The author of this article, based on analysis of listed family companies, also prepared a proposal of a succession model, assuming the following stages (Majda-Kariozen, 2020):

1. The potential successor's professional education (education in Polish and/or foreign educational institutions).
2. The potential successor's professional experience (first gained outside the family company, then in the family company).
3. The potential successor's career path (starting work in the family company from the lowest positions and gradually moving up, which serves to increase responsibility and mutual exchange of knowledge between the senior and the potential successor; preparation for the succession of management control begins in the company).
4. Management succession (starting with the successor's entry into the management board, through the function of vice president of the management board, up to full succession of management control understood as the successor taking over the position of CEO).
5. Ownership succession (taking place in stages; the succession of management control significantly precedes the transfer of ownership of the family company).

When raising the issue of the stages of the succession process, it is worth referring to the latest model created by A. Lewandowska, who redefined the 4W model by adding one more variable, namely the developed common vision of the future. These five elements create so-called succession diamond model (Lewandowska, Lipiec, 2021). Referring to a jointly developed vision of the future, which was developed in accordance with the aspirations and views of both the founding/senior generation and their successors, is an element that is often called the essence of the succession process (Potts et al., 2001; Chrisman, Chua, Sharma, 1998). There is also agreement in the world of science about the importance of the educational paths of a potential successor. Due to the importance of the mentioned process, some researchers believe that the educational path of a potential successor should start in childhood. Through the selection of an appropriate educational along with learning about the specifics of a company. This approach is also recommended by the European Union Commission (2009). Also, the acquisition of knowledge about the enterprise by the next generation is a factor that increase the competences of the successor. This experience should contribute to understanding of the specifics of the enterprise, its organizational culture, management methods and methods of building and maintaining relationships (Brockahus, 2004; Lansberg, Astrachan, 1994). In the framework of educating the next generation to be new leaders, gaining experience outside the family enterprise is also often emphasized, which the author of this paper also mentioned. The advantage of such a solution may be preparing the potential successor to solve a wider range of problems that the company may face (Correll, 1989). The last phase of the succession process, according to the presented models, focuses on the so-called "changing of the guard". At this stage, scientists emphasize primarily the aspect of the relationship and bonds created between the founder/senior and the successor. There is a consensus in the literature that succession process should be announced in advance to both family members and employees

from outside the family after mutual arrangements (Dyck et al., 2002; Sharma et al., 2001; Handler, 1990; Sonnenfeld, Spence, 1989).

4. Review of research results- succession process at WSE

According to the author's knowledge, one of the first empirical analysis on the phenomenon of planning and implementing the succession process in family companies listed on the Warsaw Stock Exchange (WSE) on the main market was conducted by the author of this study in 2017, before the list of family businesses was introduced on WSE. The list of companies listed on the Warsaw Stock Exchange (WSE) subject to empirical analysis was taken from the Thomson Reuters database and included entities belonging to the Warsaw Stock Exchange Index (WIG). This choice was intentional, because the indicated index is the oldest and the widest index published by the Warsaw Stock Exchange, which allows for the mapping of the broadest picture of the market. The number of family companies that met the definitional criteria adopted at that time was 63⁴ (Majda-Kariozen, 2020). Data related to illustrating the characteristic and status of planning and implementing succession process at that time are presented below.

Table 1.
Gender of seniors in listed family companies in 2017

Senior gender	Number of companies	Percentage share of companies
Male	60	95,20%
Female	3	4,80%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 2.
Education level of seniors in listed family companies in 2017

Education level	Number of companies	Percentage share of companies
Vocational/secondary education	12	19,00%
higher education	45	71,40%
Ph.D. or higher	6	9,60%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

⁴ The definition adopted for the research is- a family listed company is a company in which a family member is the CEO of management board, the management or supervisory structures may include other members of the same family and direct or indirect ownership in the amount of a minimum of 25% of the votes at the general meeting of shareholders belong to a member or members of this family. The mentioned family is the founder of the company and in exceptional cases gained control.

Table 3.*The period of management control exercised by the senior in listed family companies in 2017*

Length of holding the management control-CEO position (in years)	Number of companies	Percentage share of companies
Up to 10 years	11	17,46%
Up to 20 years	24	38,09%
Up to 30 years	26	41,25%
Over 30 years	2	3,20%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 4.*Age of seniors in listed family companies in 2017*

Age of seniors (in years)	Number of companies	Percentage share of companies
Under 40 years old	5	6,81%
Under 50 years old	18	27,43%
Under 60 years old	27	46,34%
Over 60 years old	13	19,42%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

The data included in tables 1 to 4 present profiles of seniors at the verification time. The variables presented seem to have a significant impact on the discussed process. In relation to the gender of the current CEO (senior) the majority of the companies are represented by men - 60 analyzed entities (95.2%), only in three cases they were represented by women (4.8%). According to the socialization theory, this knowledge may be crucial when selecting a potential successor. Seniors education level of was as follows: from vocational/secondary in 11 companies (17.5%), through the largest group representing higher education - 46 entities (73%), to having a doctoral degree or higher in 6 companies (9.6%). The length of holding the CEO position by seniors in the case of 11 of the analyzed companies, hold the position up to 10 years. In 24 entities the current CEOs hold the indicated position for up to 20 years. Up to 30 years the position of the CEO was unchanged in 26 companies, for above 30 years only in 2 companies. Thus in relation to the age of seniors holding the position of CEO, it should be noted that there were 5 of them before the age of 40, up to 50 years old there were 18, up to 60 years old there were 27 and above 60 years old 13. It should therefore stated that in the vast majority of the analyzed entities seniors did not exceed 60 years, which may be one of the factors influencing the succession situation. In order to reflect the succession process as fully as possible, the author presented the characteristics of successors in listed family companies in the tables below.

Table 5.*Number of children of the CEO (senior) in the management boards in listed family companies*

Number of children	Number of companies	Percentage share of companies
0	55	87,30%
1	6	9,50%
2	2	3,2%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 6.*Number of children of the CEO (senior) on the supervisory boards in listed family companies*

Number of children	Number of companies	Percentage share of companies
0	46	73,00%
1	14	22,20%
2	3	4,80%
Total	63	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 7.*Gender of children of the CEO (senior) holding position on the company's bodies*

Gender	Company body	Number of children
Female	Management Board	1
	Supervisory Board	7
Male	Management Board	9
	Supervisory Board	13

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 8.*Education level of children of the CEO (senior) holding position on the company's bodies*

Education level	Number of children
Vocational/secondary education	3
Higher education	25
Ph.D. or higher	2

Source: Majda-Kariozen, 2020, pp. 144-159.

Table 9.*Age of the children of the CEO (senior) who are members of the company's bodies*

Age of children (in years)	Number of children
Under 30 years old	10
Under 40 years old	16
Under 50 years old	4

Source: Majda-Kariozen, 2020, pp. 144-159.

The second group of variables characterizing family companies on the WSE within the studied phenomenon refers to successors who held management and/or supervisory positions. In 6 of the studied entities, one child of the CEO (senior) held the position on the management board, and in 2 companies there are two children. In most of the studied companies offspring were not present on the management boards. In the supervisory boards in 14 companies there was one child and in 3 there were two children. The analyzed presence of children in companies bodies allows to stated that offspring can be found more often in the supervisory boards than in

the management boards. In companies in which children of the CEO were present in the management bodies there were 9 sons and 1 daughter, while in supervisory boards there were 12 sons and 7 daughters. In relation to the level of education of the potential successors: 3 children had secondary or vocational education, 24 children had higher education and 2 children had a doctoral degree or higher. When characterizing the age ranges of the successors, it should be noted that 10 children were before their 30th birthday, 15 were between 30 and 40 years old, four children were in the management or supervisory bodies under the age of 50. When comparing the data presenting the age of the CEO, it should also be considered that it is possible that the successor already functioned in listed family companies, but in lower positions and therefore were not included in the above variables. This assumption is consistent with the succession models presented above.

Table 10.

Number of companies with completed management succession

Number of companies	Percentage share of companies
3	4,80%

Source: Majda-Kariozen, 2020, pp. 159-184.

Based on the qualitative research conducted by the author it was possible to verify the progress in the process of management succession. Based on the collected data three companies had undergone management succession. These companies were: Indypol S.A., Energoinstal S.A. and Cyfrowy Polsat S.A. According to the author's knowledge one of the first management successions on the WSE took place in the Indykpol S.A. in 1999, when Feliks Kulikowski, the founder and former CEO handed over this function to his son - Piotr Kulikowski. Despite such a significant passage of time there was no succession of ownership. The second indicated company was bought by the oldest employee Stanisław Więcek in 2010, who held the position of CEO until the introduction of his sons (Michał Więcek, current CEO, Jarosław Więcek, Vice CEO). Also in this case, there was no succession of ownership. In the last indicated company the eldest son of Zygmunt Solorz-Żak, Tobiasz Solorz, held the position of CEO since December 2015. It should be noted that Tobiasz Solorz stopped holding the position of CEO in March 2019. The last variable presented refers to the determination of the progress of ownership succession.

Table 11.

Generation number in company ownership

Generation number in company ownership	Number of companies	Percentage share of companies	Cumulative percentage of companies' share
I generation	52	82,50%	82,50%
I & II generations	11	17,50%	100%

Source: Majda-Kariozen, 2020, pp. 144-159.

Based on the collected data it can be seen that in listed family companies, only the first generation still dominates in the ownership structure - this situation occurred in 52 companies, constituting 82.5% of the entities examined. While the division of ownership between the first

and second generation occurred in 11 companies, constituting 17.5%. Comparing the data from the tables presenting the presence of children in the management and supervisory bodies of the company (tables 5 and 6) with the data contained in table no. 11, it should be stated that the seniors were more willing to involve children in the functioning of the family company than to transfer the ownership to them. In none of the analyzed family companies the second generation do not independently own the company. The results obtained allow to assume that the seniors were more keen to start the process of management succession than the ownership succession.

Since 2021 a list identifying only family companies has been available on the WSE. Since that year Grant Thornton has been preparing business and financial analyses for this group of business entities yearly (GPW uruchamia..., 2021). Before overviewing the results of empirical analyses related to the characteristics of the succession phenomenon. It is worth drawing attention to the definitions of family companies used in those annual reports. In the first edition Grant Thornton considered a company to be family when it is headquartered in Poland, listed on the WSE, in which private individuals hold more than 50% of the shares (entities from the financial and bank sector were excluded). As the authors of the report indicated they did not analyze family connections and considered that adding additional criteria to it is misleading and does not come close to the actual state of affairs. On this basis they identified 139 such entities (Grant Thornton, 2021). It is worth noting, that the definition proposed by the authors of the report was changed the following year and that time it considered a family company to be a company in which the person who founded or took over the company together with their relatives and descendants, hold at least 25% of the votes at the general meeting of shareholders (Grant Thornton, 2022). The revised definition already includes the previously criticized aspect of family ties and remained unchanged in subsequent years of the research. Thus, for 2022 172 family companies were identified, 166 family companies in 2023 and 172 in 2024 (Grant Thornton, 2022, 2023, 2024). Such significant differences in the qualified number of family companies may result from the adoption of different definitional criteria and data collection time. Due to the change in the definition the author of this paper presented data intended to show the status of the succession process separately for 2021 and jointly for 2022, 2023 and 2024.

Table 12.

Percentage of women and men among seniors and successors by function in family companies

Corporate body	Gender	Percentage share of companies (seniors and successors)
Management Board	female	11%
	male	89%
Supervisory Board	female	28%
	male	72%

Source: author's own elaboration on Grant Thornton, 2021.

Such aggregated data did not allow to answer the question about the degree of advancement of the succession process in family companies. From such grouped data, in which the groups of seniors and successors were combined, it can only be concluded that men predominated in the key bodies of companies recognized as family-owned in 2021.

Table 13.

Percentage of women and men among seniors and successors by ownership of family companies

Senior/Successor	Gender	Percentage share of companies
Senior	male	76%
	female	15%
Successor	male	8%
	female	1%

Source: author's own elaboration on Grant Thornton, 2021.

In relation to the progress in the process of ownership succession, it can be seen that the vast majority of companies considered family-owned did not include successors in shareholder structure, which does not seem to be surprising, because according to the models of the succession process management succession precedes ownership succession. From the above classified data could only be stated that in the ownership structure predominance the male sex among both seniors and successors.

Due to the mentioned change of the definition of family companies data for subsequent years has been aggregated. It should be noted that reports prepared by Grant Thornton only illustrates the percentage of companies in terms of the presence of family in the management boards and supervisory boards without division into successors and seniors, so verification of the management succession seems to be impossible. The data considering succession process from 2022 to 2024 were presented below.

Table 14.

Percentage of women and men among seniors and successors by function in family companies

Year	Corporate body	Gender	Percentage share of companies (seniors and successors)
2022	Management Board	female	11%
		male	89%
	Supervisory Board	female	28%
		male	72%
2023	Management Board	female	10%
		male	90%
	Supervisory Board	female	27%
		male	73%
2024	Management Board	female	14%
		male	86%
	Supervisory Board	female	30%
		male	70%

Source: author's own elaboration on Grant Thornton, 2022, 2023, 2024.

Table 14 shows the share of women and men in the most important bodies of companies recognized as family companies between 2022-2024. However, as it was stated combining the group of seniors and successors only allows to state that men predominated in all years. When analyzing the above data, it should also be noted that in each year covered by the study a different number of that family companies were recognized, therefore it is difficult to assess the progress of the management succession process on this basis.

Table 15.

Percentage of women and men among seniors and successors by ownership of family companies

Year	Corporate body	Gender	Percentage share
2022	Senior	female	24%
		male	85%
	Successor	female	8%
		male	20%
2023	Senior	female	28%
		male	95%
	Successor	female	8%
		male	16%
2024	Senior	female	25%
		male	97%
	Successor	female	3%
		male	5%

Source: author's own elaboration on Grant Thornton, 2022, 2023, 2024.

First of all, it should be noted that the presented data assumes that in a family companies there was more than one family member in the shareholding structure, therefore the data do not sum to 100%. It is necessary to take into account the variable number of companies that were subject to the study in the indicated period of time. Despite this, it can be seen that the ownership is mainly held by men of the first generation, then by women also of the first generation, only in third place do male successors appears, and at the end there were female successors.

5. Discussion and recommendations for future research

The presented research results were based on different definitions of family companies, which resulted in a different number of entities covered by the empirical analysis and made it difficult to draw overall conclusions. However the research carried out by Grant Thornton and published on the WSE website was characterized by such a significant degree of generality in relation to the analysis of the succession process, which despite annual publications shown only fragmentary data and de facto did not allow to track the ongoing changes.

Despite the indicated restrictions, it can also be noted that none of the presented research results verified the announcement of the succession plan in the corporate documents of family listed companies. This type of companies are liable to more rigorous information obligations

than private companies and this is why should apply the principles of corporate governance. Therefore, it seems necessary to verify the indicated research direction in particular in the annual reports in the part of the management board's. It seems that obtaining this data could show what is the approach of boards members and owners to the issue of planning and implementing the succession process and what steps are taken in accordance with the described concept. This knowledge would also allow researchers to better understand the difficulties faced by family companies within the discussed issue. Moreover, this step seems to be mandatory according to both international and Polish literature.

It should also be noted that all the presented results of the conducted empirical analyses focused on the verification of the intra-family succession. Although already at this stage it is necessary to note the possible difficulties that would concern the classification of such a company after the succession process has been completed. There is already an ongoing discussion in the literature whether a company that only holds ownership and does not hold management functions can still be defined as a family company.

It is also worth referring to the types of research conducted on the planning and implementation of the succession process in family companies in accordance with the literature considerations presented in this article. As it can be seen quantitative research can show a certain characteristic of a family company within the discussed issue, together with the moment of so called passing the baton indicated by the researchers. However it will not reflect the individual stages of the succession model in a given company, which may be extremely important for family companies undergoing the succession process for the first time. Therefore, it seems that in order to be able to reflect the progress of the planning and implementing of the succession process as fully as possible it is necessary to conduct qualitative research.

Indicating further directions of research within the discussed issue, it also seems necessary to verify the transformation of the form of ownership into family foundations, which have been operating in the Polish legal system since 2023. Their establishment was aimed to support family businesses in the process of management and ownership succession especially in the legal context. Due to the short time of presence of this legal form, verification of the scale of its occurrence seems to be an essential element of estimating the advancement of the process of succession.

6. Conclusions

Despite the differences between the presented results, which were based on different criteria of classification and focused in different number of business entities, it can be noticed that despite the passage of time, there was no significant progress in the succession process in family companies listed on the WSE. The people holding management control and ownership are still

senior males and successful management succession seems to be an exception. Based on analyzed research results it is not possible to state that there were successful cases of ownership succession within analyzed period. Therefore these data seem to be alarming. An accurate understanding of the variables influencing this state of knowledge seems to be not only important but also necessary, because otherwise the experiences of Comarch S.A. and Cyfrowy Polsat S.A. will become a new reality and family companies listed on the WSE will be only a rarity. According to the literature the succession phenomenon consists of not only the process perspective but also socio-emotional wealth, leadership and inter-generational conflicts and succession planning drivers. Variables from each category group can impact succession process, hence identifying those can allow to get deeper insight into the highlighted process. In the future research should also verify the announcement of the succession plan in the corporate documents of family listed companies to discover the approach to discussed subject.

Despite the rich national and international literature on the subject presented data do not reveal progress in the succession process among family companies whose shares are listed on the capital market. The lack of this progress cannot be explained only by the time of functioning of enterprises in the economic space or the age of founders/seniors because, as indicated by the literature succession is a process that requires time and consists of individual stages typical for each family.

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INFLUENCE OF CULTURAL ROUTES AS A DRIVER FOR CULTURAL TOURISM PROMOTION – EXAMPLE OF THE EUROPEAN PILGRIMAGE ROUTE

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Purpose: To investigate how cultural routes, specifically the European Pilgrimage Route, contribute to the promotion and development of cultural tourism in Europe.

Design/methodology/approach: Specific pilgrimage routes within Europe were analysed to understand the varied impacts of cultural tourism on local communities and cultural heritage preservation. The analysis of different routes highlighted the different tourism development strategies.

Findings: The study has demonstrated that cemetery routes play a significant role in promoting cultural tourism. These routes offer an opportunity for tourists to explore unique cultural and historical narratives, providing an alternative form of engagement with a region's heritage. Although awareness of cemetery routes is currently low, their inclusion in broader cultural tourism initiatives can contribute to the diversification and enhancement of tourism offerings, stimulating interest and expanding the cultural tourism market.

Research limitations/implications: The research focuses on a specific pilgrimage route rather than all pilgrimage routes across Europe, which limits generalizability. Addressing potential limitations of the study, such as the relatively small sample size, may not fully capture the diversity of tourist perspectives, and the limited geographical scope, focusing predominantly on Lithuania, additionally, the reliance on self-reported data introduces bias, as participants have provided socially desirable responses rather than accurate reflections of their preferences.

Practical implications: Based on the findings, tourism boards and cultural route managers can develop more targeted and effective promotional campaigns to attract visitors to pilgrimage routes.

Social implications: The research can raise awareness about the importance of cultural heritage, specifically pilgrimage routes, as part of Europe's shared cultural identity. By promoting these routes, society is encouraged to value and preserve local traditions, historical landmarks, and cultural practices.

Originality/value: The paper offers a contemporary examination of pilgrimage routes as drivers of cultural tourism in the context of today's tourism dynamics. It highlights the shift from purely spiritual journeys to multifaceted tourism experiences that include cultural, social, and economic components. This new approach contrasts with traditional studies that focus primarily on religious aspects, expanding the discussion to include how these routes function as part of the broader cultural tourism ecosystem.

Keywords: cultural routes, cultural tourism, pilgrimage routes, tourism promotion.

Category of the paper: research paper.

1. Introduction

Relevance of the topic. Cultural tourism has its roots in ancient Egypt, where people travelled to admire architectural marvels, artistic achievements, and religious sites, marking the beginnings of pilgrimage. Even then, routes connected people, history, and culture, though cultural tourism as a defined concept emerged much later.

Cultural routes enhance heritage value through artistic and cultural initiatives, serving as tools for promoting history, notable figures, and European values. The European Cultural Routes Program, established in 1987 with the Santiago de Compostela Declaration, has increased the appeal of cultural tourism across Europe.

While Europe boasts many cultural routes, Lithuania has only one national route: the 487-kilometer M.K. Čiurlionis route, dedicated to the artist and composer. The promotion of cultural tourism is a priority in Lithuanian government strategies, yet thematic routes like cemetery routes remain undeveloped.

Lithuania's cultural resources include archaeological, architectural, and artistic sites, as well as mythological, historical, and memorial landmarks, such as ancient cult sites, historic cemeteries, and burial places of notable figures. Cemeteries, as cultural and historical sites, reveal the past, represent the present, and offer insights into the future.

The European Cemeteries Route, certified by the Council of Europe since 2010, connects 63 cemeteries across 50 cities in 20 countries, offering tours and events that highlight local and European heritage. Despite its rich cemetery culture, Lithuania has not joined this initiative, missing an opportunity to develop a cohesive thematic route that could attract visitors and showcase its unique heritage.

Novelty of the Study. In recent years, shifts in the preferences of tourism consumers have become evident. Tourists increasingly seek unique and personalized experiences rather than merely replicating the experiences of others. In response to this demand, tourism offerings are gradually adapting to meet these evolving expectations. Scholars such as Ščiglienė (2014; 2017), Graf and Popesku (2016), Kuizinaitė and Radzevičius (2020), Abramavičienė (2020), as well as Moropoulou, Lampropoulos, and Vythoulka (2021), have explored the benefits and impacts of cultural routes. Additionally, researchers like Pécsek (2015) and Diogo (2017) evaluate cemetery tourism as an engaging cultural exhibition for tourists, offering both natural and cultural activities.

While cemetery tourism is rightly categorized under heritage and cultural tourism, there is a notable absence of Lithuanian studies addressing the challenges and opportunities of cemetery routes. Therefore, the **research problem** addresses the question: how can cultural routes, exemplified by cemetery routes, promote cultural tourism?

Research object - cultural routes as a factor in promoting cultural tourism.

Research aim is to evaluate the factors that promote cultural tourism using the example of the European Cemeteries Route.

Research objectives:

1. To analyse the concept of cultural tourism.
2. To present the concept of cultural routes as a tool for tourism promotion.
3. To investigate the factors promoting cemetery routes as a cultural tourism direction for Lithuanian tourists.

Research methods: the study employs analysis of scholarly literature, legal documents, websites, and other sources. Empirical methods include a quantitative survey and a qualitative semi-structured expert interview. Data analysis, systematization, graphical representation, and formulation of conclusions and recommendations are also utilized.

2. Analysis of the Concept of Cultural Tourism

For thousands of years, people have visited locations preserving remnants of ancient cultures and civilizations. Historically, pilgrims were akin to modern tourists, with early travel primarily focused on religious pilgrimages—such as Christian journeys to the Holy Land or Muslim pilgrimages to Mecca. By the 17th century, wealthier individuals travelled for cultural and educational purposes. The rise of European travel during this period led to the development of inns, hotels, restaurants, and transport infrastructure, though the primary aim remained cultural exploration. Over time, museums, exhibitions, and cultural events further incentivized tourism.

Today, tourism is deeply intertwined with culture, creating a dynamic and mutually enriching relationship. Cultural tourism emerged as a distinct concept in the late 20th century, emphasizing visits to historical landmarks, art collections, and cultural events. However, contemporary cultural tourism extends beyond visiting iconic sites. Tourists increasingly seek engagement with local communities, exploring their traditions, customs, and beliefs. Culture is thus a core driver of tourism, shaping destinations' attractiveness and enhancing their unique identity.

The United Nations World Tourism Organization (UNWTO, 2018) emphasizes the symbiosis between culture and tourism. Arts, crafts, and traditions at risk of being forgotten are revitalized through tourism, while monuments and cultural assets benefit from preservation efforts funded by tourist activities. Abandoned or neglected relics often find new life through visitor interest.

Richards (2018) highlights that while cultural tourism is a growing segment, it is not easily defined or isolated as a market. He notes that cultural consumption often represents a small proportion of tourist spending; for example, in Venice, tourists allocate most expenditures to accommodation (45%) and shopping (21%), with only 2% spent on cultural activities. Similarly, Gómez (2018) argues that "ideal" cultural tourists form a minor share of the market, with most visitors prioritizing leisure and entertainment over cultural motives.

Despite its complex definition, cultural tourism fundamentally involves consuming various cultural expressions such as heritage, art, and folklore (Mousavi et al., 2016). ICOMOS provides one of the most comprehensive definitions, describing cultural tourism as activities that allow people to explore diverse lifestyles, customs, traditions, and environments, as well as architectural, historical, or archaeological sites from previous eras (Csapo, 2012). This form of tourism differs from recreational tourism by emphasizing understanding and appreciation of the destination's cultural character.

Cultural tourism today includes creative experiences where tourists actively participate in cultural activities like painting, dancing, photography, or cooking. Smith et al. (2010) define cultural tourism as travel motivated by cultural assets, events, and practices, encompassing heritage tourism, artistic tourism, and interactions with local communities. This form of tourism offers educational, creative, and entertainment experiences through active or passive engagement.

The essence of tourism lies in transforming resources into products. In cultural tourism, resources are consumed only when prepared and marketed as attractions. Dujmović et al. (2016) identify three ways cultural resources are presented: as activities (e.g., tours of historic sites, museums, or cultural events), as media (e.g., documentaries or films), and as goods (e.g., books, art, handicrafts, or souvenirs). These transformations enable cultural resources to drive tourism while contributing to their preservation and appreciation. Cultural tourism products are described in Table 1.

Table 1.
Cultural Tourism Products

Heritage tourism	<ul style="list-style-type: none"> • Building heritage, architectural and archaeological sites, world heritage sites, art, folklore, legends, historical events and personalities.
Themed cultural routes	<ul style="list-style-type: none"> • Routes based on historical, artistic, spiritual and religious, architectural, culinary and linguistic themes.
Cultural urban tourism	<ul style="list-style-type: none"> • Tourism in historic cities, modern cities and European Capitals of Culture.
Ethnic tourism	<ul style="list-style-type: none"> • Tourism that involves exploring local traditions, crafts, ethnic minorities or indigenous cultures.
Event tourism	<ul style="list-style-type: none"> • Attracting visitors to cultural, music and art festivals.
Religious tourism	<ul style="list-style-type: none"> • Attracting visitors to religious sites and buildings, shrines and pilgrimage routes, including visitors who are interested in religious sites for their architectural and cultural significance.
Creative cultural tourism	<ul style="list-style-type: none"> • Performing arts, visual arts, literature, cinema, audiovisual production, design and printed works.

Source: made by the authors according to Dujmović et al., 2016; Mousavi et al., 2016; Council of Europe, 2020; European Commission, 2022.

As illustrated in Table 1, researchers have identified seven distinct directions within cultural tourism. Notably, each of these directions can encompass thematic cultural routes, often spanning multiple countries. The primary objective of cultural tourism is to fulfill spiritual and intellectual needs while enhancing the development of cultural tourism frameworks. This includes visits to historical sites, museums, and art galleries, alongside the creation of tailored tourist itineraries (Dujmović et al., 2016).

In summary, tourism consumption patterns have evolved significantly over time. Once considered an elite activity, tourism has transformed into a fundamental leisure pursuit for the masses and arguably the world's largest employment sector. This shift has redefined the relationship between tourism and culture. As cultural consumption has grown, tourism has emerged as a vital form of cultural engagement, supported and promoted by local, national, and international institutions.

Cultural tourism distinguishes itself from other types of tourism, primarily through its motivations. It can be defined as a form of mobility aimed at broadening one's horizons by exploring artistic, architectural, or territorial heritage. The range of cultural products within this context is extensive, encompassing art, heritage, folklore, and a variety of other cultural expressions consumed by tourists. This evolution reflects changes in both the ways tourists consume culture and how cultural experiences are curated and presented to them. Consequently, cultural tourism continues to adapt, offering dynamic interactions between cultural heritage and tourism practices.

3. The Concept of Cultural Routes as a Factor in Promoting Tourism

Cultural routes make significant economic and social contributions, prompting countries to exert considerable effort to attract cultural tourists. Cultural tourism is not only growing economically (Kuizinaite, Radzevicius, 2020) but also rapidly evolving in all aspects, with constant efforts to offer new experiences and create new travel destinations (Severo, 2018). This development has led to the creation of new tourism programs, which were previously unimaginable. These innovations respond to the increasing demand from tourists for new emotions and knowledge, seeking unusual and unique memories.

The analysis of scientific literature reveals that cultural routes encourage community involvement in cultural activities and raise awareness about shared cultural heritage. Cultural projects are also based on social principles, positioning cultural routes as sources of innovation and creativity, fostering the development of cultural tourism products and services (Paiva, Seabra, Abrantes, 2019). These routes enhance Europe's image globally, strengthen European cultural values validated through centuries of cultural exchange and creativity (Ciubotaru et al., 2015). European cultural routes foster artistic, cultural, commercial, and political ties between countries, and the Council of Europe views them as key tools for cultural initiatives and exchanges, promoting knowledge and ideas that transcend cultural and political barriers shaped by the major 20th-century conflicts (Ciubotaru et al., 2015).

In less developed or rural areas with limited financial and technological resources, cultural routes are valuable development tools, addressing local needs (Moropoulou et al., 2021). In rural areas, food and wine production are significant tourism attractions, stimulating local entrepreneurship and community initiatives. When cultural routes are linked to rural areas, the interconnections between various sectors become crucial for sustainable heritage use and innovation. Consequently, wine routes, in particular, are gaining increasing international attention and can drive regional development (Ferrara, Passarini, 2020).

Despite the European Commission's assertion that cultural routes contribute to regional economies and societies by operating on sustainable and ethical models, Graf and Popescu (2016) found that unless cultural heritage becomes a brand, it does not attract tourists. They argue that only a brand guarantees quality, ensuring tourists that each stop on the map—from restaurants to hotels—is associated with a form of local heritage and history. This requires collaboration among various stakeholders, coordinated by a brand representative. In remote areas, local heritage and culture serve as the primary source for territorial brand creation. In this regard, cultural routes present both a challenge and an opportunity for culture, science, tourism, and the economy, as they offer more effective branding and promotion than individual travel destinations. They foster innovation, creating something new and unique from available resources.

Cultural route development projects in Europe are subject to rigorous evaluation and selection. Uniform criteria apply to smaller territorial routes aiming to attract European travellers' attention. A cultural route must function as a cultural tourism product, possessing all necessary attributes and offering relevant content, information, and facilities for hospitality and accommodation services. Travelers seeking enjoyment, relaxation, and local culinary experiences must have access to these offerings (Ciubotaru et al., 2015).

Since 2010, new cultural routes in Europe have been certified. The Council of Europe's "Cultural Routes" program, as of 2021, includes 45 certified routes covering themes related to European memory, history, and heritage, contributing to the interpretation of today's European diversity. These routes include the Viking Routes, Hanseatic Routes, Mozart and Napoleon Routes, European Ceramics Route, Roman Emperor and Danube Wine Route, European Historic Gardens Route, and others. All cultural routes promote cross-border cultural cooperation across Europe (Ciubotaru et al., 2015).

The first cultural route concept emerged in 1987 with the Santiago de Compostela network, which played a symbolic role in European integration. Each year, tens of thousands of pilgrims travel to Santiago de Compostela. This route was designed to solidify core European cultural principles, including human rights, cultural democracy, European cultural diversity, identity practices, dialogue, and mutual exchange (Abramavičienė, 2020).

Currently, Lithuania is part of four European Council routes: the Way of St. James, the Jewish Cultural Heritage Route, the Iron Curtain Route, and the Impressionism Route. Lithuania is an integral part of the European network of these cultural routes. The Jewish heritage is widely spread across Europe, including archaeological sites, historic synagogues, cemeteries, ritual baths, Jewish quarters, monuments, and memorials. This route promotes understanding and appreciation of religious and everyday artefacts, acknowledging the essential role of the Jewish people in European history (Council of Europe, 2022).

In conclusion, cultural routes play a vital role in preserving Europe's rich cultural heritage. They serve as an effective means to promote cultural dialogue and international cooperation. Lithuania is part of the European network of cultural routes, joining four routes. Since 2010, new cultural routes have been certified in Europe, and the certification process for cultural routes in Lithuania was officially established only in late 2021. As such, Lithuania's M.K. Čiurlionis Cultural Route has not yet been certified.

Cemetery Route Tourism. In recent years, cultural tourism has emerged as one of the driving forces behind heritage preservation, and this trend has extended to cemetery tourism. Cemeteries are often referred to as open-air museums, as they represent a significant aspect of cultural heritage, increasingly attracting the attention of scholars, artists, and visitors. Many cemeteries feature impressive monuments that house important works of art, while others serve as repositories for numerous historical testimonies, earning them the designation of "open museums" (Pliberšek, Vrban, 2019). Cultural routes highlight the monumental and artistic-historical characteristics of cemeteries, defining them as "open museums", "museums under the

open sky", "microcosms", "local heritage sites" (Millán et al., 2019), "visitable objects", "meditation spaces", or "city-museums, tourist attractions" (Diogo, 2017). In other words, cemetery routes are presented as an alternative way to explore and discover the history and traditions of cities.

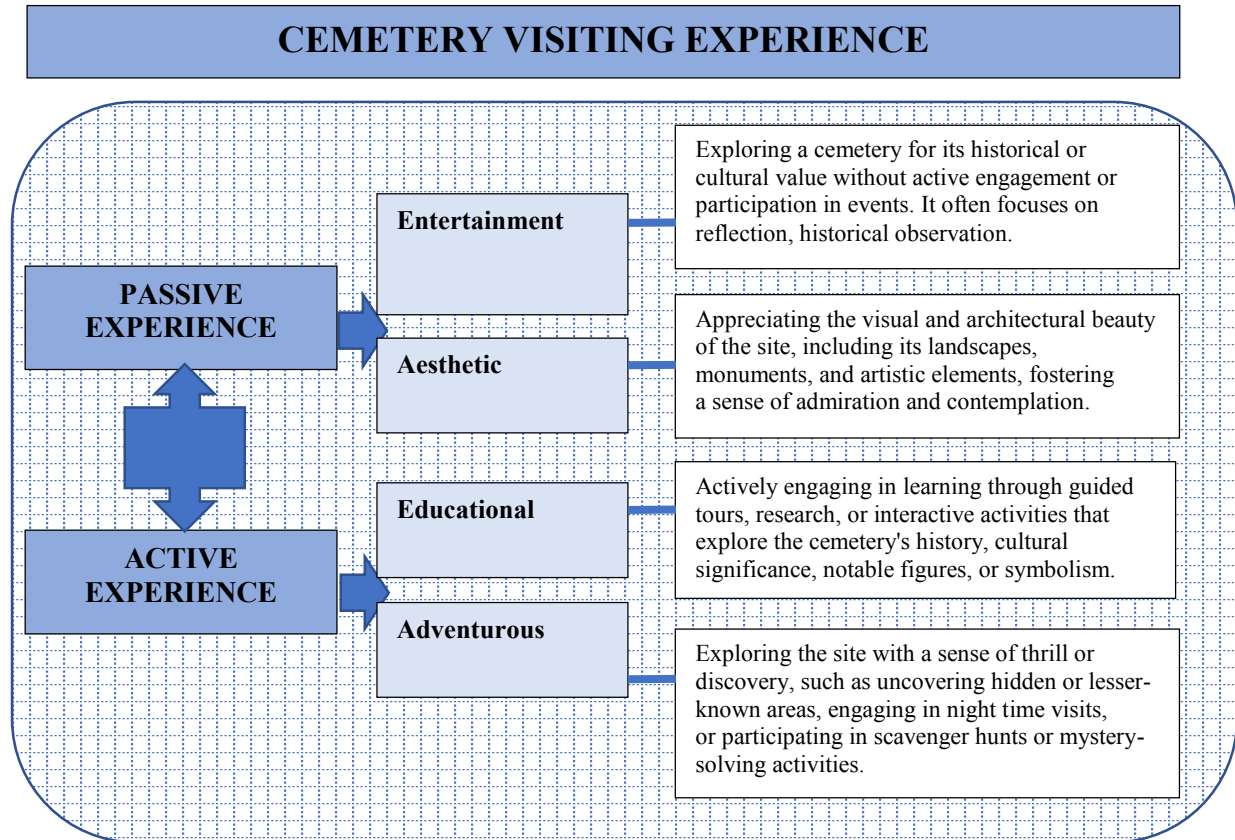


Figure 1. Cemetery Visiting Experience.

Source: made by the authors according to Pécsek, 2015.

Europe, in particular, is rich in urban cemetery heritage, with almost every major city home to at least one cemetery of cultural significance. As such, cemeteries represent a new and important "niche" tourism market with substantial growth potential, capable of yielding significant economic benefits for cities. In 2010, the European Cemetery Route was officially recognized as a certified Council of Europe Cultural Route, attracting between five and seven million visitors annually (Pécsek, 2015). A review of the scientific literature reveals that cemetery visits offer four distinct types of experiences (see Fig. 1).

As seen in Figure 1, the model encompasses two passive experiences—recreational and aesthetic—and two active experiences—educational and adventurous. Cemeteries, often referred to as open-air museums, are not only repositories of art and historical artefacts but also vibrant ecosystems. Many cemeteries are home to diverse species of birds and plants, blending cultural and natural heritage. The landscape surrounding these cemeteries, with their botanical richness, transforms them into parks and gardens, offering public enjoyment (Millán et al., 2019). The natural cemetery landscape, with green spaces, intersecting paths, and scattered benches, along with its architecture, provides aesthetic pleasure to visitors (Pécsek, 2015).

By visiting the burial sites of notable individuals and learning about their lives and achievements, visitors broaden their knowledge. Like outdoor museums, cemeteries serve as valuable sources of information about the history of a particular city (Millán et al., 2019).

Participation in local funeral rituals also provides an educational and recreational experience. It allows tourists to enter a spiritual realm while creating a unique, collective narrative. Visitors explore burial sites not only to discover artistic, architectural, and landscape heritage but also to delve into the chilling legends of violent deaths (Millán et al., 2019).

The primary goal of the European Cemetery Route is to raise awareness about European burial heritage, customs, traditions, and funeral art that represent the European continent. This international route aims to promote high-quality cultural tourism by introducing new sites and fostering international collaboration between European countries to showcase burial traditions, landscapes, and create a route that not only offers an itinerary but also provides educational opportunities. The inclusion of cultural cemetery routes in school curricula further promotes education (Interreg Central Europe, 2016).

Different cemeteries offer distinct experiences, largely depending on their style, layout, the monuments present, and the integration of greenery. Some resemble outdoor sculpture museums, others resemble botanical parks, while some lie somewhere in between. The European Cemetery Route includes 63 cemeteries across 50 cities in 21 European countries. The sculptures and engravings in these cemeteries tell the history of Europe, revealing periods in European history, burial customs, and the urban planning traditions of European cities.

In conclusion, the European Cemetery Route was officially recognized as a certified Council of Europe Cultural Route in 2010. The route aims to enrich the public's understanding of a city's history, promote quality cultural tourism, and foster international cooperation between European countries in showcasing burial traditions, landscapes, and European customs. Cemeteries offer four distinct types of experiences: two passive—recreational and aesthetic—and two active—educational and adventurous. One of the most renowned cemeteries is Père Lachaise in Paris.

Cemeteries in Lithuania Belonging to the European Cemetery Route. The European Cemetery Route has been certified by the Council of Europe since 2010; however, Lithuania is not currently among the 21 countries participating in this route. Nevertheless, over the past decade, the Association's committee has recognized more than 150 significant cemeteries across Europe. The list of significant cemeteries includes the following cemeteries in Lithuania: Rasos, which are included in the list of tourist attractions, and the cemeteries of Antakalnis and Bernardinai.

Rasos Cemetery was established at the end of the 18th century and the beginning of the 19th century. It is considered one of the oldest, most unique, and historically significant cemeteries for Lithuanian statehood and culture. As a specific cultural heritage site, it reflects several centuries of history and serves as an important tourist attraction, drawing both

Lithuanians and visitors from other European countries. Rasos Cemetery is included in the Register of Cultural Heritage of the Republic of Lithuania.

Today, Rasos Cemetery no longer serves as a burial site, and its role as Lithuania's pantheon has been taken over by Antakalnis Cemetery, established in the first half of the 19th century. Antakalnis Cemetery is the final resting place for soldiers, prominent Lithuanian artists, scientists, politicians, and victims of the January 13th and Medininkai tragedies. Several notable figures are associated with Antakalnis, and many are buried there. One of the most famous sites is the Hill of Artists, where the writers I. Simonaitytė and J. Ivanauskaitė, singers J. Miščiukaitė, V. Kernagis, as well as other renowned singers, musicians, writers, and actors, including the president A.M. Brazauskas, are buried (Tiukšienė, Sisaitė, 2015).

Bernardinai Cemetery is the second oldest cemetery in Vilnius, established in 1810. For more than 200 years, it has served as the final resting place for various cultural, social, and scientific figures.

When linking the cultural route with cemeteries, it is worth mentioning that one of the certified European cultural routes, to which Lithuania belongs, is the Jewish Heritage Route. This route includes visits not only to Jewish heritage sites such as neighbourhoods, wooden and stone synagogues, and buildings associated with prominent Jewish figures, but also to Jewish cemeteries. Visitors can explore the old Jewish cemeteries in Užupis and Šnipiškės, as well as the Vilnius Gaon Family Tomb—currently a mausoleum in the active Jewish cemetery in Sudervė. These are among the most visited Jewish sites in Vilnius, and their legends resonate with Jews worldwide (Jewish Heritage Route Association).

In summary, Rasos and Antakalnis Cemeteries represent Lithuania and even Europe. These cemeteries are valued for their uniqueness and significance to the history and culture of the Lithuanian state. They, which tell and reflect several centuries of Lithuanian history, could serve as tourist attractions not only for Lithuanians but also for international visitors.

4. Methodology for Research on the Role of Cemetery Route as a Cultural Tourism Promoter for Lithuanian Tourists

Research Methodology

Objective of the research: the aim of the study is to assess the factors promoting cultural tourism through the example of the European Cemetery Route, based on empirical research data.

Research methods: According to Kardelis (2016), two main groups of research methods are distinguished: quantitative and qualitative methods. To evaluate the factors promoting cultural tourism through the European Cemetery Route, the following research methods were chosen: a survey of tourism service consumers and a semi-structured interview with a tourism

service intermediary—an expert-guide. Thematic analysis was used to identify key themes, coding techniques to categorize responses. The interview questions were developed based on the survey questions, thus expanding the scope of the research and providing a more detailed exploration of the study's objectives and subjects. Factor analysis was used to explore underlying factors influencing cultural tourism.

Triangulation was achieved by integrating the quantitative findings from the survey with qualitative insights from expert interviews. Survey data provided broad patterns and trends regarding factors influencing cultural tourism, while the expert interview offered in-depth contextual understanding and professional perspectives. By comparing and cross-validating these findings, the study ensured a more nuanced and reliable analysis, reducing potential biases and enhancing the credibility of conclusions about the European Pilgrimage Route's role in promoting cultural tourism.

The questionnaire consists of 18 questions, four of which are demographic in nature. The questions in the survey allow respondents to choose one of the available answer options and mark their response. The questionnaire is composed of closed-ended questions that reflect the research aim and objectives. The survey includes questions related to the social-demographic characteristics of the respondents, as well as questions directly related to the research objective.

Sampling: the sample is an integral part of the research process. During the selection process, the sample size must be planned so that meaningful conclusions can be drawn, and the research objectives can be achieved. A simple random sampling method was chosen for this study. The sample consists of 175 respondents, and the sample size was determined using the Paniotto formula with a 5% margin of error.

Qualitative research sample: the qualitative research sample consists of a tourism expert and guide. The expert has over 20 years of experience in the tourism sector and is well-versed in the tourism market, knows tourists' needs, and is capable of assessing new tourist routes.

Research process: The research process was carried out in the following stages:

1. Identification of the problem.
2. Selection and analysis of scientific sources. Lithuanian and foreign scientific sources related to the chosen topic were collected and analysed. The sources were found in databases, academic journals, and online resources.
3. Preparation of the research plan and development of the research instrument. Research tasks were formulated, and the research methods were specified. The research instrument consists of a questionnaire, a written survey including demographic data and questions reflecting the research aim and objectives, as well as interview questions.
4. Data collection.

5. Data analysis, interpretation of results, and presentation. The collected data were processed using Microsoft Office Excel. The results were presented in graphical form, using percentages.
6. Preparation of conclusions and recommendations. After analysing the data, conclusions were drawn based on the results, answering the research tasks.

Research ethics: during the research, respondents were informed about the purpose of the study, and it was clarified that the results would be generalized and presented in the scientific paper. The following ethical aspects of the research were ensured (Kardelis, 2016): anonymity – the information provided by participants, regardless of its openness or personal nature, would not allow the identification of respondents; confidentiality – the researcher would remain faithful to those who assisted in the research; voluntariness – the participants voluntarily took part in the study, without any pressure; respect – participants were thanked for their participation, honest completion of the survey, and return of the questionnaires; integrity – the data collected during the research would not be altered or falsified, and the researcher commits to presenting only the data obtained from the respondents.

The justification for the survey questions is provided in the table below (see Table 2).

Table 2.
Justification for the Survey Questions

No.	Questions	Justification
1	1-2	These questions aim to clarify the respondents' opinions about the situation of cultural tourism development in Lithuania and the availability of information.
2	3-7	These questions aim to find out the respondents' opinions about their understanding of cultural tourism, what motivates them to engage in it, and whether they have heard of cemetery road routes, as this is very important for developing cultural tourism.
3	8-9	This question aims to find out in which countries and what would encourage respondents to visit cemeteries. This is important because the European Commission aims to encourage Europeans to re-explore their roots and engage in cultural tourism in their free time.
4	10-12	Csapo defines cultural tourism as an activity that allows people to get acquainted with different ways of life of other peoples, their customs, traditions, and physical environment. Therefore, these questions aim to find out what the respondents would be most interested in getting to know on the cemetery road and how the routes should be promoted so that they reach as many people as possible.
5	13-14	ASECE takes care of cemeteries of historical or artistic significance and the Rasai, Antakalnis and Bernardinai cemeteries are included in the list of visitable and significant cemeteries. Therefore, this question aims to find out whether respondents know and have visited these cemeteries. Since Lithuania has not joined the European Cemetery Route, the aim is to find out the respondents' opinion on whether it is worth it for Lithuania to do so.
6	15-18	This is a block of demographic questions that explore the gender, age, education, and income of respondents, as this will allow us to evaluate the responses according to these criteria.

Source: made by the authors.

The questionnaire was designed to gather insights into cultural tourism and the potential for promoting cemetery routes. It helped to evaluate public perceptions and attitudes toward cultural tourism, with a specific focus on the potential for cemetery routes as a niche attraction.

5. Results of the Research on the Role of Cemetery Route as a Cultural Tourism Promoter for Lithuanian Tourists

Presentation of the European Cemeteries Route. The European Cemeteries Route is a unique cultural tourism project that invites individuals to explore the rich heritage of the most renowned cemeteries in Europe, reflecting the social, cultural, and historical development of cities and local communities. The route comprises 63 cemeteries located in 50 cities across 21 European countries. The main goal of the European Cemeteries Route is to raise awareness about European burial heritage, as well as the customs, traditions, and funeral art that represent the continent.

This international route aims to promote high-quality cultural tourism by introducing new attractions, fostering international cooperation among European countries, and showcasing burial traditions, landscapes, and customs. The route is designed not only to offer a touristic pathway but also to provide knowledge, encourage ongoing research, and promote education in schools, including the integration of cultural cemetery routes into educational curricula.

The sculptures and engravings found in these cemeteries, like elegiac musical compositions, narrate the history of Europe. The cemeteries reveal chapters of European history, the continent's anthropological traits, burial customs, and the planning traditions of European cities. Cemeteries encompass four types of visiting experiences: two passive experiences (recreational and aesthetic) and two active experiences (educational and adventurous). Among the most famous cemeteries is the Père Lachaise Cemetery in Paris.

In 2010, the European Cemeteries Route was officially recognized as a certified Cultural Route by the Council of Europe.

Quantitative Research Results. The research results revealed that the tourism sector in Lithuania is moderately developed and can be further improved. Online websites, social networks, and recommendations from family and friends are the most convenient and reliable channels for obtaining information about cultural tourism sites. Tourists express interest in cemetery route itineraries; however, awareness of these routes is low. As a result, cemetery routes could be incorporated into more tourism activities as part of a broader initiative to promote cultural tourism.

The study also indicated that respondents view visits to cemeteries positively. They found it interesting or even impressive to visit cemeteries, yet this activity is not a priority attraction. Instead, it is seen more as a general part of the route, which would be considered a normal practice within the broader context of a tour. Respondents stated that while they would not specifically seek out cemetery visits on their own, they believe it would likely appeal to specialists.

A deeper analysis of cemeteries as cultural objects revealed that respondents relate their knowledge to personal interests. Some expressed a desire to visit cemeteries in various countries or continents, as burial rituals, architectural structures, and cemetery culture differ across cultures.

The study sample consisted of 66.9% women and 33.1% men. In summary, the demographic data indicates that the participants were diverse, but mostly of mature, working age, with higher education and moderate to high monthly incomes.

Thus, in conclusion, the quantitative research suggests that visiting cemeteries is not a common tourist activity for the participants, as it is often associated with discomfort, and there is reluctance to engage in such visits in unfamiliar areas due to concerns about offending local customs. However, the results also revealed that cemetery visits are considered an interesting part of an overall route program and contribute to the cultural exploration of the area.

Qualitative Research Results. During the qualitative research, the expert was interviewed to gain further insights into the quantitative results and to explore additional perspectives on the issues being analysed. As revealed by the expert, the qualitative study largely confirmed the findings from the quantitative research. However, a more detailed analysis led to insights on two main themes. The first was the motivation for visiting cemetery routes.

The expert highlighted several reasons for visiting cemetery routes, including an interest in history, the graves of famous individuals, their biographies, and burial traditions. However, the expert also pointed out that visiting cemetery routes is often associated with negative emotions for many people, especially those who have recently experienced a loss. This association creates a significant burden on individuals, making this tourism niche not widely known or promoted.

Promotion of cemetery routes should be actively advertised on traditional tourism websites, social networks, and other media channels. According to the expert, one of the most important aspects of attracting tourists to cemetery routes is presenting interesting and relevant information in a way that captures their interest. Since cemetery visits are rarely included in mainstream itineraries, they could be developed into a niche tourism sector.

In conclusion, the expert's responses corroborated the results of the quantitative study while offering additional insights into methods and motivations for promoting visits to cemetery routes.

Discussion. The research established new insights into public perceptions of cemetery routes as a niche form of cultural tourism, highlighting both the interest in and barriers to their promotion. While previous studies have recognized the cultural and historical value of cemetery tourism, our study uniquely examined its potential in the context of Lithuania and its alignment with European cultural initiatives. Similarities with prior research include the acknowledgment of cemeteries as sites of historical and artistic significance, but our findings diverge by emphasizing the low awareness of such routes and the need for targeted promotion strategies. These results suggest that while cemetery routes hold untapped potential, their success depends

on overcoming negative associations and fostering public engagement through education and marketing. Moving forward, we plan to expand the scope of research to include comparative analyses with other European countries, explore long-term trends in cultural tourism, and investigate innovative ways to integrate cemetery tourism into broader tourism strategies.

However, addressing potential limitations of the study, such as the relatively small sample size, may not fully capture the diversity of tourist perspectives, and the limited geographical scope, focusing predominantly on Lithuania, additionally, the reliance on self-reported data introduces bias, as participants have provided socially desirable responses rather than accurate reflections of their preferences. To mitigate these limitations and provide a more balanced perspective, suggestions for future research were included. These included expanding the study to encompass a broader range of European countries, employing longitudinal research methods to track changes in tourist perceptions over time, and incorporating mixed-method approaches to explore both emotional and cultural dimensions of cemetery tourism in greater depth. These enhancements contribute to a more comprehensive and transparent understanding of the research findings and their implications.

Conclusions

1. The literature research critically evaluated the concept of cultural tourism, revealing its multidimensional nature as an activity that fosters an appreciation for history, heritage, and local traditions. While the study effectively highlighted cultural tourism's role in enriching tourist experiences, its limitations include a narrow focus on Lithuanian tourists, which may not fully capture diverse cultural tourism practices globally. A key lesson learned is that cultural tourism is not only about site visits but also about meaningful engagement with history and culture. The findings underscore the importance of cultural tourism in preserving heritage and promoting sustainable tourism. Theoretically, the research contributes to a better understanding of cultural tourism dynamics, while practically, it suggests that stakeholders in the tourism industry should develop experiences that combine education, recreation, and heritage conservation to maximize cultural tourism's potential.
2. The study introduced cultural routes as effective tools for promoting tourism, with the European Cemetery Route serving as a case study. While the research successfully illustrated the potential of cultural routes to connect diverse heritage sites, it was limited by the lack of comparative analysis with other cultural routes. The new knowledge gained includes insights into how cultural routes can foster international cooperation and highlight unique aspects of European heritage. These findings are significant as they demonstrate how cultural routes can drive sustainable tourism while promoting cross-cultural understanding. The research emphasizes the need for enhanced marketing strategies and integration of cultural routes into educational curricula, offering practical implications for policymakers, educators, and tourism developers seeking to elevate cultural tourism initiatives.

3. The research identified factors promoting cemetery routes for Lithuanian tourists, including interest in historical narratives, architectural heritage, and cultural exploration. However, low public awareness and the emotional sensitivity associated with cemetery visits were identified as key weaknesses. A valuable lesson learned is the importance of addressing these barriers through targeted promotion and education. The study's importance lies in its practical implications: the insights can guide tourism stakeholders in designing engaging promotional campaigns and integrating cemetery routes into broader tourism offerings. Theoretically, it enriches the understanding of niche tourism markets and their unique challenges.

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PERCEPTION OF INCLUSIVE ADVERTISING BY REPRESENTATIVES OF GENERATION Z

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Purpose: The aim of the article is to find out how inclusive advertising is perceived by representatives of Generation Z, whether it makes them more trusting and whether it influences their purchasing behavior and attitudes.

Design/methodology/approach: The basis is focus research using the focused group interview (FGI - Focus Group Interview) method. The method of critical literature analysis and descriptive analysis were also used.

Findings: Generation Z is becoming an important consumer group, and its preferences and values will shape the future of marketing. A key trend is inclusivity, and understanding how it is perceived by younger generations can contribute to more effective communication with society.

Research limitations/implications: Topics related to diversity and inclusion evoke emotions, which leads to extreme reactions from participants. These types of emotional reactions may have made it difficult for respondents to objectively evaluate inclusive advertising. Another limitation was the group dynamics. Strong personalities dominated the discussion, and some study participants were less willing to express their own opinions. Yet another looming limitation is the evolution of attitudes, which in the case of Generation Z may change in response to social and cultural changes. The research conducted may not reflect long-term trends or future purchasing attitudes, which may change in the long run under the influence of various factors.

Practical implications: Understanding the aspects examined in the article can help companies/brands adapt their marketing strategies to the needs and values of the identified age group. Generation Z is becoming an important consumer group, and its preferences and values will shape the future of marketing.

Social implications: The research results may inspire and sensitize advertising creators and their recipients to the need to respect everyone, regardless of age, appearance, gender or sexual orientation, as well as to the need to listen empathetically to social needs. Inclusiveness is a key trend and understanding how it is perceived by the young generation can contribute to more effective communication with society.

Originality/value: The approach to the meaning and value of inclusive advertising presented in the article organizes this area and identifies opportunities to better use the potential of knowledge in this area in practice.

Keywords: inclusive advertising, generation Z, marketing communication, consumer relations.

Category of the paper: research paper.

Introduction

The image of companies and their ability to adapt to a changing environment determines the quality of their relationships with customers, and thus maintaining or gaining market advantage. Researchers agree that one of the factors facilitating such an advantage is inclusive marketing communications. A lot of inclusive advertising is appearing in the media and real space, which, it can be judged, is an important trend, especially in the context of the global social changes taking place, as well as increasing consumer awareness of diversity and corporate responsibility. A feature of inclusive advertising messages is that they move away from idealized images to show the authentic world. They no longer feature only people of admiration and popularity - stars or celebrities - but people from different social and ethnic backgrounds, with different physical abilities, also with different disabilities, with different facial features, skin color, sexual orientation, gender, height, or weight.

Inclusive advertising means well-meaning tolerance, as companies respect the needs and desires of social groups that were previously downplayed and overlooked. In this sense, it is the human being who comes first: Human First, regardless of origin, lifestyle, appearance, health status, religion, sexual orientation, material status, political or dietary beliefs (Pabian, Pabian, 2023). The essence of inclusive ads is to show that each person is a unique character, with an individual personality and a complex identity. Such ads therefore have ethical overtones, pro-social potential and high credibility. Their undoubted advantage is also that they allow the message to reach a larger and diverse audience.

However, there is a clear research gap regarding the perception of inclusive advertising by representatives of Generation Z, i.e. young people, born between 1997 and 2012. Synonymously, people born in this time frame are referred to as the Facebook generation, also the remote control and Internet generation or Generation XD (X+Digital). These “digital natives” have been exhaustively described in the literature in terms of psychological and social characteristics. Researchers agree that although the subject of this generation is complex, but what is particularly characteristic is contained in the statement that their world is ruled by phones, computers and the Internet. They are able to use the media and move seamlessly through the latest technologies.

Importantly for the considerations in this article, representatives of Generation Z pay attention to issues of social justice and representation both in everyday life and in the media. Their approach to branding, advertising and media differs from previous generations (Seemiller, Grace, 2016; Dolot, 2018; Kullolli, Trebicka, 2023; Jayatissa, 2023). In the context of these findings, however, there is a need to clarify what this different approach of the younger generation to branding, advertising and the media consists of and what specifically characterizes it. This article partially fills this research gap.

The purpose of this article is to discover how inclusive advertising is perceived by representatives of the “Z” generation, whether it inspires more trust in them and whether it influences their behavior and purchase attitudes. Obtaining an answer to the research question posed in this way is important and timely, since further economic progress will depend on young people, who will soon begin to take charge of organizations and determine the direction of their development (Pabian, Pabian, 2023, p. 476). They will be the ones who will be responsible for developing the organization and communicating with customers. Finally, they will be the main consumers of goods and services.

The research used both a qualitative method in the form of focus group interviews to obtain more detailed information on the emotions and reactions to inclusive advertising of Generation Z people. A critical analysis of the literature was also conducted. The research was based on both the literature on the subject and current reports and market research on the analyzed generation and inclusive advertising. Case studies of selected marketing campaigns were also used. The descriptive analysis method was also applied.

Inclusive advertising in light of the latest scientific findings

The genesis of inclusive business is closely linked to the evolution of the concept of corporate social responsibility (CSR) towards shared value creation, and the rise of emerging markets and the population at the base of the income pyramid. Since 1990, the Bottom of the pyramid/Base of the pyramid (BOP) concept has been evolving. In the BOP 1.0 concept, the poor were treated solely as consumers, but already in the BOP 2.0 concept, they were treated as business partners who co-create the business model and participate in the production and distribution of goods and services (Teneta-Skwiercz, 2016). Thus, in the previous thinking about inclusive business, the need to counter poverty came to the fore. Gradually, the scope of the concept broadened to include everything related to the process of change and the change in mentality that has taken place in the information society.

The scientific research strictly on inclusive advertising covers both ethical and commercial issues, especially in terms of the impact of diverse representations on the effectiveness of advertising campaigns. After all, inclusivity in a business model involves a value proposition

for the customer (Eyring et al., 2011). Researchers agree that inarguing inclusivity is now a popular marketing imperative to which companies, policies and individuals are paying increasing attention (Grieco, 2024).

Nowadays, inclusive marketing is all about reaching out to different groups in society, so in short, seeing the potential in diversity and respecting each person. This also applies to multicultural environments. For example, “multi-ethnic embedded marketing communications can be an effective means of communicating more inclusively with ethnic individuals for the benefit of consumer welfare and marketing effectiveness” (Liscandru, Chi Cui, 2018).

Accenture Strategy's 14th annual Global Consumer Pulse Research - *From Me to We: The Rise of the Purpose-led Brand* - surveyed 30,000 consumers from around the world to gauge their expectations of brands and companies. It found that 62% of them expressed the belief that companies should take a stand on social, cultural, environmental, and political issues that are close to their hearts (Davis, 2018). According to a recent IAS survey of US consumers, 45% of consumers would be likely to switch or boycott brands that have low value.

Recent published research shows that inclusive advertising, compared to non-inclusive advertising, improves both hedonic and eudaimonic well-being (Qayyum et al., 2023), as well as being a key factor influencing purchase decisions and consumer perceptions of brands Diversity and Inclusion: D&I (IAS TEAM, 2023).

A series of McKinsey reports (Why Diversity Matters, 2015; Delivering Through Diversity, 2018; Diversity Wins, 2020) reveal what the financial benefits of implementing more diverse and inclusive advertising campaigns can be (McKinsey&Company, 2020). While some researchers question the claim that business benefits exist for organizations with more diverse leadership (Gardner, 2023), according to most, the formula of *diversity + inclusion = better financial performance works across the board*. People, in turn, feel included when they are treated “fairly and respectfully” Bourke, 2018).

The literature also extensively discusses ways and means of adapting democratic legitimacy and inclusivity to place branding. Here, there is the important issue of the need for representation and advocacy for marginalized groups, such as migrants (Bisani et al., 2024), as well as socially silenced or discriminated against groups, such as communities with a different sexual orientation or gender identity LGBTQIA+ (McKenzie et al., 2024). It also underscores the need to continuously raise awareness of the need for inclusivity, not only by adequately saturating *European entrepreneurship curricula* (Henry et al., 2024), but already at the level of teacher preparation training.

Methods

In the literature one can find research results on consumer perceptions of inclusive advertising, but without dividing them into age groups, which can lead to falsification of results and creation of generalizations. This is because seniors will react differently to specific images and messages, and differently to representatives of the younger generation, i.e., people just entering adult and responsible life. Taking this into account, the purpose of this article is to discover how inclusive advertising is received by representatives of the “Z” generation, whether it inspires more confidence in them and whether it influences their behavior and purchase attitudes. Accordingly, a research problem was formulated, which took the form of the following question: how does inclusive advertising affect the attitudes and purchasing decisions of Generation Z in Poland?

For the purpose of achieving the above-mentioned goal, three research tasks were formulated, including, in turn:

- a) *analyzing the level of interest of Generation Z representatives in inclusive advertising,*
- b) evaluation of the impact of inclusive advertising on the perceived authenticity of the product/brand,
- c) assessing the impact of diversity in advertising on the preferences and consumer choices of the analyzed generation.

In addition to descriptive analysis, focus research using the Focus Group Interview (FGI) method was used to identify the issues under study in relation to Generation Z. This is a qualitative research technique, which involves soliciting the opinions of groups of people, in our case students from Generation Z, about the phenomenon under study. The opinions, gathered during a discussion involving 5 to 10 students, were conducted by a moderator (one of the authors of the article), who guided the conversation, using a specially prepared script. The research was conducted over a period of two months: June and October 2024. A total of 70 people participated.

At the beginning of the interview, the moderator defined the concept of inclusive advertising and then asked open-ended questions according to a developed questionnaire. Each question in the interview was preceded by a brief introduction and their problem content was derived from the adopted stages of the research tasks, hence section I included questions related to the analysis of the level of acceptance of inclusive advertising by Generation Z students, section II - questions on the impact of inclusive advertising on the perceived authenticity of the product/brand, and section III (the final section) - questions aimed at assessing the impact of diversity in advertising on the preferences and consumer choices of the analyzed generation.

Inclusive advertising in the opinion of respondents – research results and discussion

In order to determine the respondents' level of acceptance of the type of advertising studied, they were asked about their viewership. The majority of Generation Z representatives confirmed the viewing of inclusive ads, expressing their positive reception. When asked what emotions inclusive advertising evokes in them, students mentioned most often:

- a) acceptance - this trait indicates that Generation Z representatives value diversity and inclusiveness, so ads that show people with different skin colors, gender identities or sexual orientations may inspire a sense of acceptance and belonging;
- b) empathy - Generation Z can empathize with and better understand the challenges faced by other social groups;
- c) inspiration - advertisements that promote values such as equality inspire Generation Z to take action, engage socially and fight for a better world;
- d) confidence - students show confidence in brands that focus on inclusivity and diversity;
- e) motivation - students said that inclusive advertising campaigns motivate them to take action, especially in the context of fighting for human rights and equality.

The next interview question sought to determine: Does inquisitive advertising deepen brand trust with Generation Z? Respondents unanimously confirmed this fact, stating, among other things, that: “inclusive advertising has the potential to deepen brand trust among Generation Z”.

As can be judged, these opinions are the result of the fact that the generation under analysis has grown up in an era of diversity and equality and is therefore more sensitive to issues of inclusiveness and diversity. Therefore, advertisements that reflect diversity in culture, ethnicity, gender, etc., can build positive brand associations. Respondents further stressed that inclusive advertising could attract more attention because “it shows real human experiences, which is often more compelling than traditional homogeneous images”. As a result, brands that invest in inclusive campaigns can build stronger and more positive relationships with Generation Z consumers.

Respondents were then asked about the issue of the impact of inclusive advertising on their perceived authenticity of the product/brand. The results of this part of the interview showed that representatives of the surveyed generation show significant interest in authenticity, presented in advertising campaigns. Advertisements that depict diverse groups of people, including ethnic differences, gender differences, sexual orientations, and disabilities, attract their attention and build trust in the brand. Respondents' answers thus indicate that a realistic portrayal of society is particularly important to Generation Z. Therefore, ads that show real stories and real people, rather than idealized images, are more compelling to them. They gain their trust and are more likely to be viewed.

The purpose of the next part of the interview was to determine: Does diversity in advertising influence the preferences and consumer choices of people representing Generation Z? Therefore, respondents were asked what type of diversity in ads they find most compelling and influential in their consumer decisions? In asking respondents about this question, it was determined that they showed specific preferences for diversity in ads, and the most frequently mentioned were:

- a) ethnic and cultural diversity: respondents said that advertisements that depict people from different ethnic and cultural groups are particularly appreciated by them;
- b) gender and identity diversity: respondents expressed acceptance in ads of images of people with different gender identities and sexual orientations, and appreciated the actions of brands representing diversity in this regard - indicating the openness of Generation Z to LGBTQ+ issues;
- c) age diversity: according to respondents, ads that show people of different ages are well received - a fact that indicates that Generation Z sees the value of experience and that everyone should be represented in ads;
- d) themes of social responsibility: respondents unanimously stressed that ads that address socially important issues, such as equality, climate change or human rights, are particularly important to them, and they want brands to be involved and act accordingly;
- e) representation of the body and health: representatives of Generation Z appreciate diversity in the representation of bodies in ads, which includes models of different sizes, as well as people with disabilities.

Conclusion

New trends in marketing communications are a response to new consumer needs and social challenges. These are mental, intellectual changes that are taking place especially among the younger generation. In the context of the dynamism of technological change, the implementation of the principles of corporate social responsibility and the development of the concept of sustainable development, the philosophy of inclusive (inclusive) marketing deserves special attention. Understanding the aspects of inclusive marketing explored in the article, the reception of inclusive advertising and its impact on the young generation can help companies/brands adapt their marketing strategies to the needs and values of the identified age group. Generation Z is becoming an important consumer group, and their preferences and values will shape the future of marketing. Inclusivity is a key trend, and understanding how it is perceived by younger generations can contribute to more effective communication with the public.

In approaching the discussion of the results of the presented focus studies on the reception of inclusive advertising by Generation Z, it is also worth addressing the issue of various weaknesses and limitations that may affect the results obtained. The discussion on this topic is usually undertaken by researchers and experts in the fields of marketing, social communication, and psychology. In the literature, one can find analyses of focus research methodologies that point to their specific weaknesses and limitations (Roller, Lavrakas, 2015; Almeida et al., 2017; Basnet, 2018). The most important of these with regard to researching Generation Z, according to the authors of the article, include:

- a) subjectivity - can affect the interpretation of the responses obtained; survey participants may also feel social pressure to present opinions in line with popular trends, which can distort actual sentiments;
- b) representativeness of the sample - the number of participants in a focus study is usually limited, which may affect the ability to generalize the results to the broader Generation Z population.

However, the research conducted by the authors of this study is a pilot study. Further in-depth research is planned on this issue, taking into account varied qualitative techniques.

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CONTEMPORARY COMPETENCES OF MANAGERS AND THEIR ROLE IN BUILDING ORGANIZATIONAL RESILIENCE

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Purpose: The aim of the article is to present the role and specificity of key managerial competencies in the form of knowledge, skills, attitudes, motivations that modern managers should have and develop in order to effectively build the resilience of the organization in a rapidly changing environment.

Design/methodology/approach: The research was aimed at a critical analysis of the phenomenon and was carried out on the basis of an in-depth analysis of domestic and foreign literature as well as synthesis and logical inference.

Research limitations/implications: There is no single, universally accepted definition of the concept of organizational resilience in the literature on the subject, but the concept of managerial competence is a fairly well-recognized area. However, there is little research on their development in the context of organizational resilience. The article analyzes the concepts of organizational resilience and the factors influencing it, as well as analyzes the elements that make up contemporary managerial competencies and discusses examples of good practices of their application in the context of building organizational resilience reflecting these elements.

Practical implications: The application value of the article is that managers receive specific information on which and what elements of competence to improve from the perspective of strengthening the organization's resilience.

Social implications: Modern managerial competencies emphasize managing teams based on cooperation and trust. Such an approach fosters the integration of employees and affects their positive interpersonal relationships, which in turn contributes to building a strong organization.

Originality/value: Improving managerial competencies is an important condition from the perspective of strengthening strong resilience of the organization. To achieve this, it is necessary to deepen knowledge in the field of crisis management, change management, monitoring global trends, e.g. digital transformation, sustainable development and others. It is also important to develop communication, analytical and strategic skills using digital tools, take care of the development of self-awareness and empathy and cultivate ethical values, as well as orientation towards the implementation of innovations in the organization, openness to change and adaptation to them. The development of these competences will contribute to effective response to crisis situations and quick adaptation to changing environmental conditions.

Keywords: competences of managers, organizational resilience.

Category of the paper: Research Paper.

1. Introduction

Currently, the environment in which enterprises operate is very unstable, which is influenced by numerous unpredictable factors, e.g. the Covid-19 pandemic, floods, wars, high inflation and others. Unfortunately, few organizations can deal with this. These crises often lead to the collapse of organizations, as evidenced by numerous studies (Gittell et al., 2006; Chen, 2021; Putro, 2022). Only a resilient organization can survive the crisis by efficiently adapting to new challenges and rapidly changing external conditions. It is therefore important to support the resilience of the organization for its sustainable functioning.

The ability of an organization to survive or succeed in a changing and unpredictable environment is significantly influenced by the managerial staff, who are the carriers of norms and trust in the organization. Their competences in the form of knowledge, skills, attitudes, motivation or experience can help an organization survive in a complex and ambiguous business climate. Knowledge of technology, change management, emotional intelligence or strategic agility (Landry, 2019) are only a small part of the competencies important from the perspective of building strong organizational resilience. Knowledge, especially in the area of modern technologies, is becoming increasingly important in the context of digital transformation, as it enables managers to use it to implement innovation and operational efficiency (LeanIX, 2024). Change management expertise is also essential to ensure smooth transitions during organizational restructuring or in response to external disruptions (Rowland, Thorley, Brauckmann, 2023). Skills such as emotional intelligence, which includes self-awareness, empathy, and the ability to communicate effectively, are crucial for leaders who want to effectively lead their teams in difficult times (Landry, 2019) while building trust and positive relationships between employees. Leaders with high emotional intelligence can navigate interpersonal dynamics and foster team culture, which is essential for maintaining morale and productivity in the face of uncertainty. In addition, maintaining a competitive advantage requires strategic agility, which is the ability to quickly modify plans in response to the market (Elali, 2021). It can be stated that the indicated managerial competences are the basis for looking into the future and flexible adaptation to changing environmental conditions.

The aim of the article is to present the role and specificity of key managerial competencies that modern managers should have and develop in order to effectively build the resilience of the organization in a rapidly changing environment. The article reviews the literature critically and looks at the definitions of contemporary managerial competencies and how important it is to support organizational resilience. In addition, examples of good practices were analyzed, in which the indicated competences contributed to the survival of the organization in an unstable environment.

2. Organizational resilience and factors affecting it

In the era of pandemics, climate change, financial crises or increasing digitalization, organizations must not only survive but also develop in these difficult circumstances. Therefore, building organizational resilience plays an important role, strengthening its ability to survive in the face of crises, adapt to changing conditions and the ability to quickly respond to threats. The table below presents selected definitions of organizational resilience.

Table 1.
Selected definitions of organizational resilience

Author	Definition
Amisha, 2024	Resilience refers to an organization's ability to withstand and recover from disruptions, whether internal or external.
Goh, 2023	The ability of an organization to deal with and adapt to disruptive events—such as recessions, natural catastrophes, technological breakthroughs, or challenges from the marketplace—while preserving its essential operations, integrity, and long-term sustainability is known as organizational resilience.
Jia, Chowdhury, Prayag, Chowdhury, 2020	Organizational resilience is defined as the capacity of an organization to both prevent and respond to unexpected disruptions in a proactive manner (i.e., the reactive aspect) and to respond quickly and effectively to any disruption in order to ensure business continuity (i.e., the proactive aspect).
Duchek, 2020	Organizational resilience pertains to the capacity of an entity to identify possible hazards, manage unfavorable circumstances, and adjust to evolving circumstances.
Denyer, 2017	The ability of an organization to recognize, plan for, react to, and adjust to gradual changes and unexpected disturbances in order to continue operating and grow is known as organizational resilience.
Linnenluecke, 2017	The ability of an organization to recover, adapt, and bounce back in the face of disruptions is known as organizational resilience.
Vogus, Sutcliffe, 2007	Organizational resilience is defined as the capacity of an organization to withstand stress and enhance performance in the face of hardship.
United Nations, 2007	Resilience is the ability of a system or society exposed to threats to adapt to a new situation by resisting or making changes to maintain an acceptable level of functioning.

Source: own study.

Based on the definitions presented, it can be concluded that the resilience of an organization is the ability of a company to effectively cope with unexpected disruptions and crises by adapting and maintaining business continuity.

One of the most important elements of building an organization's resilience is strengthening its ability to adapt. Today's organizations operate in an environment where change occurs extremely quickly, so these organizations must efficiently adapt to changing conditions, which enables them to maintain a competitive position in the market. Another inseparable element of building resilience is risk management. Companies with risk management competencies are better prepared for unpredictable situations such as economic crises, supply chain disruptions, and cybersecurity issues. Resilient organizations identify potential risks and implement measures that minimize their impact on the organization's operations. A key aspect of building organizational resilience is also ensuring its business continuity. In the face of sudden disruptions, these companies must be able to operate without interruption. Strong resilience

mechanisms, such as business continuity plans, asset protection systems, and crisis management strategies, help companies stay operational in challenging conditions. Building the resilience of an organization is not limited to protecting it from the effects of crises. Companies that can effectively face challenges are also able to be more competitive in the market. Moreover, difficult circumstances often create the opportunity to implement innovative solutions that strengthen the company's position on the market.

Organizational resilience is influenced by factors such as: organizational resources; organizational competences; organizational relations; organizational communication; social capital; organizational strategy; organizational learning; passion for work; business model; organizational leadership; organizational trust; threat perception; cognitive competence; emotional competence; organizational effectiveness; organizational culture; organizational commitment; organizational changes; Responsibility; organizational structure. It is important that the organization is oriented towards strengthening them evenly, which will result in its potential to build a strong organization. An important role in all this is played by the managerial staff, their knowledge, skills, attitudes, motivations and experience allow them to quickly identify the factors causing the crisis and at the same time strengthen the organization and strive to get out of it, which in turn will ensure the balance of the organization and a stronger position on the market.

3. Contemporary competences of managers - literature review

Managerial competencies play an important role in building organizational resilience. Over the years, definition of competencies has evolved in management literature to encompass a wide range of attributes necessary for addressing modern challenges. The table below presents the definitions of competences by various authors.

Table 2.
Competences- definition overview

Author	Definition of competence
UNESCO International Bureau of Education, 2017	The combination of knowledge, abilities, and attitudes that enables people to solve issues, adapt to changes, and apply their knowledge in novel contexts.
Fukada, 2018	Skill that is developed via education and experience.
Tondeur et al., 2020	The capacity to carry out a task successfully and efficiently.
Vitello et al. 2021	The capacity to integrate and apply contextually appropriate knowledge, skills, and psychosocial elements (such as beliefs, attitudes, values, and motivations).
Pereira et al., 2023	Set of complex actions, including knowledge, skills, attitudes, and values, that are activated to effectively solve issues and interact in certain situations.
Robertson, 2023	Underlying characteristic of an individual, including motives, traits, self-concepts, attitudes, or values, as well as content knowledge or cognitive skills that drive superior performance in a job or task.

Cont. table 2.

Van Echtelt, 2024	<p>The capacity to perform a task successfully and efficiently. It consists of the following three components:</p> <p>Information. Knowledge and expertise specific to a position or sector</p> <p>Skills. A person's capacity to carry out a certain work or address an issue at a high level of expertise In.</p> <p>Character attributes and aptitudes. The attributes and capabilities that define and characterize a person</p>
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Source: Own study.

From the table above, it is evident that definitions of competence vary, reflecting different interpretations across fields.

The concept of competence can be considered both to the organization, human resources, as well as to the managerial staff. One of the approaches to the analysis of the concept of competence is to consider it in relation to the organization. Organizational competencies "are created through the integration and coordination of individual competences, they are a combination of the knowledge, skills and advantages of employees, but they are more than a simple sum of competencies and individuals." Another approach to the issue of competences is to consider them in relation to the employees of the organization. A distinction can be made here between competences related to human resources and competences related to managerial staff. According to P. Louart, "competences – are the professional abilities of employees (their knowledge, skills, experience, attitudes) considered in relation to the position held or their potential capabilities in relation to other types of activity. They have technical, social (connections with other people) and conceptual (creative) aspects. "In turn, managerial competencies are characterized as the motivations, personality traits, abilities, knowledge, and values required to enhance management performance (Gamarra, Giroto, Seguí, 2019). Other authors define managerial competencies as a subset of a broader category of individual competencies that include the drive, character attributes, skills, knowledge, and values required to enhance management performance (Gamarra, Giroto, Seguí, 2019). They present the observable knowledge, abilities, and attitudes what managers need to have in order to succeed in carrying out their responsibilities in a global context (Martínez, Hernández, Gómora, 2016). Managerial competences are also the set of skills, behaviors, and knowledge that managers need to perform their jobs effectively". These skills include problem-solving, communication, strategic thinking, and leadership (Torrington, Hall, Taylor, Atkinson, 2020).

On the basis of the analyzed literature, it can be concluded that managerial competencies are typically stand out components: knowledge, skills, attitudes, motivations, and experience. Each plays a significant role in the effectiveness of modern managers, particularly in their ability to foster resilience.

Being knowledgeable entails having taken in and processed a body of knowledge large enough to comprehend and formulate the spectrum of professional problems that we may realistically anticipate encountering. Although knowledge is a prerequisite for competence, it is not sufficient on its own (College of Alberta Psychologists, 2022). Modern managers

require knowledge beyond traditional business practices. They must understand digital transformation, sustainability, and global economic trends (ACPM Global, 2023). Knowledge of strategic management is also important because provides a solid foundation in strategic models, organizational behavior, and approaches for navigating transitions effectively (Ferreira, Mueller, Papa, 2020). Managers also must be well-versed in risk and change management and crisis preparedness, which have become critical as organizations face frequent disruptions, such as pandemics and environmental crises (Mizrak, 2024). Additionally, knowledge of cybersecurity measures is vital for protecting the organization's data and ensuring operational resilience in the face of potential threats.

Another important element of competence is skills, which are defined as specific learned actions that can vary greatly in complexity. By identifying a person's skill set, we can evaluate whether their education and work experience have adequately prepared them for a particular job (Škrinjarić, 2022).

In the literature, various divisions of skills are discussed, but the most typical classification is presented by R.L. Katz. Autor divides skills into three categories: technical, social, and conceptual. Most divisions proposed by other authors are similar in nature.

Technical skills: These involve specific knowledge and abilities required to perform specialized tasks. Involves the practical application of project management tools, data analysis, and risk assessment techniques, ensuring efficient execution and minimal disruption during transitions (Martins, 2024). In today's digital landscape, technological literacy is crucial for managers to effectively utilize digital tools, data analytics, and cloud-based platforms to streamline operations and make informed decisions (Ahmed Mohamed, Kinslin, 2020; Yeşilyurt, Vezne, 2023). Understanding how to implement and manage technology systems can help managers anticipate disruptions, quickly respond to challenges, and maintain continuity during crises.

Social skills - these encompass emotional intelligence (EQ), which contains self-awareness, empathy, and the ability to communicate effectively (Cavaness et al., 2020). Social skills are essential for leaders to manage teams effectively, fostering collaboration and maintaining morale, especially during times of crisis (Bhoumick, 2018). Molinillo S. and other authors also agree with this, and point out that Positive approach to social interaction supports collaboration, active engagement, and teamwork, strengthening organizational cohesion (Molinillo et al., 2018). Managers to build fostering trust and open communication within the team, they help to create a support network that can withstand setbacks. These leaders are also better equipped to navigate conflicts, provide emotional support, and motivate their teams, helping individuals stay focused and resilient during periods of uncertainty or organizational change.

Conceptual skills are indispensable for modern managers as they pertain to the ability to understand complex situations and anticipate future challenges (Gutterman, 2023). These skills include strategic thinking, critical analysis, and problem-solving, all of which allow managers

to foresee the long-term implications of their decisions. By thinking broadly and preparing for a range of potential outcomes, managers can build organizational resilience, ensuring the company can pivot quickly in response to external disruptions, such as economic downturns or industry shifts. Conceptual skills also enable managers to foster innovation, leading to the development of contingency plans and strategies that strengthen the organization's adaptability and long-term sustainability.

Together, technical, social, and conceptual skills empower modern managers to not only lead effectively but also build resilient teams and organizations that can thrive in dynamic, unpredictable environments.

Another important element of competence is attitude, understood as a manager's mindset or approach to their role. According to Calvert (2019). Attitudes are crucial for effective leadership, particularly in challenging circumstances. In a VUCA (Volatile, Uncertain, Complex, Ambiguous) environment, attitudes such as adaptability, openness to change, and resilience are essential for managing teams effectively. Managers with a growth mindset are more likely to inspire confidence in their teams and maintain stability during crises.

At the heart of effective leadership lies the concept of motivation, which serves as the internal drive propelling managers toward achieving organizational goals. This internal drive encompasses professional aspirations, ethical values, and a strong commitment to long-term objectives (Fahriana, Sopiah, 2022). Leaders motivated by the principle of long-term organizational resilience are more inclined to implement strategies that prioritize sustainability and risk mitigation. Such a commitment ensures that managers not only address immediate challenges but also focus on the long-term success and stability of the organization (Freudling, 2020). By cultivating a motivated leadership team, organizations are better equipped to navigate uncertainties and position themselves for sustained growth in a dynamic business environment.

Experience plays a vital role in effective leadership. It is defined as the cumulative knowledge and skills gained through practical exposure in various roles and responsibilities (Michel, 2022). Experience plays a vital role in shaping a manager's ability to deal with crises and lead organizations through change. Managers with extensive experience in managing change or navigating crises are better equipped to foster organizational resilience by anticipating potential disruptions and crafting strategic responses to mitigate risks (Molek-Winiarska, 2022).

The competencies outlined above knowledge, skills, attitudes, motivations, and experience are critical in fostering organizational resilience. Managers play a crucial role in building resilience by effectively leading their teams through periods of uncertainty and driving adaptive strategies.

On the basis of the analysis presented, the table below shows the model of contemporary managerial competencies important for building organizational resilience and the possibilities of their improvement.

Table 3.*Model of contemporary managerial competencies important for building organizational resilience*

Element of competence		Specific areas	Characteristics	Improvement
Knowledge		Risk management	Identify, analyze, and minimize potential risks and uncertainties before a problem occurs.	Training, courses, application of ISO 31000 norms and standards, case studies
		Crisis management	Respond quickly to actions that occur during a crisis to minimize its effects and restore the normal functioning of the organization.	Training and workshops, crisis simulations, case studies
		Change management	Planning, coordinating and supporting activities aimed at the effective implementation of changes in the company.	Training, courses, use of change management tools
		Strategic management	Creating contingency plans, scenarios that predict various possible crisis situations.	Training, courses, workshops, use of tools in the field of strategic analysis
		Global trends in the environment	In particular, knowledge in the field of digital transformation, sustainable development – including the concept of corporate social responsibility (CSR), climate change, cyber threats and others.	Regular tracking of trends, networking with professionals, participation in trainings
Abilities	Technical	Use of digital tools	Faster decision-making, improved security, protection against cyber threats, greater flexibility to adapt to a changing environment, as well as greater innovation and operational efficiency.	Attending courses and training on specific digital tools
		Data analysis	It enables you to anticipate and prepare for and mitigate risks.	Getting to know analytical tools, case studies
		Management of technological systems	Anticipate disruptions, respond quickly to challenges, and maintain continuity in crisis situations.	Trainings and specialist courses in the field of information systems management, network technologies or project management, analysis of industry literature
	Social	Self-conscious	The ability to reflect on one's own life, emotions, thoughts and needs. This skill allows you to understand yourself and your reactions in various situations, which is necessary for effective management of emotions and relationships with others, as well as translates into better decision-making and positive interpersonal relationships.	Using mindfulness exercises, practicing meditation, reflection, openness to feedback
		Empathy	The ability to empathize with the emotions of others and understand their motives and needs. This allows you to build trust and commitment of employees in the organization.	Practice attention and observation, active listening
		Communicate effectively	The ability to convey clearly and coherently precise information, which facilitates a better understanding of organizational goals, in addition, effective communication enables managers to effectively resolve conflicts in the team, which is crucial in crisis situations.	Training, workshops, cooperation with mentors or coaches

Cont. table 3.

	Conceptual	Strategic thinking	Managers who think strategically are able to predict changes in the market environment and adapt their operating strategies accordingly, which increases the organization's ability to adapt in the face of crises.	Defining the vision of the future of the organization and goals to be achieved in the long term, analyzing opportunities and threats, strengths and weaknesses of the organization, participation in workshops and trainings
		Critical analysis	Critical analysis allows for a more accurate assessment of the consequences of decisions made, which is conducive to the implementation of more thoughtful actions in the face of a changing environment.	Collecting and analyzing various sources of information. Analysis and evaluation of materials from the perspective of their credibility, purposefulness or impact on the context.
		Problem solving	This ability allows you to quickly identify threats and solve problems, making the organization more flexible and resilient to change.	Using creative thinking techniques and other tools, e.g. (cause and effect diagrams, mind maps) to better visualize problems and related dependencies.
Attitudes and motivations		Adaptability	The ability to adapt to changing market conditions allows for a flexible response to crises and unforeseen challenges.	Openness to different perspectives and the search for innovative solutions.
		Openness to change	Being open to new ideas and innovations allows the organization to quickly adapt strategies to changing needs and circumstances.	Development of flexible thinking through modification of views or strategies, comprehensive development in various areas
		Commitment to tasks	faster identification of the problem and response to changing conditions, which makes it easier for the organization to go through crisis situations.	Setting clear, precise goals, developing soft skills, e.g. time management, coping with stress
		Ethical values	Ethical behavior contributes to building strong and harmonious teams. Managers who support ethical values become an authority for employees, which fosters better cooperation and efficiency, and fosters the building of social capital in the organization.	Development and implementation of a code of ethics, which defines standards of behavior and values, ethical conduct in the activities carried out, building a culture of openness, participation in training in this area
Experience		Proper analysis of the situation and making the right decisions	Experience allows us to better predict and respond to the changing environment and crises, which allows organizations to adapt faster to changing market conditions. It is crucial for an organization's ability to survive and thrive in challenging environments.	They are acquired over the years through professional and life experience, as well as participation in trainings, courses, workshops, apprenticeships, as well as through other forms and activities

Source: Own study.

The table above presents a model of contemporary competences of managers important from the perspective of building organizational resilience. Based on the literature review it was found that its most important elements include knowledge of risk, crisis, change and strategic management, as well as global trends in the environment. Technical skills in the form of using digital tools, data analysis, managing technological systems. Social skills in the form of self-

awareness, empathy and effective communication, as well as conceptual skills such as strategic thinking, critical analysis and problem solving. Among the attitudes and motivations that are also part of competence, the ability to adapt, openness to change, commitment to the implementation of tasks, cultivated ethical values and both professional and life experience were distinguished. The table also indicates opportunities for further improvement of managerial competences, among others through active participation in various types of training, courses, cooperation with experienced mentors or coaches, as well as all kinds of workshops or internships.

4. Examples of best practices in using modern managerial competencies in the context of building organizational resilience

Organizations depend on the competences of their managers to reduce risks and uncertainty, and guarantee survival during times of crisis. Organizational resilience is greatly enhanced by managerial competences, which include knowledge, technical, social, and conceptual abilities, as well as attitudes, motivations and experience (Vitello, Greator, Shaw, 2021). This section presents these examples to managerial competencies and their function in fostering organizational resilience by providing real-world examples of how particular managerial competencies support organizational survival and adaptation during crises.

Managerial knowledge in crisis management, global trends, and cybersecurity is crucial for informed decision-making during disruptions. For instance, during the COVID-19 pandemic, companies with a deep understanding of crisis management frameworks were better prepared to respond swiftly and mitigate damage (Lengnick-Hall, Beck, Lengnick-Hall, 2011). A good practice example is organizations that proactively monitored global trends like digital transformation and sustainable development. Leaders knowledgeable about digital tools and their business impact rapidly implemented remote work solutions and adjusted business models to sustain operations (Almeida, Santos, Monteiro, 2020). For example the CEO of General Motors (GM), demonstrated managerial competencies in building organizational resilience, particularly during the COVID-19 pandemic and the company's transition to electric vehicles (EVs). Her strategic foresight, adaptability, and ability to manage crises were evident when GM quickly retooled its factories to produce ventilators and personal protective equipment during the pandemic, showcasing the company's agility in responding to a national crisis (Sorkin, de la Merced, Friedman, Hirsch, 2020). Additionally, long-term focus on sustainability and electric vehicle innovation has positioned GM for future success in a rapidly changing industry, demonstrating resilience by aligning with global market and regulatory shifts (Ivanova, 2021).

Furthermore, as the use of digital platforms increased and cyber-attacks escalated, cybersecurity education became crucial. Cybersecurity protocols managers preserved operational integrity and safeguarded confidential data in a digital setting (Ahmad, Maynard, Shanks, 2015). This kind of foresight emphasizes how crucial knowledge is for identifying hazards and putting plans in place to strengthen organizational resilience.

Technical skills - including proficiency with digital tools, data analysis, and technological system management - enable organizations to adapt to rapid changes. Companies that successfully transitioned to remote work during crises often did so because their managers were skilled in using digital collaboration platforms like Microsoft Teams and Zoom (OECD, 2020). Integrating data analytics helped managers make data-driven decisions on resource allocation and supply chain adjustments, critical for navigating uncertainty (Srinivasan, Swink, 2017). One real-life example of technical skills in managerial competencies for building organizational resilience is SpaceX. Deep technical expertise in aerospace engineering played a critical role in the company's ability to innovate and survive in a highly competitive and high-stakes industry. CEO of SpaceX actively contributed to rocket design and problem-solving, enabled SpaceX to overcome multiple early failures and eventually achieve historic successes, such as launching the Falcon 9 rocket and pioneering the reusable rocket technology. This technical knowledge allowed organization to make informed decisions, push for innovation, and navigate the complex technical challenges that have enabled SpaceX to establish itself as a leader in the space industry (Vance, 2015). Another interesting example is a retail organization used predictive analytics to track shifts in consumer behavior during the pandemic. Managers analyzed this data in real time to adjust inventory and marketing strategies, ensuring supply chain efficiency and customer satisfaction (Queiroz et al., 2020). This demonstrates how technical competence in digital tools and data analytics directly influences organizational resilience.

Emotional intelligence is also an important component of managerial competences. Understanding emotional intelligence and communicating well are essential for keeping morale up and team together in times of crisis. Strong emotional intelligence managers foster supportive work environments where people feel valued despite outside demands. This includes having empathy and self-awareness (Goleman, 2017). Organizations where leaders maintained open communication during the pandemic reduced anxiety and fostered trust (Dirani et al., 2020). Interesting example of social skills that contribute to building organizational resilience can be Starbucks. Managers of this organization are well-known for his exceptional interpersonal skills and ability to foster a strong organizational culture. During challenging periods, such as the 2008 financial crisis, organization prioritized open communication and employee engagement, recognizing that a motivated workforce was essential for resilience. Starbucks implemented initiatives like providing health benefits to part-time employees and engaging in active dialogue with staff to understand their concerns and needs. This focus on relationship-building and empathy helped create a committed workforce that was better

equipped to adapt to changing market conditions and economic challenges. This competence not only strengthened employee morale but also reinforced customer loyalty, allowing Starbucks to navigate through crises more effectively (Schultz, Gordon, 2011). Other interesting example is a global corporation developed well-being programs under the direction of emotionally aware managers. These featured venues for employees to air problems and resources related to mental health. These methods demonstrate how compassionate leadership strengthens organizational resilience through building a driven workforce in facing situations of adversity (Rudolph et al., 2021).

Conceptual skills like strategic thinking, critical analysis, and problem-solving are integral to organizational survival during crises. Managers with strong strategic thinking can foresee risks and opportunities, enabling pivots in business models and resource redeployment (Mintzberg, 1994). Companies in the hospitality industry that survived the pandemic redefined strategies by expanding into new markets, such as offering delivery services to counteract declines in traditional operations (Jones, Comfort, 2020). An exemplary instance of conceptual skills in managerial competencies that contribute to organizational resilience can be seen in PepsiCo. The managers of the organization demonstrated remarkable conceptual skills by strategically reorienting the company's vision to focus on sustainability and health amid changing consumer preferences. Recognizing the growing concern for health and wellness, they led the "Performance with Purpose" initiative, which aimed to reduce sugar, sodium, and saturated fats in PepsiCo's products while promoting environmental sustainability and positive social impact. Managers ability to conceptualize and implement this long-term strategy helped PepsiCo adapt to market changes, maintain competitive advantage, and build resilience against economic downturns. This approach not only diversified the company's product offerings but also aligned PepsiCo with evolving consumer values, ultimately contributing to its sustained growth and success in a volatile market (Nooyi, 2018). Critical thinking was also crucial in managing supply chain disruptions during COVID-19. Manufacturing leaders employed problem-solving to develop alternative supply chains and adapt production lines to changing demand (Ivanov, Das, 2020). This strategic foresight underscores the importance of conceptual skills in building resilient organizations.

Another important element of competences are attitudes and motivations. A leader's attitude including adaptability, openness to change, and commitment to innovation significantly influences an organization's ability to weather crises. Managers who exhibit adaptability and embrace change guide their organizations more effectively through volatile environments (UNESCO International Bureau of Education, 2024). During the digital shift caused by the pandemic, organizations led by managers open to new technologies pivoted to e-commerce or virtual services faster than competitors (McKinsey & Company, 2020). An illustrative example of attitudes and motivations in managerial competencies that foster organizational resilience is Microsoft. Managers of this organization adopted a growth mindset, which emphasizes learning, adaptation, and resilience in the face of challenges. Their belief in empowering employees and

fostering a culture of collaboration and innovation was critical in transforming Microsoft into a more agile organization. By encouraging open communication and valuing diverse perspectives, managers motivated employees to embrace change and pursue continuous improvement. This shift in attitude not only revitalized Microsoft's workforce but also led to significant advancements in cloud computing and artificial intelligence, helping the company recover from stagnation and thrive in the competitive tech landscape (Nadella, 2017). This situation exemplifies how positive attitudes and motivations can cultivate resilience and adaptability within an organization. Innovation commitment is also crucial for resilience. Organizations that promoted innovation gave managers the freedom to test out innovative processes and offerings, exploiting chances in an environment of change. During the epidemic, companies in the automotive sector led by innovators changed their focus to manufacturing vital medical supplies, enabling them to continue operating and meeting the requirements of the public at large (Chesbrough, 2020).

Managerial experience in dealing with previous crises is invaluable. Managers who have navigated past challenges can anticipate problems and devise effective solutions. Studies show that leaders with prior crisis experience implemented risk mitigation strategies early during COVID-19 (Wenzel, Stanske, Lieberman, 2020). For example, experienced airline industry managers applied lessons from the 2008 crisis to streamline operations and renegotiate supplier contracts, helping them stay afloat during travel restrictions (Franke, John, 2011). Managers with experience in cross-cultural communication and global operations responded more agilely to international supply chain disruptions due to prior knowledge of logistics solutions and regulatory environments (Van Hoek, 2020). This highlights experience as a crucial competency in enhancing organizational resilience.

Managers' ability to leverage their knowledge, technical and social skills, conceptual thinking, attitudes, motivations and experience is essential for building organizational resilience during crises. Each competency plays a pivotal role in how effectively an organization adapts and thrives amid uncertainty.

5. Conclusion

The article highlights the critical role of today's managers in building organizational resilience in a rapidly changing and unpredictable business environment. Managerial competencies such as knowledge, technical, social or conceptual skills, as well as attitudes, motivations and experience play an important role in effective crisis management and innovation. The development of these competencies enables organizations not only to survive, but also to thrive in the face of challenges such as pandemics, climate change, economic crises,

digital transformation, and more. On the basis of the analysis, the following conclusions of a research and utilitarian nature were drawn.

- Organizational resilience is a key ability of a company to cope with unforeseen disruptions, crises or maintaining business continuity. It means not only survival, but also quick adaptation to new conditions in order to continue functioning and development.
- The factors that strengthen the resilience of an organization include, among others: organizational resources, competences, communication, social capital, strategy, organizational culture and trust.
- A key role in strengthening the resilience of the organization is played by the managerial staff, in particular their competences in the form of knowledge, skills, attitudes, motivation and experience.
 - Managers' knowledge should cover areas such as risk, crisis and change management, as well as knowledge of global trends such as sustainable development or digital transformation.
 - Technical skills in digital tools and data analytics are crucial for faster decision-making and flexible response to change. Social skills such as empathy, emotional intelligence and effective communication support building trust and cooperation in teams, which is crucial in difficult times. Conceptual skills, including strategic thinking and problem-solving, allow managers to better anticipate market changes and innovate strategies.
 - Managers' attitudes and motivations, such as openness to change, ethical approach, and commitment, support building organizational resilience.
 - Experience in managing past crises allows you to better deal with future challenges, which strengthens the organization's ability to adapt and maintain business continuity.
- It is important to continuously develop competences through active participation in courses, trainings, workshops, internships or by cooperating with experienced mentors and coaches.

Improving these competencies is crucial for building strong and resilient organizations, capable of flexibly adapting to changing market conditions and effectively dealing with crises.

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DETERMINANTS OF NATURAL FOOD CHOICE – STUDIES AMONG POMERANIAN CONSUMERS

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Purpose: The purpose of the study was to identify variables influencing consumer interest in natural foods among a selected group of Pomeranian consumers.

Design/methodology/approach: The research instrument was a survey questionnaire administered through the CAWI method using Google forms. The survey was conducted in a group of 403 respondents in Pomerania, northern Poland. The research tool used covered the following topics: attitudes towards natural food, attitudes towards health and nutrition, and lifestyle elements. Spearman's rank correlation analysis was applied, and a multinomial ordered logit model was constructed, in which the dependent variable was the variable exploring attitudes towards health and nutrition.

Findings: An extended statistical analysis of the empirical data, with the construction of a multivariate logit model, showed that only a change in the attitudes of Pomeranian consumers towards health from negative and ambivalent to positive, would lead to a change in their eating behaviour by increasing the purchase and consumption of natural foods. It is interesting to note that Pomeranian consumers who value the convenience and speed of meal preparation want to make conscious, rational (beneficial to their health) food choices.

Research limitations/implications: The research has certain limitations. Despite the large size of the study group, the results obtained are not representative and cannot be generalised to the population of adult consumers in Poland.

Practical implications: An analysis of respondents' attitudes towards health issues and consumption of natural foods showed that gender and lifestyle have a differential impact on consumers' attitudes towards health and willingness to purchase natural foods (in Northern Poland).

Social implications: Extended statistical analysis of empirical data by building a multivariate logit model showed that only a change in the attitudes of Pomeranian consumers towards health from negative and ambivalent to positive would lead to a change in their eating behaviour by increasing the purchase and consumption of natural foods.

Originality/value: The presented modelling approach extends the knowledge of the determinants of natural food consumption.

Keywords: natural food, health concern, sustainable behaviour, consumers, Northern Poland.

Category of the paper: Research paper.

1. Introduction

The Lifestyle is a variable that determines human behaviour in various aspects of life and has therefore become a subject of analysis for researchers from different scientific disciplines. This has resulted in diversity in its interpretation and definition (Syrek, 2022; Siciński, 1980; WHO). Lifestyle is defined as a configuration of attitudes and behaviours, choices and habits that condition an individual's daily life (Rogo, 2016). This approach has been found to be particularly important in the context of studying generational differences (Syrek, 2022). Hence, lifestyles are determined by the choices and behaviours of individuals, which are determined by their attitudes. An attitude is defined as a positive or negative attitude towards attitude objects, which can be persons, groups of people, situations or other objects (foods, objects, institutions, symbols, phrases, slogans, ideals) (Thurstone, 1946; Eagly, Chaiken, 1993; Engel et al., 1993; Jeżewska-Zychowicz, Pilska, 2009; Meiselman 1996; Reber, Reber, 2001; Wojciszke, 2000). Attitudes are located between two extremes: a strongly positive attitude and a strongly negative attitude (Wojciszke, 2000). The literature also defines attitude as a cognitive-behavioural structure oriented towards the attitude object, constituted by three components: cognitive, emotional and behavioural (Gutkowska, Ozimek, 2005; Stasiuk, Maison, 2014). An attitude can also be described in a wider sense, namely as a reaction that expresses itself in: a) beliefs, consisting of an individual's knowledge, perceptions and beliefs about an object; b) feelings, which are reduced to liking or disliking an object; c) intentions, which are the readiness to behave in an appropriate manner (Wosińska, 2004).

The influence of attitude on intention to behave and behaviour itself has been analysed in numerous scientific papers (e.g. Ajzen, Fishbein, 1975, 1980, 2000; Bagozzi, 1981; Bagozzi et al., 2000; Eagly, Chaiken, 1993; Leone et al., 1999; Itzhakov, Reis, 2021). There are four types of attitudes: negative, positive, indifferent and ambivalent. The last of these is characterised by the simultaneous presence of positive and negative attitudes towards an object and often applies to food products and certain behaviours (e.g. contraceptive use, cigarette smoking) (Stasiuk, Maison, 2014). Due to their complex nature, ambivalent attitudes are more easily changed than their other types. An ambivalent attitude is very often adopted towards an unfamiliar food (Van Harreveld et al., 2015) and results from an aversion towards the attitude object while at the same time feeling the importance of this object, which causes the individual to feel internally torn and indecisive. Because such an attitude poses a kind of threat to the

individual, people are motivated to resolve their ambivalent beliefs in order to restore cognitive coherence (Van Harreveld et al., 2009).

Environmental problems and their adverse impacts on humans have become an important issue to be analyzed by academics (researchers), governments and organizations, and their managers, especially when organic foods are considered (Eberle et al., 2023). Economic development has generated environmental degradation. The environment has changed considerably worldwide because of factors such as climate change, air and water pollution, waste generation and natural disasters (Maichum et al., 2016). Following this reality, the consumer begins to demonstrate this concern with the environment, opting for environmentally friendly, sustainable or green products (Yadav, Pathak, 2016; Qi, Ploeger, 2021). Consumers buy organic food, mostly because of health concerns, to avoid contamination by chemical waste, concern about the sustainability of the environment, and because these foods are associated with greater nutritional value (Seufert, Ramankutty, 2017; Eberle et al., 2022). Environmental awareness is increasingly shaping consumption patterns, especially in developed markets, influencing purchasing habits and decisions in the organic food segment (Wierzbinski et al., 2021). Responsible consumers are influenced by the environment in which they live and demographic, socioeconomic and cultural characteristics combined with the personality and voluntary attitudes directed to environmentally correct aspects (Zhang et al., 2019; Melovic et al., 2020). In this sense, it appears the consumer's ecological awareness positively influences the consumer's attitude toward the consumption of organic food (Rana, Paul, 2020; Jäger, Weber, 2020). Conscious consumption can be defined as the act of consuming, simultaneously optimizing the environmental, social and economic consequences of the acquisition, use and willingness to meet the needs of current and future generations (Phipps et al., 2013; Lira et al., 2022). The attitude of choosing and buying organic foods is guided by the health benefits that this type of food can bring (Bian, Forsythe, 2012; Farias et al., 2019) and promoting the good living and quality of life (Balderjahn et al., 2018). The attitudes of consumers, with concerns regarding ecological aspects, are influenced by their knowledge and principles, and they expect from green or ecologically correct products the satisfaction of their needs and environmental benefits, which are additional values (Rana, Paul, 2017). Some studies have suggested the need to test the influence of consumer attitude in the purchase intention of organic foods (Aitken et al., 2020; Dangi et al., 2020; Zaremohzzabieh et al., 2021).

The aim of the study was to identify variables influencing consumer attention to natural foods among a selected group of Pomeranian consumers. The following research hypotheses were formulated:

- H1. Consumer attitudes towards natural products may be related to health and nutrition attitudes.
- H2. Variables describing lifestyle may influence attention to health and nutrition.

2. Research methodology

The survey was conducted in spring 2024 among 410 Pomeranian consumers living in Gdynia, Sopot and Gdansk (northern Poland). Respondents were recruited using a snowball technique. Information was collected on the demographics of the respondents: gender, age, monthly income. The study group was dominated by people describing their financial situation as “I/we can afford some, but not all expenses” (36.63%) and “It allows me/us to satisfy only elementary needs” (22.28%). The detailed characteristics and structure of the research sample are presented in Tables 1-2.

Table 1.

Study sample characteristics

Parameters	Number of Respondents [n]	Percentage [%]
Gender		
Female	201	49.87
Male	202	50.13
Age [years]		
19-24	158	39.21
25-29	108	26.80
30-34	44	10.92
35-39	46	11.41
40-44	25	6.20
45-49	12	2.98
50-54	7	1.74
55-59	3	0.74

Source: own elaboration based on survey results.

Table 2.

Self-assessment of financial situation

Income	Women		Men	
	[n]	[%]	[n]	[%]
Is totally inadequate	3	1.49	2	0.99
Allows me/us to meet only elementary needs	13	6.47	45	22.28
I/we can afford some but not all expenses	86	42.79	74	36.63
I/we can afford everything	67	33.33	39	19.31
I/we can afford everything and I/we can still save	32	15.92	42	20.79

Source: own elaboration based on survey results.

The empirical material consisted of results obtained using the CAWI (Computer-assisted web interview) survey technique (via Google Forms). All respondents gave their free, informed consent to participate in the study and were assured of its anonymity.

The survey instrument consisted of the following scales:

- Lifestyle. It measured 10 statements: “I am a person committed to work” (1), “I am a person committed to study” (2), “I am a pleasure-oriented person” (3), “I value convenience and short preparation time of the meals I eat” (4), “I am a person who pays attention to the consumption of food with high nutritional value” (5), “I am a person who values the culinary traditions of the region I come from” (6),

“I am a person with high health awareness” (7), “I am a person with high physical activity” (8), “I pay attention to the state of my health” (9), “I pay attention to what food I eat” (10). The first, fifth, sixth, and seventh items were adapted from Arvola et al. (2007) and the others (2, 3, 4, 8, 9, 10) were additional.

- Health and Nutrition Attitudes Scale. The scale developed by Roininen and Tuorila (1999) was used in this study. The scale consists of 10 statements: “I am afraid that I will get fat” (1), “I am afraid that I will develop hypertensive disease” (2), “I am afraid that I will develop coronary heart disease” (3), “I am concerned that my diet provides a lot of energy” (4), “I am concerned that my diet provides a lot of fat” (5), “I am concerned that my diet provides a lot of cholesterol” (6), “I am concerned that my diet provides a lot of sugar” (7), “I am concerned whether my diet provides enough energy” (8), “I am concerned that I consume foods containing additives” (9), “I am not concerned that my diet provides a lot of salt” (10). In line with the methodology, reverse scoring of the respondents' answers to statement number 10 was used: “I am not concerned that my diet provides a lot of salt”.
- Attitudes Towards Natural Products Scale. The study used a scale developed by Roininen and Tuorila (1999). The scale consists of 6 statements: “I don't pay attention to the additives present in the food I eat every day” (1), “I try to eat food that does not contain additives” (2), “Food with artificially enhanced taste is harmful to my health” (3), “I don't eat processed food because I don't know what it contains” (4), “Organically produced food is no better for my health than conventionally produced food” (5), “I would like to eat only organically produced vegetables” (6). In accordance with the methodology, reverse scoring was used for the respondents' answers to statements numbered: 1 – “I don't pay attention to additives present in the food I eat every day”, and 5 – “Organically produced food is not better for my health than conventionally produced food”.

During the survey, the respondent expressed his or her level of approval or disapproval of all posted items using a 5-point Likert scale, where the values 1 and 2 mean “definitely no” and “mostly no”; the value 3 means “don't know/don't have an opinion”; and the values 4 and 5 mean “mostly yes” and “definitely yes” (Likert, 1932).

After recoding the statements, the answers were summed and the following two indicators were calculated: mean value (X) and standard deviation (SD). In addition, three categories of attitudes were distinguished, corresponding to negative, ambivalent and positive attitudes.

In addition, the empirical material collected was presented in the form of a percentage distribution of the answers given regarding attitudes and lifestyle determinants (the answers were aggregated and presented for 3 groups: “no” (the number of “definitely no” and “mostly no” responses were aggregated); “don't know/don't have an opinion” and “yes” (the number of “definitely yes” and “mostly yes” responses were aggregated).

Spearman's rank correlation analysis was used to establish the relationship(s) between lifestyle and attitudes towards health and nutrition, and lifestyle and interest in natural products.

A multinomial ordered logit model was fitted in which the dependent variable was a variable examining attitudes towards health and nutrition. The explanatory variables were concern for health and nutrition, and attitudes towards natural products. The objective variable was selected lifestyle attributes: "I am a pleasure-oriented person", "I am a person who values the culinary traditions of the region I come from", "I value convenience and short preparation time of the meals I eat", "I am a person with high health awareness", "I am a person with high physical activity". A validity table was used to check the quality of the model. The calculated R^2 was 54%.

A significance level of $p < 0.05$ was assumed for all statistical analyses. Calculations were performed using Excel 2000 and Statistica 13.3 (Tibco Software, Palo Alto, USA).

3. Results and discussion

3.1. Attitude towards health and nutrition and natural foods

The study group was dominated by people with ambivalent (37.22%) and positive (36.97%) attitudes towards health and nutrition. In the women's group, a similar proportion of people with negative to positive attitudes was observed, while in the men's group, almost three times fewer people with negative attitudes (16.83%) towards health and nutrition were observed, compared to those with ambivalent and positive attitudes (Table 3).

For attitudes towards natural foods, ambivalent attitudes were observed as the dominant attitude both in the whole group (56.33%) and among women (56.72%) and men (55.94%) (Table 4).

Table 3.

Attitude towards health and nutrition

Attitude	Whole group		Women		Men	
	[n]	[%]	[n]	[%]	[n]	[%]
negative	104	25.81	70	34.82	34	16.83
ambivalent	150	37.22	65	32.34	85	42.08
positive	149	36.97	66	32.84	83	41.09

Source: own elaboration based on survey results.

Table 4.

Attitude towards natural foods

Attitude	Whole group		Women		Men	
	[n]	[%]	[n]	[%]	[n]	[%]
negative	81	20.10	36	17.91	45	22.28
ambivalent	227	56.33	114	56.72	113	55.94
positive	95	23.57	51	25.37	44	21.78

Source: own elaboration based on survey results.

Environmental problems and their negative impact on people have become an important issue analysed by scientists, governments and organisations and their managers, especially as regards organic food. Environmental awareness, healthy consumption, consumer attitude and price consciousness are the most important determinants of purchasing organic food. An important aspect of stewardship is the promotion of ecological behaviour focusing on the ecological development of the environment (Parashar et al., 2023).

3.2. Health and nutrition and the attitudes of Pomeranian consumers towards natural foods

Based on the analyses of the empirical data, significant positive and negative correlations were observed for a number of statements from the Health and Nutrition Attitudes Scale and the Attitudes Towards Natural Products Scale, which differed between women and men. The highest correlations were observed between the statements “I am concerned that my diet provides a lot of sugar” and “I am not concerned that my diet provides a lot of salt” and statements from the Attitudes Towards Natural Products Scale (Table 5). The strongest correlations were observed in the group of women afraid that “I will develop coronary heart disease”, including a significant negative correlation (-0.61) for the statement “I don't pay attention to the additives present in the foods I eat every day”. Thus, the less concerned women are about the potential occurrence of coronary heart disease, the more they definitely do not pay attention to additives present in food. For comparison with the male study group, it was found that among men a low negative correlation was observed for this question (-0.33). Significant moderate correlations were observed for women stating “I am worried that I will develop hypertensive disease” (positive correlation 0.54) and the desire to “eat only organically produced vegetables” and for women stating “I am not concerned about them providing a lot of salt in my diet” (negative correlation -0.54) versus the desire to ‘consume only organically produced vegetables’. Significant moderate correlations were also observed for men stating “I am concerned that they provide a lot of sugar in my diet” (positive correlation 0.54) and the statement “Food with artificially enhanced taste is harmful to my health” (Table 5). Interestingly, for the statement “I don't pay attention to the additives present in the food I eat every day”, almost twice as weak correlations were observed among men, compared to women, for most of the statements on the Attitudes Towards Natural Products Scale. Furthermore, for two statements of the Health and Nutrition Attitudes Scale - “I am afraid that I will get fat” and “I am concerned that my diet provides a lot of energy” – significant correlations were observed only for men (Table 5). For the statement “I don't pay attention to the additives present in the food I eat every day” (Attitude Towards Natural Products Scale), significant correlations with the statements of the Health and Nutrition Attitudes Scale were observed mainly for women. Only for the statement “I am concerned that my diet provides a lot of sugar” was a similar correlation observed for women and men (0.49 and 0.46 respectively), and for the statement “I am not concerned that my diet provides a lot of salt” a significant negative

correlation (-0.20) was observed for women and a significant positive correlation (0.17) for men (Table 5). The statement “Food with artificially enhanced taste is harmful to my health” was more often observed to have significant (mostly negative) correlations with the statements of the Health and Nutrition Attitudes Scale for men (Table 5). Some interesting differences were observed between women and men. For example, for the statements “I don't eat processed foods because I don't know what they contain”, “I am concerned that I will develop coronary heart disease”, “I am concerned that my diet provides a lot of fat” and “I am concerned that my diet provides a lot of cholesterol”, a significant positive correlation was observed in women and a significant negative correlation in men (Table 5). Interesting differences were also observed between women and men for the statement “Organically produced food is not better for my health than conventionally produced food”. More significant correlations were observed in the female group than in the male group. Furthermore, for the statements “I am concerned whether my diet provides enough energy” and “I am concerned that my diet provides a lot of sugar”, negative correlations were observed in women, while positive correlations were observed in men (Table 5). For the statement “I would like to eat only organically produced vegetables”, slightly higher correlation coefficient values were observed among women than among men. Also, for two statements – “I am afraid that I will get fat” and “I am concerned that my diet is providing a lot of sugar” - significant negative correlations were observed in women and positive correlations in men (Table 5).

Table 5.

Correlations of statements of the Health and Nutrition Attitudes Scale and the Attitudes Towards Natural Products Scale by gender of respondents

Statements on the scales	*I don't pay attention to the additives present in the food I eat every day		I try to eat food that does not contain additives		Foods with artificially enhanced taste are harmful to my health		I don't eat processed foods because I don't know what they contain		Organically produced food is no better for my health than conventionally produced food		I would like to consume only organically produced vegetables	
	W	M	W	M	W	M	W	M	W	M	W	M
**I am afraid of getting fat	0.02	-0.25	-0.23	0.13	0.17	0.06	-0.09	0.01	0.27	0.09	-0.17	0.27
I am afraid I will develop hypertensive disease	-0.47	-0.31	0.15	-0.12	-0.19	-0.30	0.14	-0.24	-0.51	-0.05	0.54	0.35
I am concerned that I will develop coronary heart disease	-0.61	-0.33	0.11	-0.07	-0.14	-0.33	0.15	-0.25	-0.49	-0.08	0.51	0.36
I am concerned that my diet provides a lot of energy	-0.47	-0.25	0.24	-0.04	-0.04	-0.20	0.14	-0.37	-0.42	0.16	0.51	0.34
I am concerned that my diet supplies a lot of fat	-0.51	-0.34	0.26	-0.11	-0.04	-0.33	0.21	-0.29	-0.44	0.07	0.53	0.30

Cont. table 5.

I am concerned that my diet provides a lot of cholesterol	-0.49	-0.35	0.23	-0.09	-0.05	-0.36	0.22	-0.27	-0.44	-0.09	0.48	0.38
I am concerned my diet provides a lot of sugar	-0.30	0.28	0.49	0.46	0.40	0.54	0.34	0.11	-0.26	0.22	0.25	-0.29
I am concerned that my diet provides a lot of energy	-0.01	-0.21	-0.16	-0.04	-0.25	-0.10	0.00	0.15	-0.19	-0.19	0.13	0.13
I am concerned that I am consuming foods containing additives	0.00	-0.02	-0.15	-0.04	0.00	-0.06	-0.19	-0.15	0.14	0.09	-0.12	-0.07
I am not concerned that my diet provides a lot of salt	0.41	0.22	-0.20	0.17	0.29	0.35	-0.20	-0.14	0.68	0.41	-0.54	-0.16

Explanatory notes: *Statements included on the Attitudes Towards Natural Products Scale; **Statements included on the Health and Nutrition Attitudes Scale; W – women; M – men; numbers in bold are statistically significant at $p < 0.05$.

Source: own elaboration based on survey results.

According to the literature, consumers show interest in consuming more organic food due to its alleged positive health effects, lower content of harmful substances and organoleptic qualities (Gundala, Singh, 2021). In addition, characteristics of food information-seeking consumers have been found to strengthen the relationship between attitudes towards consuming organic food and behavioural intention to consume organic food (Sadiq et al., 2021). Following relevant national guidelines would be beneficial for public health and the environment, and that alternative diets such as plant-based diets offer even less environmental impact. In order to promote sustainable dietary habits globally, the authors of the publication recommend revising the guidelines to prioritise sustainability, while taking into account regional contexts and cultural preferences. Such an approach may be key to promoting a dietary shift towards sustainability globally (Nguyen et al., 2016; Nguyen et al., 2017; De Groot, Steg, 2008). While controlling for cultural values, the findings show that personal values, specifically biospheric values, predict sustainable consumer patterns and that consumers' worldview moderates this relationship. Such findings may help practitioners to develop strategies to influence consumer intentions and behaviours concerning green products (Caniëls et al., 2021).

3.3. Extended data analysis using a multivariate ordered logit model

In the course of the research procedure, the target variable was assumed to be an ordinal variable: health and nutrition attitudes (categories: negative, ambivalent, positive), so a multinomial ordered logit model was constructed. The explanatory variables were lifestyle elements describing the surveyed group of Pomeranian respondents:

- “I am a pleasure-oriented person”;
- “I am a person who values the culinary traditions of the region I come from”;
- “I value convenience and short preparation time of the meals I eat”;
- “I am a person with high health awareness”;
- “I am a person with high physical activity”.

The independent variables were unbalanced, so the following response categories were combined: 1. mostly no and definitely no; 2. mostly yes and definitely yes. This resulted in 3 response categories: disagree, I don't know/ I have no opinion, agree (Table 6).

Table 6.
Multivariate ordered logit model

Variable	Category	Coef.	Std. Err.	t-value	p-value	95% confidence		OR
I am a pleasure-oriented person	I don't know, I have no opinion	0.074	0.583	0.127	0.899	-1.089	1.215	1.077
I am a pleasure-oriented person	I agree	-0.413	0.527	-0.785	0.433	-1.468	0.619	0.661
I am a person who values the culinary traditions of the region I come from	I don't know, I have no opinion	0.105	0.256	0.408	0.683	-0.398	0.609	1.110
I am a person who values the culinary traditions of the region I come from	I agree	0.320	0.273	1.172	0.241	-0.213	0.858	1.377
I value convenience and short preparation time of the meals I eat	I don't know, I have no opinion	3.729	0.538	6.938	0.000	2.701	4.814	41.645
I value convenience and short preparation time of the meals I eat	I agree	2.428	0.362	6.701	0.000	1.736	3.162	11.341
I am a person with high health awareness	I don't know, I have no opinion	-0.711	0.317	-2.244	0.025	-1.337	-0.093	0.491
I am a person with high health awareness	I agree	0.382	0.258	1.482	0.138	-0.123	0.888	1.465
I am a person with high physical activity	I don't know, I have no opinion	-1.137	0.246	-4.616	0.000	-1.625	-0.658	0.321
I am a person with high physical activity	I agree	-0.345	0.328	-1.051	0.293	-0.990	0.301	0.708
negative ambivalent		0.634	0.583	1.087	0.277	-1.089	1.215	1.077
ambivalent positive		2.596	0.598	4.340	0.000	-1.468	0.619	0.661

Explanatory notes: values in bold are significant at $p < 0.05$.

Source: own elaboration based on survey results.

Although the p -values suggest that some independent variables are statistically significant, the 95% confidence interval was also checked. If the confidence interval includes or crosses a value of 1, a statistically significant effect of the variable cannot be confidently stated (Figure 1).

Assuming a significance level of 5%, the statistically significant variables were: I think I am a person who values convenience and speed of food preparation (categories: don't know, agree), I think I am a person with high health awareness (category: don't know), I think I am a person with high physical activity (category: don't know).

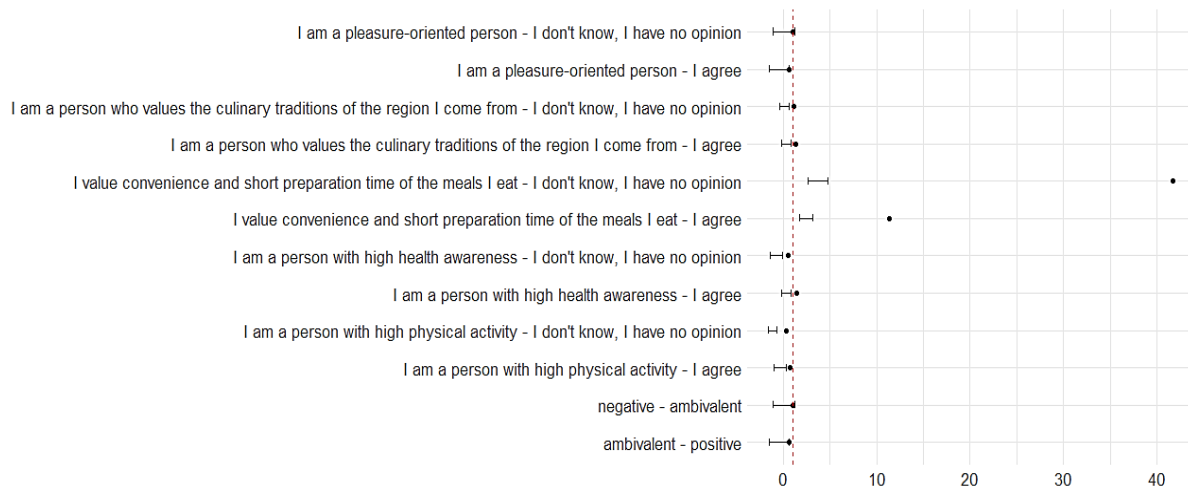


Figure 1. Odds ratio with 95% confidence interval.

Source: own elaboration based on survey results.

In interpreting the individual variables, the odds ratio was used. The interpretations were as follows:

- Those unable to specify whether they value convenience and speed of food preparation are 41 times more likely to have a more positive attitude regarding health and nutrition than those who do not value convenience and speed of food preparation, all else being equal.
- Those who value convenience and speed of meal preparation are 11 times more likely to have a more positive attitude regarding health and nutrition than those who do not value convenience and speed of meal preparation, all else being equal.
- Those unable to identify whether they are health-conscious are 50% less likely to have more positive attitudes about health and nutrition than those who disagree with the statement that they are health-conscious, all else being equal.
- Those unable to identify whether they are health-conscious are 68% less likely to have a more positive attitude about health and nutrition than those who disagree with the statement that they are health-conscious, all else being equal.

It is interesting to note that Pomeranian consumers who value convenience and speed of food preparation want to make informed, rational (beneficial to their health) food choices. According to Carfor (2021), attitude and perceived behavioural control are the strongest determinants of intention to purchase natural foods, followed by trust and personal norm. Consumers' intention to purchase natural foods is also related to their assessment of the consequences and opportunities associated with their purchasing behaviour, as well as their moral judgement attributed to pro-environmental determinants. The literature emphasises the role of intention in organic food purchasing decisions through the managerial implications for effective packaging design that promotes sustainability values and generates positive attitudes and behaviours towards organic food (Margariti, 2021). Changing respondents' attitudes from

ambivalent to positive towards organic foods will lead to an expansion of the range of foods consumed (Mikulec et al., 2023). It is also important to skilfully capture the potential of both individuals and communities to engage with climate change and their readiness for change, thereby promoting sustainable behaviour (Duradoni et al., 2024).

The study results show that the group of Pomeranian consumers have ambivalent attitudes towards natural food. Consumers in Poland and India cite the availability and price of organic food as the main barriers to increasing purchases (Smoluch-Sikorska, 2024; Vyas, 2019). It should be highlighted that measures to maintain organic market development should be carried out with particular emphasis on the continued participation of retail chains in the distribution of organic food and the increased involvement of large companies in processing organic food (Smoluch-Sikorska, 2024). Pang et al. (2021) show that perceived vulnerability, response efficacy, self-efficacy, subjective norms, and attitudes influence the intention to purchase organic food. Malaysian consumers were more likely to have a positive attitude towards organic food when they have adequate information on the vulnerability of food production risks and its consequences (Pang et al., 2021). For Europe, shifting toward more plants, including those from organic crops diets would be healthier and simultaneously reduce the per capita environmental footprints. Dietary changes can lead to win outcomes for human society and the planet. Dietary change strategies should consider diverse needs (e.g., undernutrition vs. diet-related-non-communicable diseases) and regional captive solutions (e.g., local food availability, regional production condition, food preferences, trade partnerships) (Chen et al., 2022; Tucci et al., 2024).

4. Conclusion and future perspectives

The study showed that both women and men reported positive and ambivalent attitudes towards concern for health and nutrition and ambivalent attitudes towards the consumption of natural foods (low-processed foods). Women who expressed concern for their health in terms of hypertension prevention declared a willingness to consume organically produced vegetables. The surveyed group of Pomeranian food consumers (men) reported anxiety about consuming a lot of sugar and salt in their diet and that they would get fat. Despite the anxiety stated, the men did not express a readiness to change their eating behaviour in terms of health concerns. In contrast, women, who feared that they would develop ischaemic heart disease and were concerned that they were consuming a lot of total fats and cholesterol in their diet, stated that they did not consume processed foods because they did not know their composition.

Extended statistical analysis of empirical data by building a multivariate logit model showed that only a change in the attitudes of Pomeranian consumers towards health from negative and ambivalent to positive would lead to a change in their eating behaviour by increasing the

purchase and consumption of natural foods. It is interesting that Pomeranian consumers who value the convenience and speed of meal preparation want to make conscious, rational (beneficial to their health) food choices.

The results of the survey are limited due to the narrow survey sample and their scope. However, the analysis of the respondents' attitudes towards health issues and natural food consumption showed that gender and lifestyle have differential effects on the attitudes of consumers (in northern Poland) towards health and willingness to purchase natural foods.

The authors are of the opinion that research on the dietary choices made by food consumers in Poland should be continued. The study will also be helpful for governments, strategists and practitioners in achieving sustainable consumption goals through natural foods.

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IMPACT OF WORK-FAMILY CONFLICT ON TURNOVER INTENTION OF EMPLOYEES THROUGH ORGANISATIONAL COMMITMENT AND PROFESSIONAL IDENTITY

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Purpose: This study investigates the impact of work-family conflict (WFC) on turnover intentions (TI) among employees in Pakistan's high-tech industry, with organisational commitment (OC) and professional identity (PI) as mediators.

Design/methodology/approach: Data collected from 301 respondents using validated scales were analysed via Hayes' PROCESS macro in SPSS.

Findings: Results reveal a significant positive relationship between WFC and TI, underscoring the role of resource depletion as per the Conservation of Resources theory. Additionally, OC and PI were found to mediate this relationship, highlighting their critical influence on employee retention.

Practical implications: The findings emphasize the need for organizations to implement work-life balance policies, foster commitment, and strengthen professional identity through mentorship and recognition initiatives. By addressing WFC and enhancing workplace support, organizations can reduce turnover intentions, promote employee well-being, and sustain competitiveness in high-demand industries.

Originality/value: This study pioneers the exploration of professional identity as a mediator between work-family conflict and turnover intention, particularly within Pakistan's collectivist high-tech sector, an underexamined context.

Keywords: work-family conflict, turnover intention, organisational commitment, professional identity, Pakistan.

Category of the paper: Research paper.

1. Introduction

Work-family conflicts have received significant attention due to their impact on the professional and social lives of individuals (French et al., 2022; Smith et al., 2022). Such conflicts disrupt the employees' engagement in work and the family spheres and reduce their overall job and life satisfaction (Bruck et al., 2002). This negative impact affects not only organisations but also the entire society's quality and performance (Hsiao, 2022; Talukder,

2022). This contrasts with the positive effects of work-family enrichment phenomena, as exposed by Wayne et al. (2006), Greenhaus & Powell (2006), Heikkinen & Lämsä (2017) and Stellner (2022). Therefore, the avoidance of work-family conflicts among employees whose contribution to intangible assets development today is evident (Kucharska, 2021), is of high interest to both science and practice (Dodanwala et al., 2022; French et al., 2022; Martineau, Trottier, 2022; Smith et al., 2022).

Human resource management faces a fundamental concern regarding retaining employees, particularly those who are highly skilled and considered top talent (Su et al., 2020). The matter of employees' turnover intention has received substantial attention in behavioural sciences research for many years (Joo, Park, 2010; Wang et al., 2017). Both organisational productivity and employee morale are adversely affected by high turnover, as noted by Chen et al. (2017). Additionally, Sulek et al. (2017) found that human capital is also negatively impacted by this issue. A high rate of employee turnover leads to increased costs associated with turnover (Lim et al., 2017). Hence, the current global situation presents a significant challenge as organisations grapple with the issue of employee turnover intentions (Yildiz et al., 2021).

Hofstede et al. (2010) observed that in societies with a collectivistic orientation, individuals are expected to uphold harmonious connections with their extended family members. In Pakistan, there exists a strong commitment to nurturing enduring connections with extended family (Islam, 2004). Therefore, family duties frequently go beyond obligations to one's immediate offspring and partner. People often have financial and emotional responsibilities towards relatives outside their immediate family circle (Powell et al., 2009). Hence, in cultures that prioritise collective values, the responsibilities towards extended family members might draw away the time and energy of employed parents (Raymo et al., 2015; Hassan et al., 2010). This, in turn, can lead to conflicts between their work and family commitments.

In their study, Mumu et al. (2021) provided compelling arguments regarding the association between work-family conflict (WFC) and both job satisfaction and the intention to quit. They emphasised the significance of additional research in this particular field, indicating a need for further literature on the subject. Despite the growing recognition of the importance of WFC, there is limited research addressing this issue in the context of Pakistan (Faiz, 2015). The relationship between factors such as WFC and the turnover intention of employees has not yet been thoroughly investigated within the context of Asia, specifically in Pakistan (Faiz, 2015).

Furthermore, as far as we know, no prior research has explored the mediating role of professional identity in the relationship between WFC and turnover intention. Studies on professional identity have primarily concentrated on educators, nursing students, and employees in the hospitality sector (Nie et al., 2021; Wang et al., 2020; Worthington et al., 2013). There is scarce academic research on the professional identity of individuals working in the high-tech industry. Therefore, this study aims to address this gap in the existing literature by investigating the impact of WFC on employees' turnover intention in Pakistan's high-tech

industry, considering the mediating roles of organisational commitment and professional identity.

Following this brief introduction, the remaining parts of the research article are arranged as follows: The study begins with an introductory section, which is accompanied by a description of the theoretical basis and the formulation of hypotheses. Next, the research methodology, analysis, and findings are presented. This is followed by a discussion and a conclusion summarising the key points of the study.

2. Literature review and hypotheses formulation

2.1. Work-family conflict and turnover intention

Work-family conflict refers to “a state in which there is an imbalance between an individual's work and family roles where work responsibilities spill over to the family side” (Netemeyer et al., 1996). The inherent mismatch between the domains of professional and personal life results in conflicts when roles in one area (such as work) disrupt the functioning of the other area (such as family) (Haar, Martin, 2022). WFC arises when individuals struggle to maintain a harmonious equilibrium between their professional obligations and personal responsibilities at home, finding it challenging to balance commitments both at the workplace and in their personal lives due to the time required by both domains (Aboobaker, Edward, 2020). There are two categories within the concept of WFC: one is when work impacts family life (referred to as work-family conflict), and the other is when family responsibilities affect work (known as family-work conflict) (Allen et al., 2000; Shockley, Singla, 2011). A comprehensive analysis has shown that the effect of work-family conflict is considerably more noteworthy than the effect of family-work conflict (Amstad et al., 2011).

Turnover intention pertains to the concept of employees within an organisation intending to leave their current place of employment or position (Li et al., 2015). Individuals who are inclined to quit their jobs can lead to a range of detrimental effects on the organisations they are a part of (Lee et al., 1999). The reason that work-family conflict leads to a desire to leave a job can be understood through the conservation of resources theory, which suggests that WFC arises when an individual puts too much effort and energy into their work, leaving them with inadequate resources to dedicate to their familial obligations (Grandey, Cropanzano, 1999; Liao et al., 2022).

There are multiple aspects that contribute to employees' desire to leave the organisation. Nevertheless, the primary cause frequently relates to dissatisfaction with one's job (Anvari et al., 2014). When an employee faces a conflict between their family and work life, they are inclined to experience increased levels of dissatisfaction compared to situations where such

conflicts do not arise. Therefore, in order to prevent a reduction in the workforce, it is essential for the organisation to establish a suitable working environment across different levels. This can be achieved by implementing measures such as work-life balance policies, which contribute to employees' well-being and their active participation in their assigned roles (Ribeiro et al., 2023). Prior research has clearly established that work-family conflict greatly influences the likelihood of an intention to resign (Chen et al., 2018; Ghayyur, Jamal, 2013; Gull et al., 2021; Kengatharan, Kunatilakam, 2020; Li et al., 2021; Liu et al., 2020; Mumu et al., 2021). Given the reasoning provided above, we hypothesise that:

H1: WFC affects the turnover intention of the employees.

2.2. Work-family conflict, organisational commitment, and turnover intention

The topic of organisational commitment has garnered significant attention in the field of research over many years (Chanana, 2021; Meyer, Allen, 1991; Yahaya, Ebrahim, 2016). It has been acknowledged as a crucial factor in the management studies and the broader scope of organisational literature (Rahman et al., 2018; Yahaya, Ebrahim, 2016). In particular, Meyer and Allen (1991) studied the nature and underlying theoretical principles of organisational commitment. Meyer and Allen (1991, p. 61) state that organisational commitment can be defined as “a psychological state, reflecting a desire, a need, and an obligation to maintain employment in an organisation.” Allen and Meyer (1990) theorised it in three dimensions: normative commitment, affective commitment, and continuance commitment. According to Allen & Meyer (1990), “Employees with strong affective commitment remain because they want to, those with strong continuance commitment because they need to, and those with strong normative commitment because they feel they ought to do so.” Therefore, these distinct forms of commitment play a crucial role in understanding employee retention. Understanding the underlying motivations behind these different types of commitment provides valuable insights for organisations seeking to foster employee retention.

Several researchers have found that when work-family conflict rises, stress, fatigue, anxiety, and tension in all aspects of daily life, including work, increase, and job satisfaction and job performance decrease significantly (Allen et al., 2000b; Driscoll et al., 2004). Furthermore, WFC has been reported to have an adverse effect on the quality of life (French et al., 2018). In particular, it is noted that WFC exerts a substantial impact on the variables related to job performance (Eby et al., 2009). A typical example is organisational commitment, which serves as a key indicator for evaluating and judging organisational performance. Several studies have confirmed that WFC influences not only organisational commitment but also work negligence, turnover, and absenteeism (Frone et al., 1997; Goff et al., 1990; Netemeyer et al., 1996). According to numerous researchers, WFC negatively and significantly impacts organisational commitment (Hendra, Made, 2019; Hidayati et al., 2019; Mukanzi, Senaji, 2017).

Multiple studies have demonstrated organizational commitment as the vital antecedent of turnover intention (Larkin, 2015; Li et al., 2021). Previous research highlights a crucial connection between organisational commitment and turnover intention, which involves the development of emotional attachment known as affective commitment, and when organisations treat employees well, it creates a sense of obligation, which leads to positive thoughts about the organisation and reduced likelihood of leaving (Williamson et al., 2009). Studies have shown an inverse connection between organizational commitment and the intention of preschool teachers to quit their employment (Chao, 2010; Choi, 2013). Moreover, several studies have used organizational commitment as a mediator in examining the relationship between various variables. For example, a study by Albalawi et al. (2019) examined its mediating role in the connection between perceived organisational support and turnover intention. Furthermore, multiple studies have found that organizational commitment serves as a mediator in the association between WFC and TI (Chan, Ao, 2018; Hatam et al., 2016; Li et al., 2021; Zhou et al., 2020). Based on the above discussion, we propose the following hypotheses:

H2a: WFC has a considerable negative impact on organizational commitment.

H2b: Organisational commitment has a considerable negative impact on turnover intention.

H2c: Organisational commitment mediates the relationship between WFC and turnover intention.

2.3. Work-family conflict, professional identity, and turnover intention

Professional identity refers to “the attitudes, values, knowledge, beliefs and skills shared with others within a professional group” (Adams et al., 2006). Professional identity (PI), which refers to one's perspective of the social significance and worth of the work they engage in, is a significant factor, and has been shown to be strongly associated with turnover intention, burnout, and job satisfaction among specialists (Sabanciogullari, Dogan, 2015; Zhang et al., 2018). According to the perspective of social occupational cognition theory, when the occupational environment does not match the expected career outcomes, it can reduce the individual's identification with the professional activities they are engaged in (Lent, Brown, 2013). As a result, their self-awareness and emotional experience of professional activities may decline, potentially triggering the intention to quit (Lent, Brown, 2013). Work-family conflict reduces the consistency between the current professional environment of preschool teachers and their expected professional results, thereby affecting the professional identity of preschool teachers, which can easily lead to their intention to leave the profession (Zhou et al., 2020). In addition, a study found that work-family conflict can significantly reduce an individual's professional identity (Cohen-Scali, 2003).

The connection between professional identity and retaining students in nursing programs, as well as quitting career as a nurse, is strongly linked (Worthington et al., 2013; Yang, Yin, 2019). Enhancing employees' professional identity can significantly reduce their intentions to leave the company. If the staff member believes that their work holds significance and creates value for themselves, they will have a stronger professional identity, experience greater engagement and satisfaction in their job; whereas if their professional identity is weaker, they may consider leaving their current job when a suitable opportunity presents itself (Applebaum et al., 2010; Poon, 2004). Given the reasoning discussed above, we hypothesise that

H3a: WFC is negatively associated with professional identity.

H3b: Professional identity is negatively associated with turnover intention.

H3c: Professional identity mediates the relationship between WFC and turnover intention.

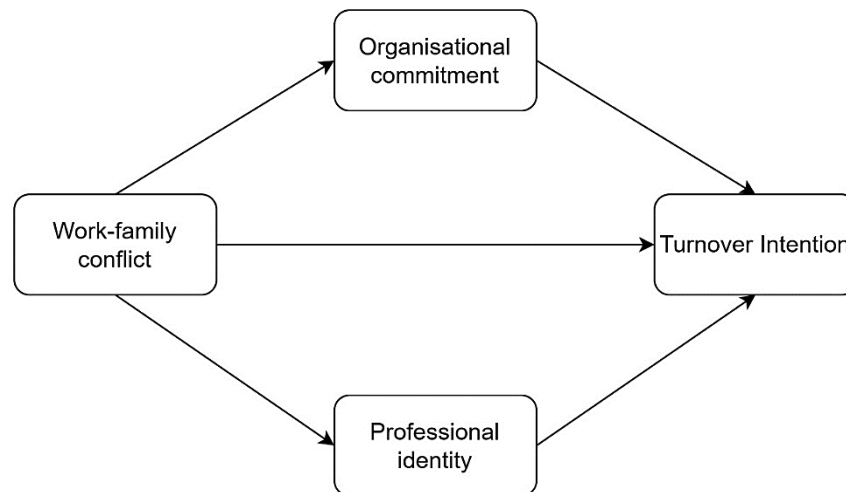


Figure 1. Research Model.

Source: Own study.

3. Methods

3.1. Sampling

The study targeted employees working in high-tech enterprises located in Pakistan. A random sampling method was employed to select a representative sample of high-tech enterprises. This ensured that the sample adequately represented different regions of Pakistan. Questionnaires were distributed to 550 individuals employed in high-tech enterprises in Pakistan. After excluding any invalid responses, a total of 301 questionnaires were obtained, resulting in an overall response rate of 54.7%. A total of 301 participants were deemed appropriate for the study. Table 1 presents the demographic characteristics of the participants.

Table 1.*Demographic characteristics*

		Frequency	Percentage
Gender	Male	160	53%
	Female	141	47%
	Total	301	100%
Age in years	20-25	18	6%
	26-30	49	16%
	31-35	89	30%
	35-40	46	15%
	41-45	37	12.2%
	46-50	36	11.9
	51 and over	26	8.63%
Education	Bachelor Degree	94	31%
	Master's Degree	137	45%
	PhD Degree	69	23%
Working years	0-3 years	61	20%
	4-5 years	97	32%
	6-15 years	115	38%
	16-20 years	24	8%
	21 and over	4	1.3%

Source: Own study.

3.2. Data collection and analysis

Data was collected using a structured, self-reported questionnaire. The survey was administered to the participants either in person or through online platforms, depending on their preferences and feasibility. Participants were provided with explicit guidelines on completing the survey and were assured that their responses would be treated as confidential and remain anonymous. Data collection continued for three months. Hypothesis testing and data analysis were conducted using Hayes' PROCESS using SPSS version 23. The PROCESS macro is widely employed in social science research as it offers a more accurate and efficient approach for examining the connection between variables (MacKinnon et al., 2012). Descriptive statistics analysis was also performed using SPSS version 23. The PROCESS macro (bootstrap set to 5000) was utilized to examine the indirect effect (Hayes, 2013). Additionally, an analytical method known as conditional process analysis (Model 4), as outlined in Hayes (2013), was employed to investigate how organisational commitment and professional identity mediate the relationship between WFC and turnover intention.

3.3. Measures

The measurement of WFC was evaluated using a scale devised by Carlson et al. (2000). The scale consists of nine statements that are evaluated on a five-point Likert scale, with options ranging from 1 (representing strong disagreement) to 5 (signifying strong agreement). An example statement from the scale is: "My work keeps me from my family activities more than I would like." This study adopted the scale developed by Allen & Meyer

(1990) to measure organisational commitment. The scale comprises three dimensions and consists of 18 items. Each dimension has six items: affective commitment (e.g., “I do not feel like part of the family at my organization”), normative commitment (e.g., “I would feel guilty if I left my organisation now”), and continuance commitment (e.g., “Changing professions now would be difficult for me to do”). All the items are assessed on a five-point Likert scale, where 1 represents “strongly disagree” and 5 represents “strongly agree”.

Turnover intention is measured utilising the scale designed by Tett & Meyer (1993). The scale contains four items. A sample item is “I often think of quitting the job”. The items are presented to the respondents using a five-point Likert ranging from 1 (never) to 5 (always). The scale developed by Brown et al. (1986) was used to evaluate professional identity. The assessment comprises three subscales, namely professional cognition with three items, professional impact with three items, and professional evaluation with four items. Overall, there were a total of 10 items, and participants were required to provide their responses on a five-point Likert scale, where 1 represents “never” and 5 indicates “very often”.

4. Analysis and results

4.1. Preliminary analysis

Data cleaning and screening are essential parts of ensuring the data set is free from errors. For this purpose, missing value analysis is performed, and the results show that there are no missing values in the file. Data normality is assessed through Skewness and Kurtosis (Hair et al., 2006). The acceptable range for Skewness is less than 2 and for Kurtosis is less than 3 (Kline, 1998). As observed in Table 2, the Skewness and Kurtosis values are within an acceptable range. Therefore, the data does not deviate from the normal distribution. Hence, the data is suitable for further analysis. Cronbach's alpha was used to confirm the reliability of each variable. A Cronbach's alpha value of 0.70 is considered within the acceptable range (Hair et al., 2010). Table 4 indicates that all the values of the study variables meet the criteria. The correlation test was conducted to assess the strength and relationships among the independent, mediating and dependent variables. As shown in Table 3, the result shows that there is a positive correlation between all the variables.

Table 2.
Descriptive statistics

Variables	Mean	SD	Skewness	Kurtosis
WFC	3.83	0.86	-0.73	-0.16
OC	3.81	0.64	-0.91	0.87
TI	4.09	0.75	-0.83	-0.02
PI	3.95	0.87	-0.82	0.40

Note. Note: WFC = Work-family conflict, OC = Organizational commitment, TI = Turnover intention, PI = Professional identity, SD = Standard deviation.

Source: Own study.

Table 3.
Correlation analysis

	WFC	OC	TI	PI
WFC	1			
OC	0.70**	1		
TI	0.63**	0.51**	1	
PI	0.74**	0.65**	0.70**	1

**Correlation is significant at the 0.01 level (2-tailed).

Note. WFC = Work-family conflict, OC = Organizational Commitment, TI = Turnover Intention, PI = Professional identity.

Source: Own study.

Table 4.
Reliability of variables

Study Variables	Cronbach Alpha	No of items
WFC	0.95	8
OC	0.96	18
TI	0.86	4
PI	0.91	10

Note. WFC = Work-family conflict, OC = Organizational commitment, TI = Turnover intention, PI = Professional identity.

Source: Own study.

4.2. Process Macros results

To test the study hypotheses, Process macro in SPSS version 23 was utilised. Hayes' PROCESS macro model 4 was applied to test the mediational effect (Hayes, 2013). Before running the complete model, the model was examined to determine if it fulfils Barons and Kenny's (1986) conditions for investigating mediation. The first condition is that WFC must be correlated with turnover intention. Table 5 shows that WFC is significantly and positively associated with TI (coefficient = 0.44, $P < 0.001$), providing support for H1. Therefore, the first condition is fulfilled.

The second condition requires that the independent variable must have a correlation with the mediator, while the mediator must have a correlation with the dependent variable as stated in the third condition. Hypotheses H2a and H2b stated that WFC is negatively associated with OC, and OC is negatively associated with turnover intention. The results indicate that WFC is negatively associated with OC (coefficient = 0.50, $P < 0.001$), and OC is negatively related to

turnover intention (coefficient = 0.40, $P < 0.001$). Therefore, hypotheses H2a and H2b are supported.

H3a and H3b state that WFC is negatively and significantly associated with professional identity, and professional identity is negatively related to turnover intention. The results show that WFC is negatively associated with PI (coefficient = 0.32, $P < 0.001$), and PI is negatively related to turnover intention (coefficient = 0.38, $P < 0.001$), which supports hypotheses 3a and 3b.

Table 5.
PROCESS macro's results

Relation	Direct Effect			Indirect Effect	
	Coefficient	t value	p value	LLCI	ULCI
WFC → TI	0.44	8.53	***	0.34	0.55
WFC → OC	0.50	15.56	***	0.44	0.57
OC → TI	0.40	2.85	***	0.33	0.61
WFC → PI	0.32	6.27	***	0.22	0.42
PI → TI	0.38	8.59	***	0.29	0.47

Note. LLCI = Lower level of the confidence interval, ULCI = Upper level of the confidence interval.

Source: Own study.

To test the mediational effect, 5000 bootstrapping with a 95% confidence interval is conducted on PROCESS macros (Preacher, Hayes, 2008). According to Preacher & Hayes (2008), Indirect effect would be significant if confidence interval does not contain zero. Hypotheses H2c and H3c indicated the indirect effect of WFC on turnover intention through organisational commitment and professional identity. Table 6 shows that the organisational commitment mediated WFC and turnover intention relationship (coefficient = 0.29, 95%; CI [0.20, 0.50]). These upper and lower values do not overlap with a value of zero, which supports hypothesis H2c. Similarly, the results indicate that professional identity mediates the connection between WFC and turnover intention (coefficient = 0.32, 95%; CI [0.25, 0.45]) and thus provides evidence in favour of hypothesis H3c, as demonstrated in Table 6.

Table 6.
Indirect effect

Indirect Effect	Coefficient	LLCI	ULCI
WFC → OC → TI	0.29	0.20	0.50
WFC → PI → TI	0.32	0.25	0.45

5. Discussion

This study provides empirical analysis of the relationship between WFC and turnover intention, focusing on the mediating roles of organisational commitment and professional identity among employees in Pakistan's high-tech industry. The findings align with and expand

on existing literature, offering critical insights into the unique dynamics of high-stakes, high-demand sectors.

As prior studies have established, WFC is a significant predictor of TI. Our results corroborate this link, demonstrating that WFC is positively and significantly associated with turnover intention. These findings are consistent with existing research (Ghayyur, Jamal, 2013; Li et al., 2021; Mumu et al., 2021), reinforcing the understanding that employees facing conflict between their professional and personal responsibilities are more likely to consider leaving their organisation. This issue is particularly pronounced in the high-tech industry, where the fast-paced and demanding environment intensifies the challenges of balancing work and personal life. Such conflict erodes job satisfaction and triggers turnover intentions, highlighting a pressing need for organisations in this sector to develop effective work-life balance initiatives.

Moreover, the findings confirm that organisational commitment mediates the relationship between WFC and turnover intention. Employees experiencing high levels of WFC report diminished organisational commitment, which in turn increases their propensity to leave. This aligns with previous research (Chan, Ao, 2018; Hatam et al., 2016; Li et al., 2021; Zhou et al., 2020), underscoring the importance of fostering a supportive workplace culture to strengthen employees' emotional and psychological attachment to their organisations. Practical interventions, such as flexible working arrangements, career development programs, and managerial support, could enhance organisational commitment and mitigate the adverse effects of WFC on employee retention.

Additionally, professional identity emerged as another critical mediator in the WFC-TI relationship. Employees grappling with significant WFC tend to develop weaker professional identities, further intensifying their intentions to quit. This finding underscores the broader implications of WFC, which not only undermines organisational loyalty but also weakens employees' identification with their professional roles. In line with social occupational cognition theory, employees who perceive a misalignment between their work environment and professional aspirations are more likely to disengage, ultimately considering alternative career paths (Cohen-Scali, 2003; Lent, Brown, 2013). Organisations should actively support employees in reconciling professional and personal identities, potentially through mentorship programs, role enrichment opportunities, and recognition initiatives.

Overall, this study highlights the critical need for high-tech enterprises to address WFC through targeted interventions that enhance both organisational commitment and professional identity. By fostering a balanced work environment and promoting a sense of belonging and professional purpose, organisations can reduce turnover intentions, improve employee well-being, and achieve long-term sustainability.

5.1. Implications

The findings offer several theoretical advancements. First, by confirming the significant impact of WFC on turnover intention, this study reinforces COR theory, which posits that individuals facing resource depletion due to conflicting work and family demands are more likely to adopt withdrawal behaviours such as turnover. The integration of OC and PI as mediators further enriches this framework by identifying specific psychological constructs that influence this process. Second, the study provides novel insights into the mediating role of PI in the WFC-TI relationship. While prior research has predominantly focused on PI in fields such as nursing or education, this study extends its application to high-tech enterprises, highlighting the relevance of professional identity in knowledge-intensive, fast-paced industries. Specifically, it emphasizes that WFC not only erodes employees' organisational commitment but also diminishes their identification with their professional roles, a connection that has been underexplored in previous studies. Finally, the study addresses a critical research gap by examining WFC and TI in the high-tech sector within a collectivist society like Pakistan, thus contributing to the growing literature on work-family issues in non-Western contexts.

The findings of this study hold significant practical relevance for organisations, particularly in the high-tech industry, where retaining skilled talent is critical. Organisations can adopt the following strategies. First, the direct link between WFC and TI underscores the need for organisations to prioritise work-life balance initiatives. Flexible working arrangements, telecommuting options, and workload management policies can help employees better balance their work and family responsibilities, thereby reducing WFC and the associated turnover intentions. Secondly, since OC mediates the relationship between WFC and TI, organisations should focus on creating an environment that fosters employee commitment. This can be achieved by promoting a supportive workplace culture, offering career development opportunities, and recognising employees' contributions. Structured mentorship programs, transparent career progression frameworks, and personalised recognition strategies can strengthen employees' commitment and mitigate the negative impact of WFC.

Third, organisations should invest in strategies that enhance employees' professional identity. Mentorship programs, skills development workshops, and opportunities for meaningful work can help employees align their professional roles with their personal aspirations. Encouraging employees to take ownership of their work and recognise its value can strengthen their identification with their professions, reducing turnover intentions. To implement these initiatives effectively, organisations can create structured competency-building roadmaps and establish peer-learning platforms that reinforce professional growth.

Fourth, the demanding nature of the high-tech sector necessitates industry-specific solutions. For example, offering targeted stress management programs, fostering innovation-friendly environments, and providing resources for time management can help employees navigate the sector's fast-paced challenges without compromising their personal lives. Lastly,

in collectivist cultures like Pakistan, where family responsibilities often extend beyond immediate members, organisations should design family-friendly policies that accommodate broader familial obligations. For instance, offering support for extended family caregiving or granting additional leave for family events can help reduce WFC and its negative consequences.

5.2. Research limitations and future research directions

This study has certain limitations that should be acknowledged. First, it focuses exclusively on employees in the high-tech sector in Pakistan, which limits the generalizability of the findings to other industries or cultural contexts. The dynamics of work-family conflict, organisational commitment, professional identity, and turnover intention may differ in less demanding industries or in countries with individualistic cultures. Additionally, the cross-sectional design of the study restricts its ability to establish causal relationships between the variables. Longitudinal research is needed to examine how these relationships evolve over time and whether the effects persist or change in different circumstances.

Another key limitation is the reliance on self-reported data, which may introduce potential biases such as common method bias and social desirability bias. These biases could influence the accuracy of responses and the interpretation of findings. Future research should consider incorporating objective measures or multi-source data to mitigate these effects. Moreover, while this study explored OC and PI as mediators, other potential mediators or moderators, such as job satisfaction, resilience, or family support, were not included, leaving opportunities for further exploration.

Future research could address these limitations by examining the WFC-TI relationship in other industries, such as healthcare or education, and in different cultural contexts, particularly in individualistic societies. Conducting longitudinal studies would also help establish causal relationships and provide insights into how WFC and its impacts evolve over time. Exploring additional mediators or moderators, such as perceived organisational support or family dynamics, could yield a more comprehensive understanding of the factors influencing turnover intention. Research could also investigate the effectiveness of interventions like flexible work arrangements, stress management programs, or mentorship initiatives to mitigate WFC and its outcomes. Additionally, future studies might focus on gender-specific experiences, as family responsibilities and WFC often vary across genders. Incorporating qualitative methods, such as interviews or focus groups, could further enrich the understanding of employees' lived experiences and provide deeper insights into the interplay of WFC and turnover intention.

6. Conclusion

This study highlights the pivotal role of work-family conflict in shaping employee turnover intentions within Pakistan's high-tech sector. The findings reveal that work-family conflict serves as a significant driver of turnover intentions, with organizational commitment and professional identity acting as critical mediators. Elevated work-family conflict erodes employees' emotional connection to their organization and diminishes their professional identity, ultimately increasing their propensity to leave. These insights underscore the pressing need for organizations to cultivate supportive work environments that address the intricate challenges of balancing personal and professional responsibilities. Prioritizing strategies to enhance organizational commitment and strengthen employees' professional identity emerges as a vital approach to mitigating the detrimental impact of work-family conflict. By doing so, organizations can not only reduce turnover intentions but also foster a more engaged, resilient, and committed workforce. These findings contribute to a deeper understanding of the dynamics affecting employee retention in high-demand sectors and offer a foundation for future studies exploring the multifaceted nature of work-family conflict and its organizational impact.

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MANAGERIAL TURNOVER AND PERFORMANCE: LESSONS FROM THE POLISH EKSTRAKLASA

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Purpose: The aim of this paper is to assess the impact of managerial turnover on organisational performance. This study contributes to the ongoing debate on whether changing a manager results in performance improvements and investigates this phenomenon in the context of resource-constrained sports organisations.

Design/methodology/approach: Using a dataset covering the 2006/2007 to 2023/2024 seasons, this study analysed 115 cases of managerial changes made during the season. For each managerial change, an alternative scenario was constructed in which the manager was retained despite similar team performance. A model was developed to assess the outcomes of both scenarios, accounting for team strength (measured by the ELO rating) and home advantage to control for match-specific influences on performance.

Findings: The results show a modest improvement in team performance following managerial changes. However, a similar improvement was observed in the alternative scenarios where no change occurred, indicating that this effect is largely attributable to regression to the mean.

Practical implications: These findings suggest that mid-season managerial changes are not associated with significant improvements in team results compared to scenarios where managers were retained. This contributes to the broader discussion on the efficacy of managerial changes in professional football leagues, particularly within financially constrained settings, exemplified by the Polish Ekstraklasa.

Originality/value: This study adds to the discourse on the implications of changes in key organisational positions. The novelty of this research stems from the application of contemporary methodological approaches to evaluate the effects of managerial changes in organisations facing numerous constraints, such as the Polish Ekstraklasa. Additionally, the study introduces a methodological innovation: the use of the ELO ranking system, which can be applied to assess the strength of teams competing in competitions marked by substantial variability in outcomes.

Keywords: managerial turnover, sport performance, regression to the mean, Polish Ekstraklasa.

Category of the paper: Research paper.

1. Introduction

Managerial changes at the highest levels of an organisation are a natural part of its functioning. These changes often occur when a contract ends, or a CEO reaches a certain age (Tena, Forrest, 2007). Occasionally, however, changes happen at less convenient times. A typical signal prompting such a change is concerning information from within the organisation, such as unsatisfactory returns for publicly traded companies (e.g., Kim, 1996; Warner et al., 1998). Therefore, it is crucial to understand the consequences of managerial changes in various aspects of organisational performance, particularly financial outcomes. However, empirical research in this field remains inconclusive. Some studies indicate that managerial changes often result in a short-term increase in stock value (Kaplan, Minton, 2012). Other studies show that many companies do not perform better after a CEO change (Wiersema, 2002), and some do not observe a significant impact of these changes on organisational performance at all (Smith et al., 1984).

A significant methodological challenge in empirical research on the effects of changing a firm's leader is the quality of data. Ter Weel (2011) suggests that this issue can be addressed by analysing data from professional sports. He argues that sports outcomes offer directly measurable performance indicators (e.g., win, draw, loss in football) at regular, weekly intervals. Sports leagues can be treated as markets where "firms" within the same industry compete, and the decisions of managers are public and directly influence results. Additionally, both a company president and a football manager must possess similar skills and qualities, such as leadership, personnel management, strategic thinking, and team-building abilities necessary for achieving organisational goals.

This study examines the impact of changing the manager on organisational performance within the sports context. The primary goal is to assess the influence of managerial changes on subsequent team performance. Firing a manager mid-season often incurs additional costs, such as the need to pay compensation for contract termination. For this reason, such changes are infrequent, and the primary reason is typically disappointing results that cast doubt on the team's ability to achieve its set objectives. This analysis uses data from Poland's top football league, the Ekstraklasa. Based on data from the 2006/2007 to 2023/2024 seasons, 127 instances of managerial changes during ongoing seasons were identified. Match outcomes were measured by points earned and, alternatively, goal differences in individual games. Using a modified method proposed by van Ours and van Tuijl (2016), a model was built to explain team results depending on relative team strength, home advantage, and binary variables indicating the treatment and control groups. The results of the study suggest that team results improve slightly following a managerial change. However, this improvement can be attributed to the phenomenon of "regression to the mean", indicating that the effect is comparable to teams that did not change managers despite a crisis.

The results are interesting for several reasons. First, they contribute to the ongoing discourse on the effectiveness of managerial changes on organisational performance. Although this phenomenon is well-studied in the context of the largest and wealthiest football leagues in Europe, there are still relatively few analyses based on leagues that exist somewhat on the margins of major European football. The findings are also of interest to the Polish football community, as common opinions about the effectiveness of managerial changes in crisis-stricken teams prove to be unfounded.

The following sections of this article are organized as follows. The second chapter provides a broader context by reviewing literature on the managerial change effect. The third chapter presents the construction of the data set and the model used to verify the research objective. In the fourth chapter, the study results and conclusions are discussed. The article concludes with a summary.

2. Literature review

Research on the effect of managerial changes in sports dates back to the 1960s, when the impact of various factors on team performance began to be analysed. One of the first significant publications on this topic is Grusky's (1963) work, which, based on data from Major League Baseball (MLB), concluded that frequent managerial changes destabilise a team, ultimately leading to decreased efficiency. The author argues that this process creates a "vicious cycle", as a sports crisis leading to a managerial change further deteriorates team results.

Gamson and Scotch (1964) challenged Grusky's theses, presenting three possible explanations for the impact of managerial changes on team performance. According to them, the most credible theory is the "scapegoat" theory, which suggests that firing a manager has no significant impact on team performance. The decision to replace a manager is often perceived as a symbolic gesture towards stakeholders, demonstrating that the management acknowledges the crisis and is ready to take decisive action. The third theory, known as the common-sense theory, assumes that disappointing results can be attributed to the manager's decisions and that a well-chosen new manager can improve the team's performance.

With the increased availability of data and the natural connection between leadership changes in sports organisations and similar phenomena in business, this topic has become a significant area of interest in sports economics. While initial studies focused on data from professional leagues in the United States (Scully, 1994), research since the late 20th century has increasingly examined the impact of managerial changes in football.

Most research has focused on the wealthiest European leagues, such as the English (e.g., Dobson, Goddard, 2001; Audas et al., 2002; Flint et al., 2014; Besters et al., 2016), French (Scelles, Llorca, 2020), Spanish (Tena, Forrest, 2007; Lago-Peñas, 2011), German (Wagner,

2010; Muehlheusser et al., 2016), Italian (De Paola, Scoppa, 2012), and Dutch (Bruinshoofd, ter Weel, 2003; Koning, 2003; van Ours, van Tuijl, 2016) leagues. The results of these analyses are inconclusive. They often support the "scapegoat" theory (De Paola, Scoppa, 2012; Besters et al., 2016; van Ours, van Tuijl, 2016), showing that while team performance may improve slightly following a managerial change, this is merely a regression to the mean. Some authors, such as Wagner (2010), confirmed a positive impact of managerial changes, while Scelles and Llorca (2020) found some evidence for the common-sense theory, and Tena and Forrest (2007) observed a positive effect exclusively for home games. On the other hand, some studies (Audas et al., 2002) indicate the possibility of a "vicious cycle" effect.

Despite numerous studies on the impact of managerial changes on sports performance in top European leagues, there remains a notable research gap regarding lower-tier leagues, particularly in Central and Eastern Europe. Only a few studies examine Scandinavian leagues (Madum, 2016; Arnulf et al., 2012), the Austrian league (Wirl, Sagmeister, 2008), and the Polish league (Radzimiński et al., 2021).

Therefore, a re-examination of the managerial change effect in the Polish Ekstraklasa is warranted. This would allow for not only verifying the findings of Radzimiński et al. (2021) but also contributing to the discussion on the consequences of managerial changes within a league facing significant financial constraints. In the Polish league, these constraints not only lead to regular losses of standout players, who are difficult to replace, but also complicate the hiring of managers with established international reputations. Additionally, the heavy reliance of Polish clubs on public funds, including funds from state-owned companies and municipal entities, affects the stability of results and fosters a preference for short-term goals over long-term development of sporting quality. Due to these reasons, the Polish Ekstraklasa, with its unique characteristics, presents a significant yet underexplored area for research on the impact of managerial changes on sports performance, which this study aims to address.

3. Methods

3.1. Dataset

The study uses data on match outcomes, team ELO rankings, average bookmaker odds for individual matches, and managerial changes from 18 consecutive seasons of the Polish Ekstraklasa, spanning from 2006/2007 to 2023/2024. The data sources include the websites www.betexplorer.com, www.football-data.co.uk (for match outcomes and bookmaker odds), www.clubelo.com (for ELO ranking data), and www.transfermarkt.pl (for managerial changes). Information on managerial changes was verified against official press releases to confirm the reasons for these decisions.

During the period under analysis, the number of teams participating in the league and the structure of the league itself varied. In the 2006/2007–2012/2013 and 2020/2021 seasons, 16 teams competed in a double round-robin format, playing each other twice (home and away). In the 2013/2014–2019/2020 seasons, after a regular season, the league was split into two groups of eight teams, which then played a single round-robin. Since the 2021/2022 season, 18 teams have competed in a double round-robin format. Given that each match involves two teams and both teams' results were analysed separately, a total of 4910 matches, corresponding to 9,820 events, were examined.

A distinctive characteristic of the Polish league, compared to Europe's top leagues, is its schedule. Due to weather conditions, in addition to the typical summer break, the Ekstraklasa also has a nearly two-month winter break. During this period, the transfer window allows for significant roster changes and tactical adjustments. Consequently, managerial changes during the winter break do not exhibit the typical characteristics of mid-season changes analysed in this study. To address this, each season was divided into two competitive rounds: fall and spring, treated as independent periods.

3.2. Team Performance and Form

In each match, a team can achieve one of three outcomes: win, draw, or loss. Since teams' face opponents of varying levels throughout the season, a measure of team form should consider not only points earned (3 points for a win, 1 point for a draw) but also the differences in team potential. In the literature, there is consensus on the measures describing current and long-term team form.

The "Match Surprise" (MS) is defined as the difference between the points earned in a given match and the expected points based on bookmaker odds (Stadtman, 2006). It is represented by the following equation:

$$MS_k = R_k - (3 \cdot p_k^w + p_k^d) \quad (1)$$

where:

R_k represents the points earned in match k ,

p_k^w and p_k^d denote the probabilities of winning and drawing in match k , as determined by bookmaker odds.

The team's form throughout a round is measured by the "Cumulative Surprise" (CS), as proposed by van Ours and van Tuijl (2016). It is calculated as the sum of match surprises from the beginning of the round to a given point and is expressed by the equation:

$$CS_n = \sum_{k=1}^n MS_k \quad (2)$$

The value of cumulative surprise reflects how the team is performing relative to expectations. Significantly low negative values indicate underperformance, which can increase the likelihood of a managerial change.

3.3. Treatment and Control Group Construction

The purpose of this study was to analyse the impact of managerial changes on team performance. To achieve this, a modified procedure proposed by van Ours and van Tuijl (2016), later used by Besters et al. (2016), Scelles and Llorca (2020), and Flepp and Franck (2021), was applied.

From the raw data for the 2006/2007-2023/2024 seasons, 387 instances of managerial changes were identified. Changes made during the summer and winter breaks, as well as those occurring within the first or last three rounds of each half-season, were excluded. Temporary managerial changes and those not due to managerial dismissal (e.g., voluntary resignations unrelated to team performance) were also eliminated. Finally, instances of multiple managerial changes within a single team during the same round were excluded.

This process resulted in the selection of 127 mid-season managerial changes. For each instance, two scenarios were constructed: the first describing the team's form from the point of the change to the end of the round, and the second, an alternative scenario, assuming that despite similar results, the team management decided against a managerial change, giving the manager a chance to address the crisis.

The search for the optimal alternative scenario was conducted within the same club and rounds where no managerial change occurred. This was based on a comparison of cumulative surprise values. Following van Ours and van Tuijl's (2016) suggestions, it was assumed that the difference between the cumulative surprises for the actual and counterfactual managerial change scenarios should be less than 0.5. In cases where multiple scenarios met this criterion, the one with the smallest difference between match rounds was chosen as the alternative. As a result, an alternative scenario was matched for 115 of the 127 managerial changes considered. Instances where no alternative scenario was found were not included in the empirical analysis.

3.4. Empirical model

The analysis of the managerial change effect was conducted using the following model:

$$y_{ijk} = \eta_{ik} + r'_{ijk}\beta + \delta d_{ijk} + \lambda c_{ijk} + \varepsilon_{ijk} \quad (3)$$

In this formula, the dependent variable y_{ijk} refers to the measure of outcomes, such as points earned or goal difference, for the i -th team in the j -th match of the k -th season. The constant η_{ik} captures the unobserved quality of the i -th team in the k -th season. r'_{ijk} is a vector of variables affecting match outcomes, d_{ijk} and c_{ijk} are binary variables identifying observations assigned to the treatment and control groups, respectively. ε_{ijk} represents the error term.

From the research perspective, the key parameters are those for the d_{ijk} and c_{ijk} variables. The parameter δ measures the effect of the actual managerial change on team performance, while λ reflects the impact of retaining the manager (hypothetical change). Positive and statistically significant values of these parameters indicate an improvement in team results following a managerial change, whether actual or hypothetical. To confirm the existence of the "new manager effect", it is necessary to test whether the parameter for the managerial change is significantly higher than that for the hypothetical change. This is done using an F-test of parameter equality.

Two primary factors are recognized in the literature as potentially affecting match outcomes (r'_{ik}). The first is playing as the home team. Numerous empirical studies (e.g., Nevill, Holder, 1999; Pollard, 2008) confirm the existence of the "home advantage" phenomenon in football, primarily attributed to fan support and better adaptation to local pitch conditions. Therefore, the variable $HOME_{ijk}$, which indicates match location (1 = home team), is included in the model.

The second factor is the opponent's sporting level. In the literature, this is often captured using the team's final position in the previous season (Besters et al., 2016) or the current league standing of both teams (Scelles, Llorca, 2020). However, in a competitive and unpredictable league such as the Polish Ekstraklasa, referencing previous season results may not accurately reflect the current potential of the teams. Moreover, using ordinal variables like league position can be misleading as their significance varies depending on the timing within the season.

This study proposes an innovative measure – the ELO ranking system – as an alternative to traditional indicators. While originally developed for assessing chess player skill (Elo, 1978), the system's flexibility and ability to reflect both current and long-term sporting form have made it widely adopted in various sports, particularly for forecasting football match outcomes (Hvattum, Amtzen, 2010). The ELO system evaluates relative team potential, giving higher weight to strong performances against well-ranked opponents. For each observation, the variable ΔELO_{ijk} represents the difference in ELO rankings between the home and away teams.

Based on these data, binary variables d_{ijk} and c_{ijk} were defined, taking the value of 1 for matches played after the actual or hypothetical managerial change date and 0 for other cases.

Consequently, the estimated model takes the following form:

$$y_{ijk} = \eta_{ik} + \beta_1 HOME_{ijk} + \beta_2 \Delta ELO_{ijk} + \delta d_{ijk} + \lambda c_{ijk} + \varepsilon_{ijk} \quad (4)$$

4. Results and Discussion

The estimation results, presented in Table 1, illustrate the model described by equation (4), using two outcome measures: points earned and goal difference. As shown, regardless of the chosen dependent variable, all the explanatory variables are statistically significant at the 0.01 level, and the conclusions remain consistent across both measures.

Table 1.
Estimation Results for the Football Match Outcome Model

Variable	Points	Goal Difference
Home Match ($HOME_{ijk}$)	0.5045*** (0.0404)	0.6908*** (0.0531)
ELO Difference (ΔELO_{ijk})	0.0027*** (0.0002)	0.0043*** (0.0003)
Treatment Group (d_{ijk})	0.4057*** (0.0489)	0.5123*** (0.0648)
Control Group (c_{ijk})	0.4648*** (0.0513)	0.4773*** (0.0681)
F-test p-value for parameter equality	0.31	0.66

Note: Standard errors corrected for heteroskedasticity are presented in parentheses. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Own calculations.

The coefficients for the "Home Match" and "ELO Difference" variables are positive, suggesting that home teams benefit from playing on their own pitch, and a greater ELO difference, reflecting a stronger team, increases the chances of success.

The coefficients for the "Treatment Group" and "Control Group" are also positive, suggesting that team performance improves following a managerial change. However, this does not inherently confirm the "new manager effect". The positive coefficients for the "Control Group" variable imply that even without a managerial change, team performance might improve. To examine this further, an F-test was conducted to check for significant differences between these coefficients. In both models, the obtained p-values ($p = 0.31$ and $p = 0.66$) do not allow us to reject the null hypothesis, indicating that the effects of actual managerial changes and hypothetical changes are similar. Thus, in the Polish Ekstraklasa, there is no evidence that mid-season managerial changes significantly improve team performance.

These results are consistent with findings from top European leagues. Using a similar methodology, van Ours and van Tuijl (2016) obtained analogous results for the Dutch league, while Besters et al. (2016) drew similar conclusions regarding the English league.

However, comparing these results to studies based on leagues with a similar sporting reputation to the Ekstraklasa seems more relevant. Primarily, the findings differ from those of Radzimiński et al. (2022). Using data from the 2018/2019-2020/2021 seasons, these authors compared the average points earned before and after managerial changes. They observed that while performance improved following a managerial change, teams that retained the same

manager throughout the study period achieved even better results. These differences may be due not only to data from different periods but also to methodological differences.

Other empirical studies on leagues with similar sporting potential include analyses for the Austrian and Danish leagues. In the current UEFA rankings (September 2024), these leagues are ranked six and two positions above the Ekstraklasa, respectively. The study on the Austrian league (Wirl, Sagmeister, 2008) found no improvement in team performance following managerial changes, though it should be noted that the authors' methodology did not include constructing a control group. On the other hand, Madum (2016) found a positive effect of managerial changes in the Danish league, but this effect was only observed in home matches.

The results clearly indicate that the "new manager bounce" effect does not occur in the Polish Ekstraklasa. While team performance often improves after an in-season managerial change, this is mainly due to natural mean reversion, aligned with the actual potential of the team. This finding challenges the rationale behind costly dismissal decisions, as such changes primarily serve a symbolic purpose and rarely address the underlying structural problems of the team. Long-term managerial stability seems to be better, especially in leagues with limited financial resources (van Ours, van Tuijl, 2016).

It is important to note that the findings do not suggest that managerial changes in the season should be ruled out a priori. In some situations, such as conflicts between the manager and the club's board or players, the cooperation may no longer be. Each case is unique and should be evaluated individually. However, evidence suggests that in Poland, managerial dismissals during the season occur far too frequently and are often made impulsively.

It is an interesting question why clubs so frequently opt for a mid-season managerial change. A key factor appears to be the belief in the short-term effectiveness of such a move. The results indicate that, after a managerial change, the teams gain an average of 0.4 additional points per match and score approximately 0.51 more goals per game. This may create the illusion that dismissals are effective, particularly as the observer cannot compare this situation with the counterfactual scenario in which the previous manager was given the opportunity to improve results.

5. Summary

The goal of this study was to assess the validity of the managerial change effect in the Polish Ekstraklasa. Based on data from eighteen consecutive seasons, 127 instances were identified in which disappointing mid-season results led to a managerial change. For 115 of these cases, an alternative scenario was identified in which the same team was in a similar sporting situation, but the club's management chose not to dismiss the manager within the same round. The matching of these observations was based on cumulative surprise values.

The study found that both points earned, and goal difference improved after a managerial change. However, this improvement could be attributed to regression to the mean, as a statistically similar improvement was observed in teams where the manager was retained despite a sports crisis.

Although the study clearly indicates the absence of a managerial change effect, several factors explain why clubs persist in making such decisions. The primary drivers appear to be external and internal pressures, which compel decision makers to adopt bold measures aimed at alleviating the immediate crisis and restoring confidence in the organisation. These actions are often taken to address the "Ashenfelter's dip" phenomenon, where performance deteriorates before the intervention, leading to heightened expectations of a recovery following a managerial change.

Despite evidence that the observed improvement in performance after replacing a manager is often illusory, and considering the significant financial burden associated with contract termination, many clubs adhere to the "scapegoat theory." This theory suggests that any action, even if costly and potentially ineffective, is perceived as preferable to inaction, especially in a high-pressure environment where stakeholders demand visible responses to declining results.

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POTENTIAL OPTIONS FOR INTERNATIONAL TRADE

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Purpose: The main purpose of the article was to perform a critical analysis of existing theories of international trade and develop proposals for their improvement, which will allow to make the right decisions regarding trade policy in the future and to qualitatively predict the trends in the development of international trade and its impact on the socio-economic state of countries, regions and enterprises.

Design/methodology/approach: The main research methods in the article were the method of critical literary analysis and the method of morphological analysis.

Findings: Among all the theories of international trade, the most well-founded are those that explain it by natural and geographical differences between countries and differences in the costs of producing the same goods in different countries. The remaining theories of international trade require additional justification or interpret differently the influence of natural and geographical differences between countries and differences in the costs of producing the same goods in different countries.

Research limitations/implications: Further research is promising in the following areas: developing a methodology for determining the share of each of the two causes of international trade in terms of the total volume of international trade of individual countries and in terms of bilateral trade between countries; assessment of the existing distance resistance and forecasting its changes for various goods in bilateral trade between countries in terms of regions, modes of transport and time; activities of firms that can, in order to optimize taxes, carry out real or fictitious actions in the field of international trade; the impact of the national security factor on international trade.

Originality/value: There are only two reasons for international trade and, accordingly, only two most well-founded theories of international trade, which makes it possible to have three options for international trade for a single country or between any two countries.

Keywords: International trade, reasons for international trade, theories of international trade, distance resistance, options for international trade.

Category of the paper: Research paper.

1. Introduction

International trade has grown to enormous proportions, bringing significant benefits not only to its participants. At the same time, international trade also poses certain threats to enterprises and countries, related to dumping, exchange rates, foreign currency debt, and the relocation of production of goods to other countries, which is accompanied not only by economic losses in the respective states (jobs, tax revenues to budgets of various levels, etc.), but also by a decrease in national security if the production of strategic goods (weapons, medicines, etc.) is relocated. In order to predict the trends in the development of international trade and its impact on the socio-economic state of countries, regions, and enterprises, attempts have long been made to explain the causes of international trade, that is, attempts to create theories of international trade (Andresen, 2010; Jeyarajah, 2020; Mansouri, 2022).

2. Theories of International Trade: A Critical Analysis

The first theory of international trade is considered to be the theory of mercantilism (15th century), according to which a nation becomes wealthier and more powerful when it exports more than it imports (Johnson, 1974; Herlitz, 1964). According to the theory of mercantilism, a positive balance of foreign trade will remain in the country in the form of precious metals, in particular gold and silver, which, according to mercantilists and the public opinion of the time, were a measure of the wealth of countries and individual citizens.

But, if the mercantilist approach is analyzed from the perspective of the expediency of trade, it is worth emphasizing that the need for trade between countries arises when it is cheaper to purchase a desired good in another country and move it to one's own country than to produce it in one's own country (reason for international trade No. 1), or when it is possible to purchase and move to one's own country a desired good in another country that, for some reason, is not produced in one's own country or is produced in insufficient quantities (reason for international trade No. 2).

The hoarding of precious metals was actually the fashion of the time, and this means that the theory of mercantilism is not really a theory of international trade, but a theory of fashion of that time. Precious metals were exported from countries (which had efficient gold and silver deposits) where they were cheaper to countries (which did not have such deposits or their deposits were not efficient enough) where precious metals were more expensive.

The classical and even elite theory of international trade is considered to be David Ricardo's theory of relative advantage, according to which international trade can exist even under conditions of absolute advantage of one country in the production of all goods (Ricardo reduced

all costs to labor costs, which acted as a "universal currency" in his research), since it is more profitable for this country to focus on the production of goods (for domestic consumption and export) with a greater relative advantage, and to import goods with a lower relative advantage (Meoqui, 2023; Ruffin, 2002; Thompson, 2024).

In Ricardo's theory, everything seems to be elegant and delicate, understanding the theory is considered a pass to the scientific economic elite, but there is one "but". All these "relative advantages" in the production of various goods find their expression in the higher level of payment for more productive labor and in the higher exchange rate of the country that had an absolute advantage in the production of goods compared to another country. It is this increase in costs associated with wages and the exchange rate that makes it advisable to focus on the production of goods with a greater relative advantage, because only in the production of these goods will the country have (in the new conditions of the level of wages and the exchange rate) an absolute advantage. The absolute advantage of this country in the production of goods with a lower relative advantage will be lost by moving to another country, where the level of wages and the exchange rate will decrease. That is, Ricardo's theory of relative advantages is actually not one of the theories of international trade, but one of the theories of the exchange rate or one of the theories of wages.

A popular theory of international trade explanation is the Heckscher-Ohlin theory, according to which countries export goods that intensively use "surplus factors" and import goods that intensively use factors that are scarce for them (Brondino, 2023). The provisions of the Heckscher-Ohlin theory were somewhat later "mathematically supported" by Paul Samuelson, who in 1948 "proved the equalization theorem for the prices of production factors", according to which international trade leads to the equalization of absolute and relative prices for homogeneous factors of production (homogeneous capital is capital that has the same productivity and riskiness; homogeneous labor is labor with the same level of training, education and productivity; homogeneous land is land with the same fertility, soil condition, etc.) in trading countries (Brazelton, 1977; Dixit, 2012; Pickhardt, 2006).

Regarding Heckscher-Ohlin theory. Countries can export those goods for which the total costs (of production in the relevant country and transportation to the foreign market) are lower than the costs of production in the importing country. The presence of "surplus factors" affects the spatial differentiation of production costs, which can determine the feasibility of international trade, but the "surplus factors" themselves are not the cause of international trade. Therefore, the Heckscher-Ohlin theory can be considered not as a separate theory of international trade, but as a component of the theory based on the phenomenon of spatial differentiation of production costs.

Regarding the "equalization of prices" for homogeneous factors of production according to Samuelson. What kind of equalization of prices for homogeneous factors of production can we talk about if, for example, a significant difference in prices for the same quality of labor in different countries is a constant factor in the socio-economic development of civilization.

The price of land of the same quality in different countries can differ radically, since, unlike labor, land is a non-mobile resource. Similarly, we can talk about the price of capital - immobile capital of the same quality can differ significantly in price in different countries. And only mobile capital of the same quality can be characterized by a tendency to “equalize prices” in different countries.

A brief analysis of the theory of “price equalization” for homogeneous factors of production is general and has no bearing on the causes of international trade, since Samuelson did not claim to have “his” theory of international trade. Samuelson’s error regarding “price equalization” for homogeneous factors of production is not surprising against the background of another fundamental error of the Nobel laureate: in 1961 he predicted that in the period from 1984 to 1997 the USSR would overtake the USA in terms of economic size (Levy, Peart, 2009). But in 1984 the USSR began to decline critically, and in 1991 it ceased to exist. In 1997 the total size of the economies of the countries that emerged from the ruins of the USSR was no more than 25% of the US economy.

Proposed in 1966 by Raymond Vernon, the theory of the international life cycle of goods (also considered a theory of international trade) states that some goods go through a cycle consisting of four stages (introduction, growth, maturity and decline), and the production of these goods moves from one country to another depending on the stage of the cycle (Vernon, 1966). At the first stage (introduction), innovative goods are developed and produced: as a rule, the main role here belongs to economically developed countries, which will produce for the domestic market and for export. At the second stage (growth), the country where the innovation appeared, in addition to production on its territory, can start producing a new good abroad. A foreign competitor can also start producing the same good, and he can do this with minor changes, bypassing patent protection, or by purchasing a license. The produced goods will be intended for the domestic market of the relevant countries and for export.

In the third stage (maturity), global demand for the new good begins to stabilize. The technology for producing this good becomes so standardized that its production can be moved to less economically developed countries, from where the good will be exported to some foreign markets. Finally, in the fourth stage (decline), the technology is so improved that the production of the good no longer requires special labor skills, and therefore it moves to poor countries with a surplus of cheap labor, where the good will be produced both for the needs of the domestic market and for export.

In Vernon's theory, everything seems logical, but a deeper analysis shows that in fact the reasons for moving production from country to country are not problems with the availability of the technology for producing the good, but the usual geographical differences between countries (in the case when it is impossible to produce a good in some countries due to the lack of the necessary resource, for example, a skilled workforce) or the usual spatial differentiation of production costs.

In 1961, the Englishman Michael Posner proposed the Theory of Technological Gap, according to which one of the reasons for international trade is technological innovations that allow the innovator country to obtain a quasi-monopoly on the production of a new good and export it profitably and without competition (Posner, 1961). Over time, the technological gap decreases due to technology transfer, import substitution, and the introduction of interchangeable technologies in other countries. Then everything starts again: new innovative solutions (not necessarily in the same country) cause new export-import flows. Although the theory of technological lead is considered by some scientists to be an offshoot of the Heckscher-Ohlin theory, it can rather be called a component of Vernon's theory in the first stage of the life cycle of a good (implementation). If the implementation stage is implemented in a country, it is not due to the impossibility of implementing it in another country, but due to the high cost of this in the absence of the necessary resources there, primarily such as specialized infrastructure and qualified personnel. Non-mobile resources (specialized infrastructure) will need to be created, and mobile resources (qualified personnel) will need to be moved from other countries, which will require significant financial costs and a lot of time.

One of the theories of international trade is often called the gravity model, according to which trade between two countries is directly proportional to the product of their economic potential and inversely proportional to the distance between them (Anderson, 2011; Anderson, Van Wincoop, 2003; Tinbergen, 1963). In addition to GDP, the significance of countries' economies is modeled in gravity equations by population, area of countries, length of borders, etc. It can be agreed that the "force of economic gravity", that is, the size of trade between countries depends on the distance between them and the size of their economies, but they do not determine international trade. Gravity theory explains to some extent the volume of international trade, but not its reasons.

Among the theories of international trade, there is one that tries to explain its existence not from the side of production of goods, but from the side of their consumption. In 1961, Stefan Linder, studying the features of international trade in technologically new goods (refrigerators, televisions), with which US firms entered the European market in the 1950s, drew attention to the fact that although the main inventions that formed the basis for the development of these goods were made by Europeans, in practice these inventions were used in the USA to produce technologically new goods, which then conquered foreign markets, including Europe (Linder, 1961).

According to Linder, the wealthy American consumer was more inclined to consume new expensive goods, and with the increase in the standard of living of Europeans, new American goods found their way to Europe. Linder concluded that technologically complex goods are created by entrepreneurs as a response to needs that already exist, that is, primarily to the needs of the domestic market. And only after expanding production, after the saturation of the domestic market, the firm seeks to capture foreign markets. The firm will enter the foreign market on the basis of the goods it has prepared for national consumers, therefore,

the consumption structure of the importing country should be as similar as possible to the consumption structure of the exporting country. Thus, according to Linder, not only differences, but also similarities between countries can be a prerequisite for trade.

When characterizing this theory, it is worth emphasizing, first of all, that the “rich American consumer” could easily buy technologically new goods even if they were produced in Europe or, as has been the case in recent decades, in Japan, South Korea or China. At that time, the issue was not the “rich American consumer”, but the well-functioning US economy, which made it possible to produce high-tech goods at relatively low costs. At one time, American scientists had already made many inventions that were used as the basis for the production of goods in Japan - and not so much for domestic consumption as for export (including to the USA). That is, Linder's theory should be more reasonably interpreted not as a separate theory of international trade, but as a branch of the theory based on the phenomenon of spatial differentiation of production costs. A rich country can import goods, rather than produce them first for its own market and then for export.

The most recent theory of international trade is that of Paul Krugman, who won the Nobel Prize in Economics in 2008 (Krugman, 1979, 1981). According to his research, economies of scale are one of the important reasons for international trade, since the optimal scale of production that ensures maximum efficiency often exceeds demand within a country, which necessitates exports (Ethier, 1982). According to Krugman, even in the absence of other reasons for international trade, economies of scale make international specialization advisable, in which countries specialize in the production of certain goods (for themselves and for export), exchanging these goods through international trade.

The claim that the effect of specialization and scale is one of the reasons for international trade is easy to refute, since in fact, although the volume of production affects unit production costs (mostly in the direction of their decrease with an increase in production volume), and may even be one of the factors of spatial differentiation of production costs (since not all places may be suitable for large-scale production, which ensures a decrease in unit production costs), exports will arise not because the capacity of the national market is less than the optimal volume of production, but because relatively low production costs make the good competitive in domestic and foreign markets.

Thus, among all the theories of international trade, the most justified are those that explain it by natural and geographical differences between states and differences in the costs of production of the same goods in different countries. This conclusion is indirectly confirmed by the fact that international trade statistics and forecasting trends in the development of international trade in the future are oriented precisely on natural and geographical differences and differences in production costs.

3. Two reasons and three options for international trade

The first reason for international trade is the existence in at least one country of the world of demand for a good that is not produced for some reason within its borders (for example, due to the lack of suitable deposits – for example mineral extraction, a favorable climate – when considering agriculture or forestry, production of necessary goods), or is produced in insufficient quantities, while such a good is produced in at least one other country of the world and can be purchased and moved to the importing country. This situation arises due to natural and geographical differences between states (differences in climate, mineral deposits, economic structure, etc.), which are inevitable, although they can change (decrease or increase), and sometimes even be leveled.

One of the most interesting and promising situations (both from a scientific and entrepreneurial point of view) in the field of natural and geographical differences between states in terms of their impact on international trade is the difference of identical goods according to the criterion of the country of production, which creates an aura of originality for the goods (after all, each country is unique). In this situation, for example, carrots grown in Germany are a different good for many consumers than carrots grown in Poland, and, as a result, a situation of export of carrots from Germany to Poland (for Polish consumers who form the demand for German carrots) and counter-export of carrots from Poland to Germany (for German consumers who form the demand for Polish carrots) is possible.

The author of the concept of the difference of goods by the criterion of the country of production is Paul Armington, who in the article “A Theory of Demand for Products Distinguished by Place of Production” substantiates the thesis that consumers, as a rule, interpret the same goods, but from different countries, as different goods (Armington, 1969). And although such an interpretation cannot be considered rational, it is real. It is known that the basis of the prosperity of Greek cities and their colonies has always been trade, but it must be taken into account that the Mediterranean is quite homogeneous in terms of climate, soils and flora, and therefore it was possible to trade not so much different goods as special qualities of formally identical goods. It is believed that the subtle differences in the taste of wine and olive oil, the subtle differentiation of the shape and decoration of ceramic vessels became the basis of well-being, and without the ability to distinguish the subtle, nuanced properties of goods, the very formation of Greek civilization in its special form would have been impossible. But in fact, the special quality of wine, olive oil and ceramic vessels was produced in another country - polis, although located nearby.

The existence of such a situation seems to mean that differences in goods according to the criterion of the country of production make international trade inevitable, since these differences cannot but exist. However, everything is not so clear-cut: the level of demand (within the country and abroad) for such specific goods may not be sufficient for profitable

production, which, thereby, negates the inevitability of international trade due to differences in goods according to the criterion of the country of production.

Adam Smith in his famous work *The Wealth of Nations* was the first to claim that a country could have natural advantages due to its climatic features or the possession of unique natural resources (Schumacher, 2020). Since Adam Smith was the official discoverer of this type of goods, they can rightfully be called “Adam Smith goods”. Formally, “Adam Smith goods” include the same goods produced in different countries (because a country is also a geographical concept), but since Adam Smith did not even mention such goods, it is appropriate to call them “Paul Armington goods”, obviously in the “Adam Smith goods” group.

The second reason for international trade is that, due to the influence of various reasons, there are differences in the costs of producing identical goods in different countries, and if the magnitude of those differences is significant enough, then it becomes advisable to export the corresponding goods from a country of relatively cheap production to a country where production is relatively expensive. Such goods can be called “Adam Smith goods-2”, since it was Adam Smith who is the author of the theory of absolute advantages, according to which the reason for the emergence of international trade is the difference in the costs of producing identical goods in different countries (Tribe, 2006).

The existence of two reasons for international trade makes it possible to have three variants of international trade, which can characterize the situation in international trade for an individual country or between any two countries (Table 1).

Table 1.

Potential options for international trade by the criterion of its causes

Variants of international trade	Reasons for international trade	
	1) natural and geographical differences between states	2) differences in the costs of producing the same goods in different countries
1	+	-
2	-	+
3	+	+

Each of the options given in Table 1 is characterized by the existence of one or two reasons that determine the international trade of a single country or trade between two countries. Thus, option 1 assumes that the cause of a country's international trade is only natural and geographical differences between states, option 2 - only differences in the costs of producing the same goods in different countries, and option 3 - both natural and geographical differences between states and differences in the costs of producing the same goods in different countries.

It is worth emphasizing that any variant of international trade can be implemented only under conditions of not very significant distance resistance, the main characteristics of which are technical capabilities, costs, safety and speed of cargo movement. The two reasons for international trade mentioned (natural and geographical differences between states; differences in the costs of producing the same goods in different countries) are necessary, but not sufficient

for the emergence of international trade, since with very significant distance resistance, production must take place close to the sales market and be oriented, obviously, to local resources, since distance resistance will be strong not only for final goods, but also for the resources necessary for the production of these goods.

Only the reduction of distance resistance (primarily due to the development of transport communications and the reduction of import and export customs duties) in the presence of at least one reason for international trade makes international trade possible, activating its potential (Table 2).

Table 2.
Situations regarding the possibility of international trade

Significance of the reasons for international trade (1) and/or (2)		Distance resistance		
		A) Very significant	B) Significant	C) Insignificant
1) Significant	Impact only 1	1.1.A) No preconditions for international trade	1.1.B) International trade possible	1.1.C) International trade possible
	Impact only 2	1.2.A) No preconditions for international trade	1.2.B) International trade possible	1.2.C) International trade possible
	Common impact 1 i 2	1.3.A) No preconditions for international trade	1.3.B) International trade possible	1.3.C) International trade possible
2) Insignificant		2A) No preconditions for international trade	2B) No preconditions for international trade	2C) No preconditions for international trade

Under conditions of very significant distance resistance, with any significance of the reasons for international trade, the prerequisites for international trade are absent (situations 1.1.A, 1.2.A, 1.3.A and 2A). Under conditions of insignificant significance of the reasons for international trade, with any distance resistance, the prerequisites for international trade are also absent (situations 2A, 2B and 2C). In all other situations, international trade is possible.

Situations regarding the possibility of international trade from Table 2 should be characterized in sectoral, spatial and temporal aspects. The sectoral aspect consists in the dependence of distance resistance on the properties of the good: in a specific space and time, distance resistance for different goods will, as a rule, be different. The spatial aspect of situations regarding the possibility of international trade consists in the dependence of distance resistance on the properties of the space that must be overcome from the place of production of the good to foreign markets (legal status of the space, availability of transport communications, physical characteristics of the space, etc.). The temporal aspect consists in the change in time of distance resistance for different sectors and spaces, as well as in the fact that in general, distance resistance is characterized by a tendency to decrease over time for all spaces and sectors. The temporal aspect also lies in the fact that sometimes new spaces and new industries may appear with their own distance resistance indicators. An example of such a new industry is the production of goods using 3D printing technologies, which is characterized by a small distance resistance when moving materials for 3D printing and a relatively large distance

resistance when moving final goods. An example of a new space can be Space, which is increasingly becoming a place of production of various goods, including for international trade.

If the reasons of international trade are considered in the long term, then interesting and important nuances appear here. First, among the natural and geographical differences between countries, it is worth distinguishing between differences that are long-term in nature and cannot really be changed (for example, climate), and differences that can be leveled over time (for example, the availability of production of certain goods, transport connections). If a decision is made regarding this second group of differences on the expediency of their leveling (for reasons of economic feasibility or national security), then this will automatically lead to the removal in the future of these current differences (for example, regarding the availability of production of certain goods, transport connections) from the list of natural and geographical differences between countries that are the cause of international trade. The possibility of such a situation should be taken into account both when classifying the causes of international trade, and when analyzing it and assessing trends and prospects.

The international trade of a country is also characterized by regional and seasonal aspects. The regional nature of international trade is manifested in the fact that at the same time some regions of the state can export a certain good, and some can import the same good. The seasonal nature of international trade is that in some periods of time the state can export a certain good, and in some periods of time the same good can be imported.

4. Conclusions

Among all the theories of international trade, the most well-founded are those that explain it by natural and geographical differences between countries and differences in the costs of producing the same goods in different countries. This makes three options for international trade possible for a single country or between any two countries. Only the reduction of distance resistance in the presence of at least one reason for international trade activates its potential.

Further research on the topic of the article is promising in the direction of developing a methodology for determining the share of each of the two causes of international trade in terms of the total volume of international trade of individual countries and in terms of bilateral trade between countries. An important direction for further research is to assess the existing distance resistance and predict its changes for various goods in bilateral trade between countries in terms of regions, modes of transport and time. It would be advisable to study the activities of transnational corporations, which can, in order to optimize taxes, carry out real or fictitious actions in the field of international trade. It would also be reasonable to research the impact of the national security factor on international trade.

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THE TRIANGLE OF HARMONIOUS DEVELOPMENT OF A MODERN ORGANIZATION – AN INTEGRATED APPROACH

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Purpose: The aim of this article is to underline and explain the need for comprehensive scientific reflection on the functioning model of organization based on two factors: work and family life with a third element – technology.

Design/methodology/approach: The article is a review and discussion. The conclusions presented in the article are the result of non-reactive research based on the analysis of secondary sources - scientific literature. The method of scientific inference was inductive. Sources of information used to write this article are interdisciplinary in nature: in the field of management sciences, sociology, psychology and ethics.

Findings: The value of the analysis is the attention focused on an attempt to maintain a balance between all components, i.e. working time, family/private life and technology (tech-life balance). The authors prepared a model in the form of a diagram of overlapping areas and their characteristics that can be used in subsequent empirical studies. For this purpose, the most important theoretical approaches present in the literature of various scientific disciplines concerning, among others, the concepts of work-life balance, sustainable digital footprint and tech-life harmony were conceptualized.

Research implications: Future research should consider examining the impact of the highlighted factors on organizational development, providing a more comprehensive analysis of the impact of individual areas on entrepreneurs' decisions.

Originality/value: This article presents a holistic perspective of conscious management within the distinguished areas of a harmoniously developing organization. Entrepreneurs can benefit from implementing a holistic management strategy that can improve business efficiency, encourage innovation, and improve coping with business challenges.

Keywords: work-life balance, technology, sustainable digital footprint.

Category of the paper: Conceptual paper.

1. Introduction

The article was inspired by theoretical reflection on the changes taking place in organizations in the context of the contemporary development of new technologies. The authors would like to pay special attention to the concepts of *tech-life balance*, *work-life balance* and *digital footprint*. All these approaches concern the dilemmas of the socio-ethical functioning of modern organizations. Accelerating changes in the labor market and the growing importance of civilization competences mean that a person as a single entity with specific cognitive abilities is not able to control all technological advances. This is also reflected in their mental state and family life. The need to acquire new skills in operating even simple devices or to use the help of professionals leads to various consequences in the form of further social problems and frustration. On the other hand, the emergence of creative solutions, new companies, new products, as well as new jobs and professions is observed. The main goal of the article will be to comprehend the functioning model of organization based on two factors: work and family life with a third element – technology. Authors will propose their own model of harmonious development of an organization considering the above-mentioned factors and suggest specific research areas assigned to them. The article is a review and discussion. The conclusions presented in the article are the result of non-reactive research based on the analysis of secondary sources - scientific literature. The method of scientific inference was inductive. Sources of information used to write this article are interdisciplinary in nature: in the field of management sciences, sociology, psychology and ethics.

2. Methodological approach

The multidimensionality of issues related to human-organization relations determines the methodological approach and scientific methods. The dynamic entry of technology not only into production, but above all into management and our private lives has led to the need for an interdisciplinary synthesis of the achievements of social, humanistic and natural sciences. Borrowing scientific achievements and engaging cybernetics has also proven necessary. Nowadays, quantitative research is commonly used in researching and analyzing social and humanistic aspects. This translates into a very rigorous approach to research methodology. However, it should be remembered that humanities and social sciences use the methodology of researching ideas, values, beliefs, stereotypes and practices related to specific social and cultural phenomena. They are located on the border between science, social perception of technology and popular culture.

For exploration, the study uses methods typical of ethical reflection, guided by the idea of synthesis, similarly to Alvin Toffler: "Without fully grasping the whole phenomenon, we cannot understand the clash of powerful forces in the modern world; like survivors we try to navigate without a compass and a map among dangerous reefs during a storm. In a highly specialized culture, in which everyone is absorbed in the detailed analysis of scattered and huge amounts of data, synthesis is not only useful, but also crucial" (1986, p. 24). The starting point of considerations around the harmonious development of an organization, together with such a constructed methodological freedom, is an attempt to combine selected problem issues. The first important dimension will concern the social and ethical aspects of the relationship between family life - work - technology - with particular emphasis on the dimension of pragmatism, trust and fascination with new technologies. The second dimension of the analysis will include determining research needs emerging as conclusions from the considerations conducted so far on the still undeveloped research areas related to harmonious development. In our opinion, the empirical use of the proposed model can inspire not only researchers from the area of social sciences and humanities, but also sensitize researchers from the area of exact sciences.

3. Main findings

Work-life balance is a key element in maintaining harmony and well-being of an individual. This is becoming the subject of an increasing number of scientific studies and empirical analyses, also by practitioners. This has its scientific implications in terms of theories being developed and research topics being undertaken. Contemporary changes in the labor market are characterized by dynamic technological progress, which is associated with the emergence of new challenges in the context of organizing working time and the employee's private space. In the context of the holistic development of an individual, *work-life balance* is fundamental for maintaining mental health, motivation and overall life satisfaction.

In turn, in the *tech-life balance* concept, technology is to be understood not only as a tool supporting productivity, but at the same time it cannot be a factor increasing the mental burden of employees. Technology undoubtedly increases operational efficiency and allows for time flexibility. On the other hand, however, the blurring of the boundaries between the professional and personal spheres is observed. Therefore, the key task of employers is to implement strategies and policies that support maintaining a balance between work and personal life, which leads to an improvement in the quality of life of employees and an increase in their involvement in achieving organizational goals.

From the employer's perspective, the issue of the *digital footprint* generated by employees is also becoming particularly important. In the era of intensive digitalization, almost all professional activities leave a trace in the form of data, which is associated with the need for responsible data management and protection of employee privacy. Employers' responsibility includes not only ensuring compliance with legal regulations on data protection, but also shaping digital social responsibility policies that consider the mental well-being and protection of the integrity of employee privacy. All these issues are analyzed within their own areas.

Based on the analyses of the most important threads characterizing individual approaches, it is time to propose a new integrated model for the harmonious development of modern organizations.

3.1. Work-life balance

Recent dynamic events in socio-economic life show the increasingly significant impact of various types of crises on the approach of employees to their professional duties. Due to global changes and experiences such as the Covid 19 pandemic, there is a need for a balanced approach to work, which is why the concept of work-life balance has gained popularity. Work-life balance is defined as achieving satisfying experiences in various aspects of life that require different resources, such as energy, time and commitment, and these resources are distributed across all areas of an individual's activity, from professional, through family, to recreational, religious and others. Work-Life Balance is the ability to combine work with other dimensions of a person's life (such as family, personal interests or social activity). We talk about balance when professional work does not take place at the expense of private life and vice versa. This is made possible by the ability to manage time spent on work and outside it "by activating benefits, organizational changes and special intervention programs" (Kubicka-Daab, Manikowski, 2003, p. 234). The origins of WLB can be traced to the 19th century labor movement seeking to regulate working conditions (including the prohibition of child labor, the introduction of minimum wages, and limits on overtime). However, it was the mass entry of women into the labor market in the 1960s and 1970s that gave rise to research on work and family, leading to the formulation of the WLB concept and models. In the 1980s, spillover theory, compensation theory, and conflict theory emerged, emphasizing the separation of work and family (segmentation), and in the 1990s, attention shifted from working mothers (and their support) to the organization and all its employees, including issues of stress, health, absenteeism, retention of valuable employees, morality, egalitarianism, job security, labor market flexibility, and global competition. It was then that WLB began to be seen as a task not only for the individual but primarily for the professional organization. The basic instruments have become: flexible working hours, flexible workplace, job sharing, holidays, employee support, etc. WLB began to be justified by the theory of boundaries and borders, enrichment theory, facilitation theory, instrumental theory, ecological systems theory, ladder theory or compatibility theory (Khateeb, 2021, pp. 29-33). In the American model, WLB is based on the

employer's voluntary action aimed at attracting and retaining valuable employees by creating working conditions that enable effective work and development. In the Western European model, the employer's activity is regulated by legislation, and the national legislator guarantees and enforces a minimum of social security for employees (Borkowska, 2010, p. 18). WLB policy evolves along with economic, demographic and social changes. Initially, it was aimed at separating private life from work in order to limit the impact of work on the private life of employees. In the next phase, the need for a harmonious combination of professional and family life through work-life and work-family programs was emphasized. With the development of the Internet and intelligent technologies and the development of e-business and e-commerce, we are dealing with the third phase – tech-life (Gajdzik, 2018; Mahajan, Guleria, 2022).

Conclusions regarding work-life balance, in the context of technology, emphasize the need for well-thought-out strategies and solutions that make it easier for employees to reconcile social and professional roles (FOB, 2020). The most important issues include moving work home, even remotely, which can lead to difficulties in separating these two spheres - private and professional life. One of the main challenges remains time conflict, when professional duties clash with the demands of private life. Digital technologies, although they offer flexibility, can also lead to being constantly "online", which results in overload and burnout. Conscious time management and limiting availability after working hours are necessary. Many studies also emphasize conflicts related to combining professional and personal roles. Employers introduce programs to support work-life balance - in practice, however, achieving balance requires the involvement of both employees and employers, including through the use of pro-family policy instruments and friendly working conditions (Žak, 2017). Appropriate time management and a clear division of responsibilities in the family can contribute to achieving harmony between these spheres. The work-life balance approach proposes implementing legal solutions that make it easier to maintain this balance, such as flexible working hours or additional parental leave. The introduction of flexible forms of work that take into account the needs of employees can help build a positive atmosphere in the workplace and promote long-term employee well-being. Employers, by taking care of the mental health and well-being of employees, can increase their engagement and loyalty, which affects the organization's results and employee satisfaction. The development of digital technologies should support, not disrupt, work-life balance, which is why strategies are necessary to limit the negative effects of being online outside of working hours and allow employees to regenerate.

3.2. Tech-life balance

Socio-economic development has been approached by various researchers, considering the industrial and post-industrial eras. This happened for many decades. Recently, however, changes known as Industry 4.0 have been taking place. The increasing automation and robotization of processes, the use of Internet information and the complexity of modern

technologies result in changes in productivity potential. In the first decade of the 21st century, there was a clear increase in the number of smart devices, changes in the structure of production plants towards Smart factories and an increasing number of users of smart home equipment. A characteristic feature of Industry 4.0 is the combination of robots equipped with artificial intelligence elements with mobile technology already known in the information society.

The history of the industry so far proves that technologies have already revolutionized the socio-economic conditions three times. It is enough to refer to the consequences of James Watt's invention (18th century), when his steam engine replaced the work of human muscles by powering the production machines of textile plants in England, through the industrial revolution based on the use of electricity, to new technologies that resulted in the implementation of automatic production based on programmable drivers and computers (Kaczmarek, 2020). Global forecasts regarding the development of Industry 4.0 are a premise for implementing new work patterns and thus changing the paradigm of the concept of human resources management. Robots will increasingly become not only assistants cooperating with employees but will also act as digital/virtual employees themselves. The new reality raises problems in planning, organizing, motivating and controlling staff that have not been noticed until recently. A new variable is introduced into the already known system, which significantly determines the implementation of an innovative approach. Human Resources departments will no longer only be responsible for the recruitment and selection of appropriate employees – often talents, their training and care for appropriate employer-employee relationships. The new reality requires the correct definition of technological potential and the possibility of implementing new, intelligent technologies and finding a balance with employee well-being. A particularly dramatic example of such actions was the time of the Covid-19 epidemic and the lockdown of the economy. Such a crisis has shown that an enterprise is 4.0 only when it manages to connect and integrate all activities in the supply chain and people management. It was necessary to change the nature of the work performed to a greater share of remote work or to create virtual teams (Kamińska-Berezowska, Suchacka, 2022). This made it necessary to provide employees with the opportunity to acquire the necessary digital competences. This was, of course, associated with certain difficulties depending on the nature of the work performed so far. One of the most interesting ideas that clearly combines the concept of Industry 4.0 with the need for possible retraining and adaptation to changes is the issue of digital social responsibility. The sources of this concept can be found within the corporate social responsibility (CSR) trend. In addition to the obvious image goals that accompany these activities, there is a growing trend of authentic digital responsibility. It translates into shaping and expanding employees' awareness (Suchacka, 2020). As part of the steps taken, programs are created to popularize this responsibility in the field of technologies used and securing digital data, training programs for employees preparing them for difficult situations in how to deal with digital information, as well as taking the concerns of customers and employees seriously.

According to Currie and Eveline (2011), the boundary between work and private life has been blurring since the 1980s, and the development and dissemination of technology make these boundaries more fluid and permeable. Technology increases work efficiency and productivity of working people, but also challenges work-life balance (Borkowska, 2004). Technology makes working people more accessible anytime, anywhere, anytime, and lives under time pressure and stress (Teagarden, Meyer, Jones, 2008). These changes affect employees not only individually, but also affect society and social groups (Wajcman, 2008). The interaction between technology and work life can take many forms: it increases employers' expectations, resulting in the feeling of constantly being on duty (Towers et al., 2006) and working in a private living space (Hislop, Axtell, 2007).

The existing literature on the subject has few studies considering the importance of new technologies in shaping human activities in the private and professional spheres (Gajdzik, 2018; Mroczkowska, Kubacka 2020; Mahayan, Guleria, 2022; Popovici V., Popovici A.L., 2020). The scarce research material makes it difficult to conduct comparative analyzes or formulate constructive conclusions, especially since there is a lack of clarity both at the conceptual stage and when developing conceptual models. Moreover, existing research brings contradictory conclusions regarding the consequences of the increased impact of technology on work and family life (Currie, Eveline, 2011; Fernback, 2018; Heijstra, Rafnsdottir, 2010). Some studies focus only on certain areas of professional work: academia (Adisa et al., 2022; Heiden et al., 2021; Potter et al., 2022), private organizations in the electricity sector (Mahajan, Guleria, 2022), banking sector (Rahaman et al., 2020) or health care (Chen, 2024). The resulting practical implications are interesting in the context of the specific nature of work but cannot be the basis for generalization to other employment sectors. The dynamics of technological change and its social effects are extremely difficult to grasp (Khallash, Kruse, 2022). The essential element of this transformation is a well-educated person who implements modern management methods, leading to building a people-focused organization, adopting a systemic approach and building a friendly, goal-oriented work environment. Another interesting concept related to this topic is the techno-stress that employees may experience. The sources of techno-stress are categorized by different researchers in various ways (Dragano, Lunau, 2020, p. 408). However, the most common causes of techno-stress include:

- techno-overload – intensifying the pace of work and extending the time of performing professional duties;
- techno-invasion – reaching users at any place and time, which may contribute to blurring the boundaries between work and other domains of life;
- techno-complexity – cases where the complexity of ICT poses a challenge to employees; this is accompanied by a feeling of incompetence and the need to devote time and effort to learning and understanding various aspects of ICT;

- techno-insecurity – feeling of threat of losing one's job to new technologies or fear of better qualified employees;
- techno-uncertainty – a sense of uncertainty due to the ongoing development of ICT – knowledge quickly becomes outdated and must be constantly supplemented with current solutions (Ragu-Nathan, T.S., Tarafdar, Ragu-Nathan, B.S., Tu, 2011, p. 310).

To deal with these issues wisely, it is important to analyze development from the employee's perspective. Kagerman and his colleagues noted that it is necessary for companies to use a sociotechnical approach in which employee participation in workplace design is crucial (Kagerman et al., 2013). Without employee participation in creating a new digital work environment, the desired results may not be achieved at all. The role of humans in the context of new technologies is changing. Unlike previous concepts, such as CIM (Computer Integrated Manufacturing), Industry 4.0 does not aim to create factories in which people will be replaced by robots. Industry 4.0 makes factories a better place to work. People are invariably the most important, and thanks to new solutions they will receive much greater support than before. However, employees very often perceive new technologies only through the prism of threat and job loss, which constitutes a huge barrier to the implementation of innovations (Grebski, Mazur, 2020).

It is worth emphasizing that, in parallel to the activities undertaken by business practitioners, researchers from various disciplines increasingly often point to the responsibility of broad elites and scientific authorities for the process of raising awareness of potential threats that may completely change our civilization due to technological changes. The perceived, disturbing trends and presented worst-case scenarios lead to the desire to control the development of technology. F. Fukuyama wrote about it at the beginning of the 21st century, pointing out the fundamental difficulties: "The only way to control the spread of technology is to create international agreements on technical restrictions, which are very difficult to negotiate and even more difficult to enforce. In the absence of such international agreements, any country that imposes regulation on its territory will simply help its competitors" (Fukuyama, 2004). Attempts are being made to systemically regulate and support people unemployed through automation and the development of new technologies. However, broader systemic solutions on a global scale are necessary. However, various analyzes show that there is no uniform approach to this issue by state governments due to their different political goals (Digital Poland Foundation, 2024). The integrity of actions taken at various levels remains a problem. However, it can be assumed that the reason is differences and degrees of advancement in the use and understanding of modern technologies. Hence, there is a need to investigate the understanding and implementation of the concept of tech-life balance and to identify problem areas in its practice.

There is therefore a justification for examining whether and how it is possible to maintain a balance between the professional and private spheres in the context of the use of new technologies in both spheres of life. Introducing the concept of tech-life balance into research

will allow for the inclusion of new, previously unanalyzed factors, but will also allow for the consideration of the perspectives of members of different sectors of the economy on the impact of technology on their work and life.

3.3. Sustainable digital footprint

With the development of information systems, the Internet and various digital platforms, employees using them while performing their professional duties leave behind digital traces. This concept appeared in English literature in the early 2000-2010s (Anjewierden, Efimova, 2006; Girardin et al., 2008; Roberts, 2000; Weaver, Gahegan, 2007). In Poland, this coincided with the emergence of the term "information management". Digital traces can be analyzed with respect to who creates them and what they are. Therefore, a digital trace is certainly created by an individual. Although it can also be created by a group. It should be remembered, however, that it is a specific person who uses a device that allows for recording a digital trace. Considering the objective dimension of a digital trace, it can be defined as information combined with metadata. This may include data such as login traces, search history, e-mail messages or activity in company applications. The digital footprint can support team management by allowing for monitoring work efficiency and identifying potential issues, such as those related to information flow. At the same time, it also poses a significant challenge to the privacy of employees, who may feel pressured to monitor their activities. In the context of security, the digital footprint can be a key factor in identifying incidents, such as attempted unauthorized access or security breaches (Golik-Górecka, 2024). Companies must therefore ensure that this data is properly secured to prevent its leakage or unauthorized use, which could expose the company to financial and reputational losses. Another problem is the risk of cyberattacks, which can be directed at employees and use their digital footprint to gain access to sensitive company data. An important aspect is balancing control over employee data with maintaining their privacy and compliance with legal regulations, such as GDPR. Therefore, companies often implement data protection policies and training to increase employee awareness of threats. Employees' digital footprints in companies are becoming significantly important for their well-being and mental health. These traces, understood as data generated by online activity, can be the basis for understanding their behavior, interactions and preferences. Analyzing digital traces allows us to draw conclusions about the work style, efficiency and mood of employees, which can be useful in creating strategies supporting their mental and physical well-being. However, collecting this data raises some ethical controversies. On the one hand, it allows us to identify areas in which employees may need support, such as stress management or building health habits. On the other hand, excessive control or monitoring can lead to employees feeling negatively about the invasion of their privacy, which can lead to increased stress levels and feelings of surveillance. Research indicates that responsible management of employees' digital traces can support their health and productivity, especially if employees are aware of and consent to such activities (Gaweł, 2022). In this context,

it is crucial to develop digital education that will enable employees to better understand their digital traces and the potential consequences of their online activities. Managing digital traces can also support employee well-being by helping them maintain a balance between their private and professional lives. Digital traces can provide information about work habits that may be related to overload or lack of engagement. Analyzing such patterns can help managers take action to improve working conditions and overall well-being.

Introducing transparency policies and employee control over their own data can lead to increased trust and a sense of autonomy. Employees who have an impact on how their data is used can feel more valued and less susceptible to the negative effects of feeling supervised. This balanced approach is increasingly emphasized by HR and IT professionals.

4. Conclusion - new integrated approach - the triangle of harmonious development of a modern organization

Considering the discussed concepts: *work-life balance*, *tech-life balance* and *employee digital footprint*, an integrated model can be created, defining research directions that could help understand the impact of each of these elements on the development of the organization and on the well-being of employees. (Figure 1).

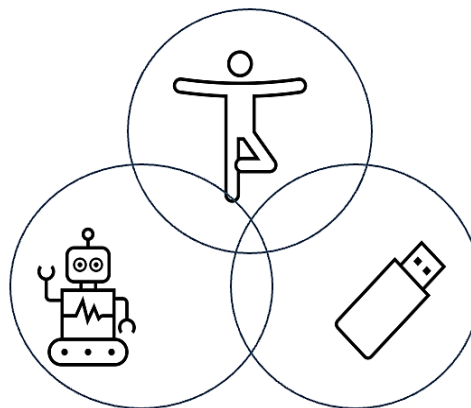


Figure 1. New integrated approach – the triangle of harmonious development of a modern organization.
Source: own elaboration.

The model is the result of overlapping areas and a proposal presented by the authors for further analysis. I do not have the character of a scientifically proven model. It is rather a loose suggestion submitted for consideration. The proposed directions of research result from the conclusions drawn from the analysis of the literature presented above.

There are several arguments in favor of conducting this type of research. First, the need to improve employee well-being and engagement is increasingly being taken into account by entrepreneurs. There is a need to identify factors that affect stress, burnout, and digital fatigue.

By understanding these factors, organizations can implement solutions and policies that support the mental and physical health of employees. The result is increased job satisfaction, which translates into higher team efficiency and engagement. Research in this area allows us to understand how organizations can promote a balanced approach to technology that increases productivity but does not lead to digital overload.

Table 1.

Potential research directions within the integrated approach of the triangle of harmonious development of a modern organization

Conceptions	Integrated research directions	
	research topic	explanation
Work-Life Balance	the impact of flexible working hours and remote work on work-life balance	research on how different work models affect employees' mental well-being and efficiency
	the importance of organizational support	analysis of the impact of organizational policies (e.g. additional days off, support programs) on the quality of work-life balance and employee engagement
	long-term effects of hybrid work	analysis of the impact of different forms of work on the quality of social relationships, stress levels and long-term career development of employees
	the role of managers and leaders in creating a work-life balance culture	study of supervisors' attitudes and their impact on employees' attitudes towards work-life balance
	work-life balance and generational differences	analysis of different expectations related to work-life balance among the Baby Boomer, Gen X, Millennials and Gen Z generations
Tech-Life Balance	the digital fatigue phenomenon	a study of how frequent exposure to technology affects employees' mental and physical well-being.
	the effects of "always-on"	an analysis of the consequences of constant availability (e.g. via email, instant messaging) on stress levels, burnout, and personal life satisfaction
	the role of "no after-hours" policies	an examination of how implementing policies that limit off-hours work affects employees' tech-life balance and work-life balance
	screen time and productivity	an analysis of how screen time affects employees' work efficiency and quality
	perception of breaks from technology	an examination of how organizations can promote technology breaks and what this means for long-term employee engagement
Sustainable digital footprint	the impact of employee activity monitoring on their sense of privacy and job satisfaction	research on how different levels of monitoring affect employee trust and comfort
	the ethics of managing a digital footprint	analysis of employee perceptions of the ethical boundaries of data collection at work, as well as the consequences of their use
	the impact of a digital footprint on work efficiency	analysis of whether digital data analysis can support or hinder task and process optimization
	employee awareness of their digital footprint	analysis of how well employees understand what data they generate and what the consequences of this phenomenon are
	the impact of data transparency on employee relationships	analysis of how an organization's openness about its digital footprint and data policy affects employee trust and engagement

Source: own elaboration.

Topics related to the ability to harmoniously combine professional and private life and to create a balance in the use of technology, issues of preventing digital addiction and technology fatigue will certainly be interesting threads of many research works in the coming years. The issues of digital generation of traces by the employee are also added to this. The introduction of research from these areas can help create more harmonious, balanced working conditions and in the management of organizations that care for the well-being of employees in a diverse and digitalizing environment.

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MULTICRITERIA ANALYSIS OF QUALITY OF LIFE – THE CASE OF POLISH VOIVODESHIPS

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Purpose: This paper aims to analyze Polish voivodeships in terms of quality of life (QoL) in 2022 and determine the criteria that can be chosen to check the QoL of Polish citizens. The study shows the usefulness of using the multicriteria decision-making (MCDM) methods to create the final ranking. These kinds of analyses can be crucial for assessing the well-being of residents of given areas. They can serve as guidelines for policymakers on how to shape regional policies. MCDM methods can be seen as valuable tools for such purposes.

Design/methodology/approach: A set of nine criteria affecting the quality of life of Polish citizens in 2022 was chosen. The data was obtained from the Statistics Poland database. The ranking was prepared using the Preference Ranking Organization Method for Enrichment of Evaluations II (PROMETHEE II). Criteria weights were determined by Shannon's entropy method and equal weight method.

Findings: The study shows that considering the chosen criteria and their weights determined with Shannon's entropy method, in 2022, QoL was the highest in the Mazowieckie and Wielkopolskie voivodeships, while the lowest in Lubelskie and Warmińsko-Mazurskie voivodeships. The research results can also lead to the assumption that geographical location significantly impacts the residents' QoL.

Research limitations/implications: The main limitation of the study was the selection of appropriate criteria that affect QoL in Poland post-COVID-19 pandemic. The subsequent ranking results are subjective due to the high dependence on criteria. The rank is also sensitive to changes in the weights of individual criteria.

Practical implications: The results of the study allow us to demonstrate the diversity of Polish voivodeships in terms of the QoL of Polish citizens. At the same time, the analysis of the criteria allowed for capturing the state of well-being of the population, considering the maximization of some criteria while, at the same time, minimization of others.

Social implications: The paper aims to highlight the importance of using MCDM methods and tools to observe the level of quality of life on the NUTS-2 level.

Originality/value: The paper shows an up-to-date approach to the problem of the multicriteria assessment of QoL in Poland on a regional level.

Keywords: quality of life, multicriteria decision making, PROMETHEE II, entropy.

Category of paper: Research paper.

1. Introduction

Quality of life (QoL) can be seen as a multidimensional concept with both objective and subjective dimensions. It can be challenging to reach a consensus on how to define QoL since it has been studied for years using various methodologies. QoL is regarded as a component of urban design and is a part of sustainable development and sustainability in general (Feneri et al., 2015). The way that modern people live makes the problem even more profound due to the fact that a person can live in one place while working and spending free time in another (Ceccato, Snickars, 1998). Overall, QoL can be seen as a complex social indicator which has its roots in economics and sociology (Imbulana Arachchi, Managi, 2023). It is one of the most important and fundamental issues in the basic categories of social statistics. The term is used in social policy, psychology, pedagogy, medicine, philosophy, economics and sociology (Roszko-Wójtowicz, Grzelak, 2018).

QoL can be viewed from two key perspectives: the subjective and the objective. Subjective QoL is one's personal view of one's own life in terms of emotional, physical and material well-being. The indicators that are used to describe these fields often measure the level of individual satisfaction with aspects such as social and working life, health, living environment, and wealth (Felce, Perry, 1995). Objective QoL is measured using objective criteria and external factors (e.g. social and economic indicators) except for personal feelings or the perception of one's environment. The objectivity of QoL can be linked to the fact that quantifiable data may be obtained on numerous aspects of QoL implementation, and a wide range of indicators can be employed for selected assessments (Pukeliene, Starkauskiene, 2011). A definition based on an objective evaluation proposed by Felce and Perry (1995) described QoL as *an overall general well-being that comprises objective descriptors and subjective evaluations of physical, material, social, and emotional well-being together with the extent of personal development and purposeful activity, all weighted by a personal set of values*. It should be noted that this definition was chosen for the study as it treats QoL broadly and considers that the interdisciplinarity of the concept results in a multitude of definitions available in literature.

Table 1.
Levels of QoL

Level	Objective	Subjective
Individual	Objective living conditions	Subjective well-being
Societal	Quality/livability of society	Livability of society

Source: (Delhey et al., 2002).

The research presented in this paper is based on an economic perspective of measuring QoL at the regional level. Achieving balanced growth and reducing disparities in regional development have become key concerns for policymakers, researchers, and planners. It is important to highlight that while QoL is closely linked to the concept of living standards, they represent different dimensions of well-being. Living standards primarily focus on

economic and material conditions, such as income, employment opportunities, and housing quality. In contrast, QoL encompasses both material well-being and non-material factors, including health, environmental quality, and overall life satisfaction.

Research on the QoL in Poland, especially in 2022, is of great importance for several reasons. Firstly, it was the time of international post-pandemic recovery, when assessing social wellbeing was crucial. Furthermore, Poland's economy experienced significant variations in inflation and changes in the labor market, potentially impacting the daily lives of its citizens. Also, these kinds of analyzes are important in terms of urban planning and future creation of social welfare programs.

2. Literature review

The analysis of various aspects and levels of QoL suggests that rather than trying to define the concept itself, it would be more effective to conduct research based on an in-depth analysis of the factors that influence it and to further classify them. Despite a growing interest in studying QoL, there is no standard classification of factors that affect it. There is also no universal methodological model for measuring it, which would also serve as a guide for the identification and systematisation of the determinants of QoL. The identification of interrelationships of the determinants proves to be a complex and time-consuming process.

The literature review shows that researchers often focus on trying to explore potential frameworks, identifying and organising the elements that shape QoL and the relationships between them. Works by various scholars show that the internal and external environment plays a crucial role in shaping QoL. The level of development of a country and its political and socioeconomic conditions give an individual the opportunity to improve their living standard and enhance overall well-being (Pukeliene, Starkauskiene, 2011).

Murgaš and Klobučník (2016) studied the QoL on a regional micro-level in 6251 Czech Republic municipalities. Their research proved that there is a substantial spatial differentiation of QoL in all hierarchical levels in the studied regions. Majeed (2018) examined how globalisation, in its economic, social and political dimensions, influenced the QoL across 44 Islamic countries over the period from 1970 to 2010. Cui et al. (2018) studied the connection between QoL and the development convergence of regional economies in China, where sustainable, high-quality growth is starting to become the key factor in driving the national economy. This can be seen as a paradigm shift from focusing on rapid economic expansion.

The literature review also shows that there are various up-to-date articles concerning the topic of QoL with regard to multicriteria decision-making. Doumpos et al. (2020) provided a quantitative approach to the problem of assessing the QoL in French municipalities. Hurajova and Hajduova (2021) pointed out that QoL can be seen as a subjective measure of happiness

that can be quantified using multicriteria techniques. Their research focused on eight regions of Slovakia with regard to nine indices representing criteria for *Technique for Order of Preference by Similarity to Ideal Solution* (TOPSIS) analysis. Muthia et al. (2024) proposed an assessment and rank for 34 Indonesian Provinces using the *Organization, Rangement Et Synthese De Donnes Relationnelles* (ORESTE) method, with 34 criteria chosen. Reig-Mullor et al. (2024) performed a comparative analysis of QoL in EU countries using *Measurement of Alternatives and Ranking according to COMpromise Solution* (MARCOS), *Evaluation Based on Distance from Average Solution* (EDAS) and TOPSIS methods. Their work described fuzzy numbers as a highly functional tool when combined with multicriteria methods.

3. Methods

3.1. Data and general problem description

Hurajova and Hajduova (2021) proposed a set of nine criteria in their research on QoL in Slovakia. Considering their work and the availability of data on Polish voivodeships, the following set of criteria was chosen:

- c₁: Gross reproduction rate – the criterion measures the average number of daughters a woman is expected to have during her lifetime; it significantly impacts economic stability, healthcare services, social infrastructure and overall QoL.
- c₂: GDP per capita (PLN) – the criterion was selected because it is one of the most widely used indicators of economic performance at both national and regional levels and has a significant impact on well-being.
- c₃: registered unemployment (%) – joblessness can be linked to high levels of stress, depression, anxiety and reduced overall life satisfaction. It can also lead to social isolation since not being employed can make a person feel disconnected from society.
- c₄: Average monthly gross wages and salaries (PLN)- increased wages allow individuals to access, e.g. higher-quality housing, healthcare, and food and thus improve QoL.
- c₅: Activity rate of persons aged 18-59/64 years (%) – more active participants in the labor market mean that there is a chance of a rise in total economic productivity and the reduction of poverty levels.
- c₆: at risk of poverty rate (%) – poverty has a significant impact on well-being as low-income limit access to necessities and are the source of economic insecurity.
- c₇: Average monthly available income for a total of 1 person (PLN).

- c_8 : ascertained crimes by the Police in completed preparatory proceedings – a high level of criminal behavior can lead to a sense of danger and create tension among people and can contribute to the creation of mental health issues (e.g. anxiety or depression), and reduce the overall sense of well-being, thus affect QoL.
- c_9 : median of prices per 1 m² of residential premises sold in market transactions (PLN) – higher prices of properties may reflect a better standard of living.

Material conditions are of great importance for economic, physical and financial aspects of everyday life. They affect well-being, life fulfillment and the feeling of stability. The criteria which may be considered important in this area are: c_2 (GDP per capita), c_4 (average monthly gross wages and salaries), c_6 (at risk of poverty rate), c_7 (average monthly available income for a total of 1 person). Two of the criteria c_3 (registered unemployment) and c_5 (activity rate of persons aged 18-59/64 years) are connected to the labor market, which also plays a crucial role in shaping QoL. It affects the levels of income, job stability, social well-being and the feeling of personal satisfaction. The first criterion c_1 (gross reproduction rate) was chosen due to its societal impact and c_8 (ascertained crimes by the Police in completed preparatory proceedings) relates to the perception of personal safety. The last criterion, which is c_9 (median of prices per 1 m² of residential premises sold in market transactions), was used as it is related to housing. All these indices can be seen as measurable and offer the possibility to perform an objective and data-driven analysis. Table 2 depicts the data that was used to conduct the research.

Table 2.

Data for sixteen Polish voivodeships and nine criteria for 2022

Voivodeship	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9
	max	max	min	max	max	min	max	min	min
	-	PLN	%	PLN	%	%	PLN	-	PLN
Dolnośląskie	1.199	88480	4.5	6945.01	79.9	9	2234.21	29.03	6936
Kujawsko-Pomorskie	1.223	68130	7.3	5888.55	80.6	17.7	2094	22.53	5651
Lubelskie	1.229	57467	8	5909.6	79.1	22.6	2020.71	15.79	6564
Lubuskie	1.213	66799	4.4	6014.38	76.3	13.3	2211.18	25.09	4951
Łódzkie	1.282	77383	5.5	6210.68	82.6	14.1	2217.58	19.38	6223
Małopolskie	1.286	72946	4.4	6824.68	72.8	13.6	2207.96	21.89	9273
Mazowieckie	1.33	126381	4.3	7913.14	82.3	10.6	2601.99	23.3	9144
Opolskie	1.195	66678	5.9	6134.18	80	12.1	1839.71	17.34	5015
Podkarpackie	1.246	58221	8.8	5662.53	71.6	17.4	1790.68	12.93	5815
Podlaskie	1.274	63697	7	6012.94	79.4	23.4	2309.02	19.44	6085
Pomorskie	1.317	80885	4.6	6696.84	79	13.7	1963.51	23.25	7708
Śląskie	1.213	85942	3.7	6727.57	77.6	7.8	2317.67	35.08	5014
Świętokrzyskie	1.186	60075	7.8	5782.6	79.3	14.8	1937.84	19.77	5938
Warmińsko-Mazurskie	1.206	58536	8.6	5674.89	75.5	20.6	2054.32	19.85	5374
Wielkopolskie	1.331	85665	2.9	6019.68	80.9	14.4	2032.52	18.9	6299
Zachodniopomorskie	1.176	67261	6.7	6169.94	76.5	13.5	2295.02	22.28	6199

Source: <https://bdl.stat.gov.pl/>, 23.01.2025.

The availability of data made it necessary to perform the analysis for 2022. The type of criteria was specified, considering whether the criterion should be minimised or maximised. What is worth noting is that for the chosen multicriteria algorithm, it was necessary to depict all the criteria as being maximised (by their transformation for the calculations).

3.2. The use of MCDM algorithms in QoL research

The use of MCDM algorithms for evaluating QoL is beneficial. They can be seen as instrumental in assessing and enhancing QoL by ranking regions, policies, or projects according to multiple factors associated with well-being. They can assist in establishing decision-making frameworks for local governments, urban planners, and policymakers, supporting them in making informed and strategic choices. PROMETHEE II can offer impartial and data-driven ranking that helps improve overall QoL.

The algorithms used for Multicriteria Decision Making (MCDM) can be divided into two types: ranking and outranking methods. Ranking methods play a vital role in decision-making processes as they enable the prioritization of alternatives in situations where multiple factors are involved. They offer an unbiased and systematic framework for the assessment and comparison of various options and ensure that well-informed and logical decisions are made. They use aggregation models, such as the weighted sum or utility functions and assume full compensation between criteria. This means that if a poor score in one criterion is visible, then it can be offset by a high score in another. Examples of such methods are *the weighted sum model* (WSM), *Analytic Hierarchy Process* (AHP) or TOPSIS.

The outranking methods, such as PROMETHEE II or ELECTRE, provide a pairwise comparison of alternatives and allow dealing with situations where some of the alternatives cannot be compared directly. Pairwise preference relations between chosen alternatives are used. Outranking methods are preferable when preference-based and nuanced decisions are to be made. For the research, PROMETHEE II was chosen as it works well for real-life applications and deals with complex quantitative and qualitative data. Moreover, it does not require normalization, which makes the results more stable and does not distort the collected data. The method uses the following steps (Brans, Vincke, 1985):

- 1) Calculation of the preference function values for every pair of objects considering all the criteria

$$d_{ij}^{(k)} = f_i^{(k)} - f_j^{(k)} \quad (1)$$

$$r_{ij}^{(k)} = \begin{cases} 0 & \text{if } d_{ij}^{(k)} < 0 \\ d_{ij}^{(k)} & \text{if } d_{ij}^{(k)} \geq 0 \end{cases} \quad (2)$$

where: $f_i^{(k)}$ - the value of the k -th criterion function for the i -th decision alternative A_i
 $k = 1, \dots, K$ and $i = 1, \dots, N$.

- 2) Finding the individual preference indices for every pair of objects concerning each criterion, with preference function values normalised using one of six generalised criteria. The research uses the Gaussian criterion as it gives the decision-maker an opportunity to evaluate the differences between the alternatives in a smooth and gradual manner. The Gaussian criterion provides a gradual shift from indifference to full preference, unlike step-based preference functions, such as the Usual or V-shaped generalised criteria.

$$G_{ij}^{(k)} = \begin{cases} 0 & \text{if } r_{ij}^{(k)} = 0 \\ 1 - \exp\left(\frac{-(r_{ij}^{(k)})^2}{2(s^{(k)})^2}\right) & \text{if } r_{ij}^{(k)} > 0 \end{cases} \quad (3)$$

The preference strength gradually increases with the growth of the value of $r_{ij}^{(k)}$. The growth curve has an S-shaped form. The parameter $s^{(k)}$ falls within the range between the equivalence threshold and the preference threshold.

- 3) Calculation of the aggregated preference indices for each pair (i, j) of decision alternatives

$$\Pi_{ij} = \sum_{k=1}^K w_k G_{ij}^{(k)} \quad (4)$$

- 4) Determination of the dominance flows (positive flows $\Phi^+(i)$, negative flows ($\Phi^-(i)$))

$$\Phi^+(i) = \frac{1}{N-1} \sum_{j=1}^N w_k \Pi_{ij} \quad (5)$$

$$\Phi^-(i) = \frac{1}{N-1} \sum_{j=1}^N w_k \Pi_{ji} \quad (6)$$

- 5) Finding the net preference flows $\Phi(i)$

$$\Phi(i) = \Phi^+(i) - \Phi^-(i) \quad (7)$$

A higher value of $\Phi(i)$ shows that the alternative is highly favoured over the others. A smaller or negative value of $\Phi(i)$ signifies that the alternative is less favoured and dominated by others. The alternatives are ordered from highest to lowest, based on $\Phi(i)$, with the top-ranked alternative representing the best option.

3.3. The process of weight determination for chosen criteria

In MCDM, the criteria do not always have the same level of significance. Assigning appropriate weights gives the decision-maker an opportunity to ensure that more important factors exert a more substantial influence on the outcome. Such a procedure results in a more relevant and precise ranking of alternatives. The weights can be set subjectively, e.g., based on expert opinions, experience, or the individual preference of the decision maker. When determining such weights is problematic, an alternative approach can be using objective weights, which can be derived through mathematical techniques that analyze the decision matrix and eliminate the need for input from experts or individual decision-makers. One of the most used approaches for such situations is the entropy-based one.

Entropy focuses on the level of disorder within a set or its uniqueness and helps assess the importance of individual criteria by analyzing variations in their values. This approach minimizes subjectivity and uncertainty associated with the preferences and assessments of the decision-maker (Kacprzak, 2018). The process for calculating criteria weights using Shannon's entropy can be outlined in the following steps (Al-Aomar, 2010; Kacprzak, 2018; Bartosiewicz, Jadczyk, 2023):

- 1) The initial decision matrix undergoes stimulation and normalization, which results in a transformed matrix:

$$F = [f_i^{(k)}] \text{ for } i = 1, \dots, N; k = 1, \dots, K$$

- 2) Entropy E_k and weights w_k for every criterion are calculated using the following procedure:

$$E_k = -\frac{1}{\ln N} \sum_{i=1}^N f_i^{(k)} \ln(f_i^{(k)}) \quad (8)$$

$$d_k = 1 - E_k \quad (9)$$

$$w_k = \frac{d_k}{\sum_{k=1}^K d_k} \quad (10)$$

There are several ways to determine the criteria weights in MCDM, since they reflect the relative importance of each criterion for the decision-maker. When it comes to the determination of subjective weights one can choose the AHP method, which assigns relative and subjective weights to criteria. In the research Shannon's entropy was chosen as it is an objective weighting method, which relies on the statistical properties of a chosen dataset. Another method of weight determination, which isn't based on subjective expert opinions, is the CRITIC (Criterial Importance Through Intercriteria Correlation) method. The procedure assigns weights according to the degree of difference (variance) and the degree of conflict (correlation) between criteria, unlike entropy, which is based on uncertainty. The advantages of CRITIC are its objectivity and redundancy reduction, as it considers both correlation and variance of the dataset, however it should be noted that it can be intensive in terms of calculations and sensitive to outliers. Entropy, on the other hand, can be seen as simple, efficient and fast in terms of calculations. That was the reason for choosing it for the calculations.

4. Research results

The use of the Shannon entropy method, based on the input data, helped in finding weights for the chosen criteria. What is worth noting is that the set of weights is assigned without any influence from the decision-maker. Thus, human bias is reduced due to the lack of personal opinions.

Considering the weight values determined with Shannon's entropy method, it can be concluded that the most important criterion is c_3 – registered unemployment (%), while the lowest weight value can be observed for c_5 - activity rate of persons aged 18-59/64 years (%). All the weights used in the research are depicted in table 3.

Variations in the assigned criteria weights can lead to shifts in the final ranking. Equal values were assigned to each criterion, and the calculations were performed again to examine how the ranking behaves with different weights for the criteria; in this case, all the criteria had the same weight value assigned, which was equal to 1/9.

Table 3.

The weights assigned for each of the criteria

Criterion	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9
Shannon's entropy (set 1)	0.0048	0.1365	0.3109	0.0236	0.0044	0.2579	0.0255	0.1463	0.0902
Equal (set 2)	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

Source: own elaboration.

The values of net preference flow $\Phi(i)$ allow classifying the voivodeships into two groups: the dominant ones with positive values of $\Phi(i)$ and the dominant ones with negative $\Phi(i)$ values. The voivodeships with negative net preference flows are outperformed by other available alternatives (are surpassed by others more frequently than they surpass them). Regions with higher net preference flows are at the top of the ranking. In 2022, the group of dominant voivodeships, considering the first set of weights, includes Mazowieckie, Wielkopolskie, Śląskie, Dolnośląskie, Lubuskie, Łódzkie, Opolskie, Pomorskie and Małopolskie (the total of 9 voivodeships). It can be suggested that these regions have more substantial advantages when considering the analysed criteria. They may also be considered more reliable to live in than the lower-ranked regions. The voivodeships with negative net flow values are Zachodniopomorskie, Świętokrzyskie, Kujawsko-Pomorskie, Podkarpackie, Podlaskie, Lubelskie and Warmińsko-Mazurskie (the total of 7 voivodeships).

Table 4.

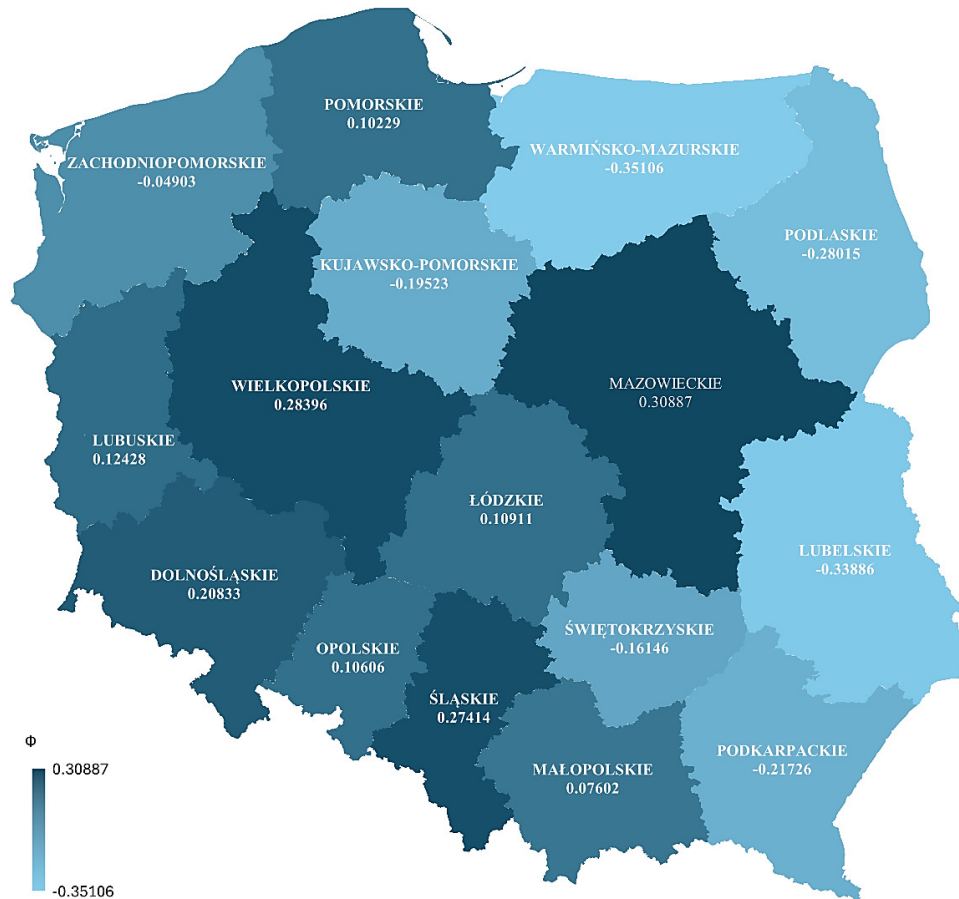
The final ranking of voivodeships in Poland, based on the QoL research (2022) using equal weights and Shannon's entropy method weights

Voivodeship	Equal weights		Shannon's entropy method weights	
	Place	Φ	Place	Φ
Dolnośląskie	5	0.1155	4	0.2083
Kujawsko-Pomorskie	12	-0.0963	12	-0.1952
Lubelskie	14	-0.1872	15	-0.3389
Lubuskie	8	-0.0109	5	0.1243
Łódzkie	3	0.1690	6	0.1091
Małopolskie	9	-0.0203	9	0.0760
Mazowieckie	1	0.4213	1	0.3089
Opolskie	7	-0.0108	7	0.1061
Podkarpackie	15	-0.2511	13	-0.2173
Podlaskie	10	-0.0490	14	-0.2802
Pomorskie	6	0.0836	8	0.1023
Śląskie	4	0.1387	3	0.2741

Cont. table 4.

Świętokrzyskie	13	-0.1639	11	-0.1615
Warmińsko-Mazurskie	16	-0.2626	16	-0.3511
Wielkopolskie	2	0.2063	2	0.2840
Zachodniopomorskie	11	-0.0824	10	-0.0490

Source: own elaboration.

**Figure 1.** Net preference values $\Phi(i)$ for the first set of weights (based on Shannon's entropy method).

Source: own elaboration.

The second set of weights showed that there were five dominant voivodeships: Mazowieckie (still at the first position), Wielkopolskie (also at the second position), Łódzkie, Śląskie, Dolnośląskie and Pomorskie. The remainder of the voivodeships can be considered dominated, with Podkarpackie and Warmińsko-Mazurskie ranked at the two last places. All the net preference flow values are depicted in the tab. 4. The analysis of both variants of the final ranking results shows that the positions of individual voivodeships can be considered relatively similar. The voivodeships dominant both times are Mazowieckie, Wielkopolskie, Łódzkie, Śląskie, Dolnośląskie and Pomorskie.

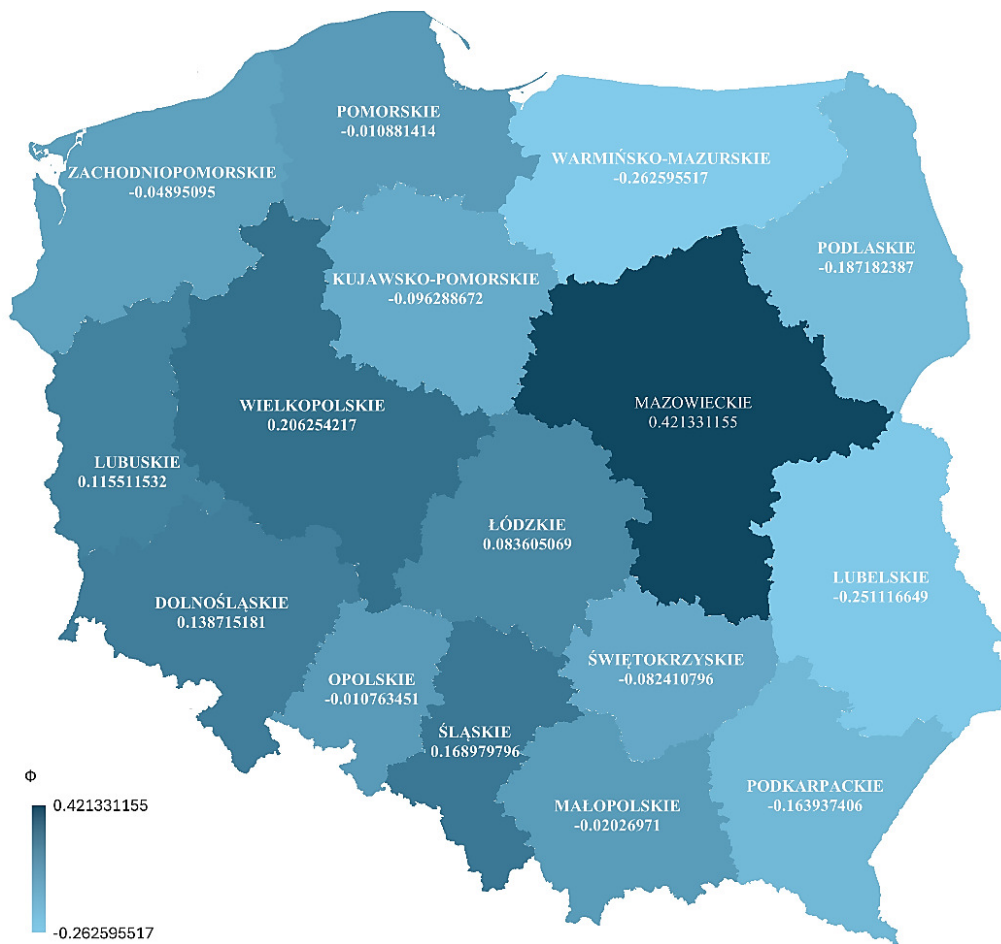


Figure 2. Net preference values $\Phi(i)$ for the second set of weights (equal weights).

Source: own elaboration.

Voivodeships with positive net flows can be seen as benchmarks for good practices. On the other hand, policymakers may focus on investing in regions with lower net preference values to enhance their overall position. The voivodeships located in the east of Poland have lower net preference flow values, which suggests that location also plays a role in shaping the overall QoL.

5. Discussions

This study examined QoL in Polish voivodeships in 2022 using multicriteria decision-making methods. The objectivity of the assessments was ensured by using two sets of weights that were calculated using Shannon's entropy method and equal weights for each of the criteria. This approach ensured that there was no need to use individual, subjective opinions of the decision-maker. The assignment of weights can be crucial for the decision process, as it affects the ranking of the alternatives. PROMETHEE II was used to rank the sixteen voivodeships, considering nine criteria affecting the QoL.

The analysis of net preference flows shows that the regions located in the east of Poland have lower QoL. These are also the regions with one of the lowest GDP per capita. The voivodeship with the highest net preference flow value for both weight sets is Mazowieckie, where Warsaw (the capital of Poland) is located. The possible reason for such results may be the fact that the eastern neighboring countries of Poland (Belarus, Ukraine) generally have a lower standard of living. This difference can be observed regarding Poland's membership in the European Union, which has contributed to its more substantial and more varied economy.

Further research on the QoL in Poland should include an extended time frame, allowing for an analysis of how events such as the COVID-19 pandemic or the war in Ukraine have affected the situation of Poles in different regions over the years. Moreover, using different weights would enable a more thorough sensitivity analysis to be performed. The study could also be expanded to include a subjective set of weights derived from the individual opinions of decision-makers using different multicriteria decision-making methods, such as the AHP method combined with Saaty's weights.

To reduce the economic divide between the lower-ranked voivodeships and the leading ones the focus should be put on enhancing regional development. The policy recommendations call for an all-encompassing approach that integrates economic, social, environmental and governance-related aspects. In terms of advancing economic growth, it could be the support for small and medium enterprises or the promotion of special economic zones. Considering infrastructure investments effort for the expansion of public transportation could be made, while in terms of housing it could be the encouragement of the development of sustainable housing to promote affordability on the housing market. What is more investments in the concept of Smart Cities could be made, with some of such initiatives already being implemented i.e. "Smart City Lublin" (Lubelskie voivodeship). The concept aims at promoting the use of advanced technologies and urban management to improve overall QoL of the residents of the city (Bednarzewska, Pastuszak, 2015). Greater flexibility in the labor market should be promoted to ensure job security. Social programs should prioritize education and the development of a skilled workforce, while also encouraging the involvement of local communities and institutions in supporting regional projects and reinforcing regional identity. What is worth noting is that lower-rank Polish voivodeships implement agendas to enhance the QoL of their citizens. The example may include the European Funds for Eastern Poland 2021-2027 that aims at reducing regional disparities and the promotion of socio-economic growth by the implementation of European Regional Development Fund in Polish eastern voivodeships (Wajda, 2022).

6. Conclusions

The concept of QoL is interdisciplinary and multidimensional. The analysis of literature helps draw the conclusion that a large number of its interpretations and definitions are the result of exploring it from different perspectives. The study is based on a multicriteria approach to the problem of QoL due to its broad applicability, as PROMETHEE II can be used to conduct research on different fields, not only economics. The main objective of this work was to assess the QoL in Polish voivodeships using nine specific criteria.

The application of PROMETHEE II shows that Polish regions are diverse, considering the net preference values. The location of the region is of key importance in the QoL. The analysis shows that Poland's eastern regions have lower quality of life and GDP per capita. The significant disparities in QoL in different regions may lead to increased migration due to the need to find a better place to work or the search for better educational opportunities. This may lead to further widening of the regional inequalities. These problems can be further studied using a different set of criteria and weights.

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PROJECT ORIENTATION AND INNOVATIVENESS WITHIN KNOWLEDGE-INTENSIVE BUSINESS SERVICES IN CENTRAL AND EASTERN EUROPE

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Purpose: This paper investigates how project-oriented structures enhance organizational innovativeness in technology-based, knowledge-intensive business service (T-KIBS) firms in Central and Eastern Europe (CEE). By focusing on how and why project orientation stimulates innovation, the study addresses a gap in project theory within innovation research.

Design/methodology/approach: A qualitative approach was adopted, involving 22 semi-structured interviews with senior management, project leaders, and innovation managers in T-KIBS companies operating in CEE. Data were collected during the third and fourth quarters of 2018 and analyzed using both categorization and thematic analysis.

Findings: Results indicate a positive association between project orientation and higher levels of innovativeness, driven by four distinguishing project characteristics: uniqueness, autonomy, co-production, and transcendence. The study proposes a conceptual model that identifies 13 potential moderators of this relationship, including management support, leadership style, strategic planning, control mechanisms, employee competences, cross-functional teams, staff engagement, client involvement, inter-project collaboration, internal reporting systems, accessible information, risk tolerance, and an overall willingness to innovate.

Originality/value: This research advances both project management and innovation theory by introducing a framework that connects project-based organizing with firm-level innovativeness in the T-KIBS sector. From a theoretical perspective, the findings highlight the significance of industry-specific contexts, suggesting that unique sectoral conditions can shape project management practices and, in turn, drive innovation outcomes.

Keywords: project, project-based organisation, innovativeness, KIBS.

Category of the paper: Research paper.

1. Introduction

The art of innovation soars to new heights. As much as innovation is indispensable for survival on the market, new ways of obtaining it are challenging for companies (Szutowski, 2018). Both innovation and new work organisation practices are omnipresent in dynamic business environment (Lundin et al., 2015). The rising popularity of projects as a means of

organising work spreads smoothly to the field of innovation management. One implication of this trend is that more innovation – and thus, more value – is created by projects (Schoper, Gemünden, Nguyen, 2016).

Evidence supports the transition from traditional organizational structures to more project-oriented ones (Wald, Schneider, Spanuth, Schoper, 2015). In the context of a single firm, such transition results in increased chances for innovation success, which in turn positively affects overall business performance. However, this relationship is complex and requires further studies in different settings. In this vein, this study relates to the stream of research on “the most advisable management practices in KIBS to foster innovation and improved performance” (Santos-Vijande, Gonzalez-Mieres, Lopez-Sanchez, 2013). Although project orientation is known to contribute to potential success of innovation development, the causal mechanism behind this remains largely uncharted. Some companies are able to benefit from increasing project intensity, while others fail to exploit project orientation. In this regard, the present study addresses the following research question: how and why project orientation contributes to higher innovativeness?

This study is based on the argument that project orientation improves the overall innovativeness of a company, by forcing a decomposition of processes, which then facilitates their management and allows the improvement of efficiency at each stage of the project. Its purpose is to identify and describe the mechanisms which allow companies to benefit from project-based organisation in terms of innovation. The study was performed in the context of technology-based knowledge-intensive business services (T-KIBS). Its spatial scope encompasses companies operating in Central and Eastern Europe. The theoretical contribution of the study consists in constructing model representation and proposing an analytical framework depicting the relationship between project orientation and T-KIBS innovativeness. The moderators proposed in this study derived from the determination of the main themes concerning project-based organisation and grouping them into categories that are key in increasing company innovativeness. Also, it exploits the niche of project-based organisation in T-KIBS, which is a largely unstudied field. Therefore, the study adds to literature on project management, innovation and T-KIBS management.

Previous scientific investigations in project management literature targeted firms offering complex products and services. Such companies are organised around key projects which are often highly individualised (Turner, Keegan, 2001). The scientific community has already produced some evidence suggesting how highly innovative projects and project portfolios should be organised, but the present study is the first attempt to include the specificity of T-KIBS operating in CEE. To date, the author has not identified any research directly addressing the link between project-based organisation and innovativeness in T-KIBS.

In order to fill the research gap, the present empirical investigation relied on qualitative methods. It employed semi-structured interviews with senior management staff, project leaders, and innovation managers in T-KIBS companies operating in Central and Eastern Europe.

On the one hand, it relies on the opinion the best-informed individuals, on the other, it solely presents the managerial perspective. Qualitative methods were selected due to the re-confirmatory character of the study focused on finding the specificity of the particular context of T-KIBS. The studied T-KIBS enterprises operated in the fields of data processing, R&D in natural sciences and engineering, and technical testing and analysis. The time frame comprised the third and fourth quarters of 2018. The sample consisted of 22 respondents in 12 companies.

The study provided evidence supporting a positive relationship between project-based organisation and innovativeness in the context of T-KIBS. It indicated, however, that the mechanism behind the increased innovativeness associated with project-based organisation is not a simple one, and the relationship is far from straightforward. It introduced an analytical framework composed of six categories, within which 13 potential moderators are clustered, including: administration (management support and project leader), management control (planning and controlling), staff (employee competences and multidisciplinary teams), interactions (with staff, with clients, and between projects), information (internal reporting and information availability) and attitudes (risk appetite and willingness to innovate). Within this context, the present study contributed to the theoretical foundation of innovation within literature on project orientation by introducing the decomposition of project-based organisation, which increases the explanatory power of work organisation type with regard to company innovativeness.

The paper is structured as follows. First, the concepts of a project-oriented company, project orientation and innovativeness, and innovativeness in T-KIBS are discussed. Second, the details of the empirical part are presented. Finally, the results are provided and discussed. The study terminates with conclusions.

2. Conceptual background

2.1. Project-oriented company

The conceptualisation of a project within the project theory boils down to the “transformation of inputs to outputs” (Koskela, Howell, 2002, p. 3). The principles for managing projects include e.g. the decomposition of the process into smaller tasks, each of which is then managed separately to increase the overall effectiveness of the process (Project Management Institute, 2000). Numerous attempts have been made to conceptualise a project-oriented company. The first date back to the late 1980s. Project-oriented companies were characterised as performing: “the management of single projects, the management of the network of projects, and the management of the relationships between the company and the

single projects” (Gareis 1989, p. 243). In the 2000s, the notion of “management by project” emerged and was incorporated into the definition: “a Project-oriented Organisation is an organisation, which defines ‘Management by Projects’ as an organisational strategy, applies temporary organisations for the performance of complex processes, manages a project portfolio of different project types, has specific permanent organisations to provide integrative functions, applies a ‘New Management Paradigm’, has an explicit project management culture, and perceives itself as project-oriented” (Gareis, Huemann, 2000, p. 709). Project-oriented organisation entails fostering decentralisation of management responsibilities and organisational differentiation, personnel development through consecutive projects, and consequently, company innovativeness. This novel approach to project management encompasses all industries and sectors and all kinds of internal and external projects – from small to mega-sized (Huemann, 2015). According to Huemann (2015), the principal objective of project management as understood today is to establish a mode of organizing for organizations, industries, and societies.

It appears that what is key to defining project-oriented organisations is their conscious decision to pursue a project-oriented work organisation, which translates into setting up a temporary work organisation to fulfil tasks, rather than delivering the end product as a project-work (Gemunden, Lehner, Kock, 2018). According to Turner and Keegan (2001), companies may provide their services to many other companies, and may thus perform numerous projects simultaneously. This stimulates the development of new products and services, and shapes future offerings. Consequently, the competitive position of the organisation improves. In contrast to the above approaches, the one proposed by Hobday relies on a company delivering a single project to a key client at a single time. According to Hobday, “it is able to cope with emerging properties in production and respond flexibly to changing client needs. It is also effective at integrating different types of knowledge and skill and coping with the project risks and uncertainties” (2000, p. 871). Such a definition applies to organisations offering complex products, i.e. ones enabled by new technologies or offering new functionalities. In these cases, each product or service delivery is treated individually, and the internal organisational structure is adapted accordingly. In this organisational structure, innovation has the necessary space to emerge (Davies & Hobday, 2005). However, for the development of a successful innovation, both the client and the supplier must share the willingness to achieve/benefit from the high degree of innovativeness and to establish clear reciprocal communication.

The potential issue lies within the supplier organisation, as following short-term goals may reduce the incentive to innovate (Winch, 2014; Winch, Leiringer, 2016). Thus, shifting to project-oriented organisation does not translate automatically to the exploitation of innovation opportunities. Hence the critical role of mutual understanding and learning, which alleviates the risk of unsuccessful new product/service development. A new product/service offering requires setting a single goal (Whitley 2006). A major drawback of the concept developed by Hobday is that the new product/service is delivered to a single customer, and each time a new

client appears, the company needs to adapt again. However, it appears reasonable to assume that the smaller the complexity of the new product/service, the higher the repeatability. Numerous examples from business practice show that complex projects aimed at the development or improvement of products and services lead not only to their offering to a single client, but also to multiple subsequent ones (Gemunden et al., 2018).

2.2. Project orientation and innovativeness

Several attempts have been made to conceptualise the link between project orientation and innovativeness. The notion is understood as organising a considerable part of company's processes and activities in the form of projects, and the second one is perceived as the ability to engage in and support new ideas, novelty, experimentation, and creative processes that may result in new products, services, or technological processes (Lumpkin, Dess, 1996). A company's strategic choice to introduce project-based organisation appears to prompt innovativeness, as the work time spent on projects positively correlates with innovation success within the company, which in turn positively correlates with business success (Wald, Spanuth, Schneider, Futterer, Schnellbacher, 2015). Interestingly, in the same study, no positive correlation was observed between work time spent on projects and business success. One of the reasons for such observation is that companies differ in their approach to projects. While some companies employ them to develop innovation, others do not use them for this purpose. As a general rule, innovativeness is usually not fully triggered when project orientation is introduced in service firms. R&D projects are rare in service-oriented sectors (10%) while being twice as important in the manufacturing industry (22%) (Schoper, Wald, Ingason, Fridgeirsson, 2018). Importantly, not all studies support the positive link between project orientation and innovativeness. An opposite observation is presented by Keegan and Turner (2002), who found that business project introduction created an unfavourable setting for innovation development, since the processes implemented within business project management were too rigid for innovation.

Based on these considerations, scientific attempts to schematise the relationship between project orientation and innovativeness were undertaken. The most influential work to date seems to be that by Gemunden, Lehner and Kock (2018), who proposed a conceptual model of the project-oriented organisation including: (1) structures – organisation, planning and controlling, and ICT-systems; (2) people – knowledge management, competence development, and teamwork leadership; and (3) values – future orientation, entrepreneurial orientation, and stakeholder orientation. Such an analytical structure captures some important areas from the innovation management perspective. However, this conceptual model has not been empirically validated. According to the author's best knowledge, to date, there have been no empirical attempts to link project orientation and innovativeness in service companies in any systematic way.

At the same time, evidence concerning the relationship between project orientation and innovativeness suggests the crucial role of budget in prompting innovativeness through the implementation of project orientation. Namely, if a specific budget is reserved for highly innovative projects, they only need to compete for resources between one another. This way, the risk of current business projects consuming all the available resources is mitigated. Also, if projects are to produce innovative outcomes, they require a fair amount of autonomy, as rigid management schemes tend to undermine creativity (Gemünden, Salomo, Krieger, 2005). Such autonomy should be guaranteed by power promoters, process promoters, and expert promoters, all acting in favour of innovation (Mansfeld, Hölzle, Gemünden, 2010; Rese, Baier, Gemünden, 2013; Rost, Hölzle, Gemünden, 2007).

2.3. Innovativeness in KIBS

Services that largely rely on professional knowledge are commonly referred to as knowledge-intensive business services (KIBS). Most companies delivering knowledge-intensive services operate on the B2B market, where the co-production of the service along with the client is a common phenomenon. The heterogenous nature of KIBS led to the distinction of T-KIBS and P-KIBS (Nählinger, 2005). The former stands for “technology-based KIBS” (e.g. hardware consultancy, software consultancy and supply, data processing, database activities, R&D in natural sciences and engineering, architectural and engineering activities and related technical consultancy, technical testing and analysis). P-KIBS on the other hand stands for “professional KIBS” (e.g. R&D in social sciences and humanities, legal activities, accounting, bookkeeping and auditing activities, tax consultancy, market research and public opinion polling, business and management consultancy activities, advertising, labour recruitment and provision of personnel, and other business activities).

Existing evidence suggests that KIBS have specific features related to innovation, such as undertaking typically informal and highly iterative innovation activities. Despite having formal development projects, which resemble those found in the manufacturing sector, a fair amount of innovation activities is employee-driven and happens outside of the formal setting (Heusinkveld, Benders, 2002). Furthermore, such companies may launch yet incomplete concepts to the market, and further advance the innovation development process iteratively with the actual service delivery (Heusinkveld, Benders, 2002; Toivonen, Tuominen, Brax, 2007; Toivonen, Tuominen, 2009). Besides, KIBS are often successful incubators for “ad hoc innovations”, developed within the customer interface while providing a specific tailor-made solution. All of the above makes identifying and replicating innovation processes especially challenging (Gallouj, 2002). The above characteristics may be observed to some extent in all service companies, but it is within KIBS that they gain full prominence, due to the complex character of customer issues.

Lundvall and Borrás (1997) attempted to identify the characteristics of KIBS that make them especially innovative. The authors pointed to (1) often decentralised, project-based and flexible organisation, (2) special attention paid to learning, human resources management and recruitment, and (3) the extensive use of new technologies including IT and computer-based systems. Importantly for the present study, such characteristics have never been tested so far in the context of introducing a project-based organisation.

The issue of project orientation is hardly ever included in the analysis of innovativeness in KIBS. Despite failing to provide a comprehensive analytical framework for the link between project orientation and innovativeness in KIBS, the conclusions provided by previous empirical studies in the service sector include numerous valuable insights, including factors that are more important for new service development projects than for new product development projects: customer involvement (Bowen, Ford, 2002; de Jong, Bruins, Dolfma, Meijaard, 2003); senior management support (Cooper 2001; De Brentani 2001), and synergy with the firm's current business (De Brentani, Ragot, 1996). Moreover, the development of innovation in project-based service companies could be very different from what is described in literature on new service development, mainly due to different capabilities and organisational structures compared to other service providers. First of all, project-oriented service firms often provide complex and unique services that entail a low-hierarchical organisational structure (Woodward, 1980). Second of all, in such companies, business projects tend to be more important compared to the functional organisation (Hobday, 2000). The organisation often relies on areas of expertise, making functional departments obsolete (Hobday, 2000). Finally, such companies have unique capabilities with regard to collaboration with customers and suppliers, internal collaboration, and project management (Toivonen, Tuominen, 2011). With respect to the above description of the specificity of service companies, including the distinctive characteristics of KIBS, the re-examination of the relationship between project orientation and innovativeness in this setting is of theoretical and practical importance.

3. Research methods

The re-confirmatory character of the study whose intent was to address specificity of T-KIBS, motivated the use of qualitative methods, which allow one to describe, understand, and interpret phenomena (Merriam, 2009). Moreover, the choice of qualitative methods seems appropriate, since the subject of the study is human behaviour in a dynamic environment. The empirical research was performed in the third and fourth quarters of 2018. It focused on T-KIBS companies that have introduced project-based organisation, and operate in the Central and Eastern Europe. The sample consisted of 22 respondents from 12 companies. The studied companies were based in Poland, Czech Republic, Slovakia, and Germany –

three in each country. The T-KIBS enterprises represented the industries of data processing ($n = 2$), R&D in natural sciences and engineering ($n = 8$), and technical testing and analysis ($n = 2$). Purposive sampling was primarily applied to recruit: senior management staff, project leaders, and innovation managers. The interviewees were selected through the analysis of companies' websites and publicly available documents. They were recruited based on their pre-assessed knowledge and experience in project management and innovation. In short, the study attempted to reach the individuals best informed with regard to the consequences of introducing project-based organisation in terms of innovativeness i.e., managers and project leaders disposing of strategic perspective in addition to the operational one, even though this caused the results to be a representation of a managerial viewpoint. Each potential respondent was invited – via phone and e-mail – to take part in a single interview. In order to obtain a comprehensive view on project-organisation and innovation, snowball sampling was used to complement purposive sampling. The recruited interviewees were asked to indicate additional participants among their associates. The interviews were carried out in English. While this strategy ensured access to individuals best informed about the studied phenomenon, it may also have introduced selection bias, as participants who were more interested or had more experiences with innovation and project-based work could have been more inclined to respond. Moreover, conducting the interviews in English could have introduced language-related biases, potentially favoring respondents who felt more comfortable with English and thus were more willing to participate. The characteristics of the interviewees and interviews are summarised in Table 1. Age and job experience are presented in years, the interview duration is given in minutes.

Table 1.
Interviewees' characteristics

No.	Age	Gender	Position	Experience	Industry	Interview duration	Sampling
1	43	M	Senior management	18	DP	29:12	P
2	27	M	Innovation manager	4	DP	27:35	P
3	33	M	Project leader	11	R&D	26:59	P
4	42	F	Innovation manager	16	R&D	31:53	P
5	32	M	Senior management	6	R&D	28:44	P
6	45	F	Senior management	23	R&D	27:12	P
7	32	M	Senior management	9	R&D	29:33	P
8	44	M	Project leader	19	R&D	30:12	P
9	47	F	Innovation manager	24	R&D	31:33	P
10	38	F	Senior management	10	R&D	27:34	P
11	51	M	Project leader	25	TTA	29:44	P
12	49	F	Project leader	25	TTA	27:12	P
13	37	M	Senior management	13	DP	26:51	S
14	35	M	Project leader	14	DP	28:27	S
15	50	M	Senior management	26	R&D	31:22	S
16	33	F	Project leader	11	R&D	30:32	S
17	41	M	Project leader	19	R&D	29:46	S
18	26	M	Project leader	3	R&D	28:51	S
19	36	F	Senior management	12	R&D	29:05	S

Cont. table 1.

20	39	F	Project leader	15	R&D	30:52	S
21	41	M	Senior management	18	TTA	27:03	S
22	33	M	Project manager	8	TTA	29:12	S

Note: M – male, F – female, DP – data processing, R&D – R&D in natural sciences and engineering, TTA – technical testing and analysis, P – purposeful sampling, S – snowball sampling.

Source: own work.

One of the two basic roles of the interviews was to enable an in-depth interpretation of previous findings (Flick, 2009). In line with the conceptual background presented previously, the study relied on semi-structured interviews. The interviewees were free to present their views, as all the questions were open-ended. The applied method was designed to identify and describe the mechanisms which allow the T-KIBS companies operating in CEE to benefit from project-based organisation in terms of innovation. The interviews were conducted by three researchers and recorded for further analysis. The protocol was verified in a field test prior to the study, in accordance with the methodology recommended in reference literature (Galletta, 2013). It was evaluated by a group of four scholars specialising in project management, who answered the questions and shared their insights on the potential improvement.

In line with the methodological recommendations, the semi-structured interview protocol covered six substantial questions, all of which allowed respondents to add their comments freely (Langridge, Hagger-Johnson, 2009). In line with the theoretical considerations presented within the conceptual background, the substantial questions referred to: (1) the relationship between project orientation and innovativeness, (2) the setting conducive to innovation within innovation projects and business projects, (3) favourable conditions for replicating successful innovation projects, (4) organisational and structural environment, including the level of decentralisation and flexibility of the organization, (5) human resources, including the importance of learning, human resources management and recruitment, and (6) technological environment, including the use of new technologies, such as IT and computer-based systems. In most cases, follow-up questions emerged spontaneously, concerning other elements and mechanisms (that allow the T-KIBS companies operating in CEE to benefit from project-based organisation in terms of innovation) discussed by the respondents. The protocol also included complementary questions concerning the respondents' age and experience.

The sample size was not determined *a priori*. In line with the methodological considerations, the aim of qualitative research is achieved when the gathered information thoroughly covers the issue of interest. The interviews lasted until the saturation point was reached (Baker, Edwards, 2012). Here, the first patterns were isolated within the first 12 interviews, and a comprehensive set of information was achieved within 22 interviews.

To ensure high quality of research, it is crucial to guarantee that it meets specific requirements (Golafshani, 2003; Ali, Yusof, 2011). To guarantee the objectivity of analysis, all interviews were recorded and the material was analysed separately by two researchers. Conclusions were formulated based on consensus between the researchers. Furthermore,

internal validity was assured by strict focus on the subject matter, i.e. the introduction of project-based organisation and company innovativeness, in the research protocol. External validity – proper coverage of the population of interest – was achieved by selection of the best-informed interviewees through an analysis of company websites and publicly available documents.

The data analysis process included both categorisation (Roulston, 2010) and thematic analysis (King, Horrocks, 2010). Thus, the two researchers first reviewed the recorded material independently to identify, define, and organize the themes that emerged from the data. Second, the researchers re-analysed the material to expand or cluster those themes and interpret their meaning. Third, they derived the key elements from the data set. The results are presented in the following section of the paper in accordance with the recommendations of Boyatzis (1998), who argued for a four-step presentation of each theme, including definition, description, exclusion, and example.

4. Results and discussion

All respondents have demonstrated a high level of dedication and professionalism by providing substantial answers to all of the questions asked. They confirmed that project orientation had been introduced in their companies ($n = 22$). Moreover, 20 respondents emphasized the role of innovation development, claiming it to be a “necessity” and “inseparable part” in all of the company’s fields of activity, and stating that without innovation, “it would be impossible to follow the market demand” (respondent 2). Such a conclusion is very much in line with previous evidence on innovation (Szutowski 2016).

In relation to the research question, the results show that project orientation in T-KIBS enterprises may indeed lead to higher levels of innovativeness. While the issue is multidimensional, these results point several antecedents explaining why the relationship between project orientation and innovativeness existed. A key contribution of the research is therefore the identification and detailed discussion of four characteristics—uniqueness, autonomy, co-production, and transience—that shape the relationship between project orientation and innovativeness in T-KIBS enterprises.

Uniqueness – as described by the interviewees – stands for the individual character of each project and results from the increasingly dynamic and complex business settings, requiring specifically tailored solutions. A number of respondents ($n = 16$) pointed out this characteristic as one of the principal causes of innovativeness in T-KIBS. As expressed by the respondent 3: “creativity is a requirement, if in each project you are to come up with a different solution”. Or in other terms: “even though some challenges tend to repeat themselves in the long run, each project is different and requires a dedicated, often newly developed, solution” (respondent 11). The observation supports previous evidence signaling that projects are especially suitable for

generating innovation because they create organizational structures around the demands addressed in specific projects (Bakker, 2010). A potential reason here, is that project orientation increases staff's commitment and task proficiency (Spanuth, Wald, 2017). However, this hypothesized mechanism requires further investigation. Nevertheless, as each project targets a one-of-a-kind issue, creative problem-solving becomes indispensable. While certain resolutions may be transmitted from one project to another, seeking a solution to the unique challenge requires an augmented level of innovativeness.

Autonomy represents the level of independence attributed to single projects. This characteristic echoed in the statements of 15 respondents. Their opinions suggested that project-orientation in T-KIBS entails that each project constitutes a separate entity and enjoys a relatively high level of sovereignty. As a consequence, single projects were detached from the established patterns of thinking, company code and norms, and as such they allowed to work out an original solution. The idea was expressed as follows: "well, in this setting you are free to work out a solution in line with your vision, as long as the client is satisfied" (respondent 12). The importance of autonomy was further supported with regard to managerial control: "we do not control much of what is happening within our project teams, we select project leaders carefully and we shift the responsibility to them. In the day-to-day operations, they are free to act almost independently" (respondent 21). On the one hand, the issue of autonomy was already present in the literature on the subject supporting the belief that the autonomy from the project sponsor is contributing to the success of the project understood as bring an idea or vision to its completion (Martens et al., 2018). On the other hand, the perspective of reducing the intensity of managerial control and substituting it by the shift of the responsibility to project leaders seems like a promising path for further exploration.

Co-production embodies project-specific and differentiated interactions of T-KIBS with the third parties. In line with the interviewees' clarifications, since the problem to be solved may not be detached from the particular company facing it, the solution can only be developed together with the client. Consequently, each project is realised in different context and benefits from the constant evaluation and adaptation based on the insights, judgement and experience (or at least a specific demand) of the company requesting support. Eleven respondents expressed the importance of this characteristic as a prerequisite of innovativeness. Respondent 22 indicated: "each client is different and has different resources, experiences etc. Thus, each project is different as we need to account for those differences and adapt accordingly. Otherwise, we won't be able to develop a dedicated solution". The similar idea was expressed by the respondent 14: "at all times we need to cooperate closely with our clients to work out a solution, otherwise we just repeat what we think is right and if it is not the case, the whole project may fall apart". The results reported here confirm that previous findings emphasising the positive effects of establishing and maintaining collaborative relationships on innovativeness (Heredia Rojas, Liu, Lu, 2018) apply in the context of T-KIBS.

Transience represents the limited duration of single projects. It was firmly emphasised by ten respondents, who indicated that once a problem is solved the project comes to termination and the staffs involved are reshuffled. The temporary leadership changes from one project to another based on the professionalism and expertise demonstrated in previous realizations. As staffs' positions are not permanently set and they may climb and fall the hierarchical ladder, the incentive to prove oneself is high. Consequently, staffs are motivated to contribute and manifest creativity, innovativeness and the open-minded solution-seeking attitude. Respondent 3 described the issue as follows: "if you have a fixed position, you don't have the motivation to act. Here it is different, you may get your own project, but you need to outperform you colleagues first". In the same vein, transience was explained as follows: "our structure is very dynamic, you may quickly move from regular team member to project leader, but also in the opposite direction. It is why we need to provide at all times at the highest level" (respondent 12). With respect to this, on the one hand, this research backs previous evidence signaling that horizontal communication and strategic decentralization bridge the divisions of traditional divisional organization, which is significantly and positively related to R&D intensity (Whittington, 1999). On the other hand however, dynamic changes in the hierarchy create uncertainty, which was found to negatively affect a person's job commitment (Keegan, den Hartog, 2004) and might be reasonably expected to lower innovativeness. Thus, this research challenges to some point previous evidence and calls for further investigation in this field.

In the light of the above, one may reasonably hypothesize that introducing project orientation in T-KIBS has the potential to increase company innovativeness. This presumption is based on the four characteristics of projects: uniqueness, autonomy, co-production, and transcendence. However, the extent to which company innovativeness may improve depends on a series of elements stimulating it.

The respondents presented very different insights as to the moderators of the link between project orientation and innovativeness. The common main categories that emerged within the whole set of interviews, in line with the specific thematic codes, were systematised and presented in a graphical form. Figure 1 presents all the moderators of the relationship between project orientation and innovativeness in T-KIBS, developed based on the themes discussed in the interviews.

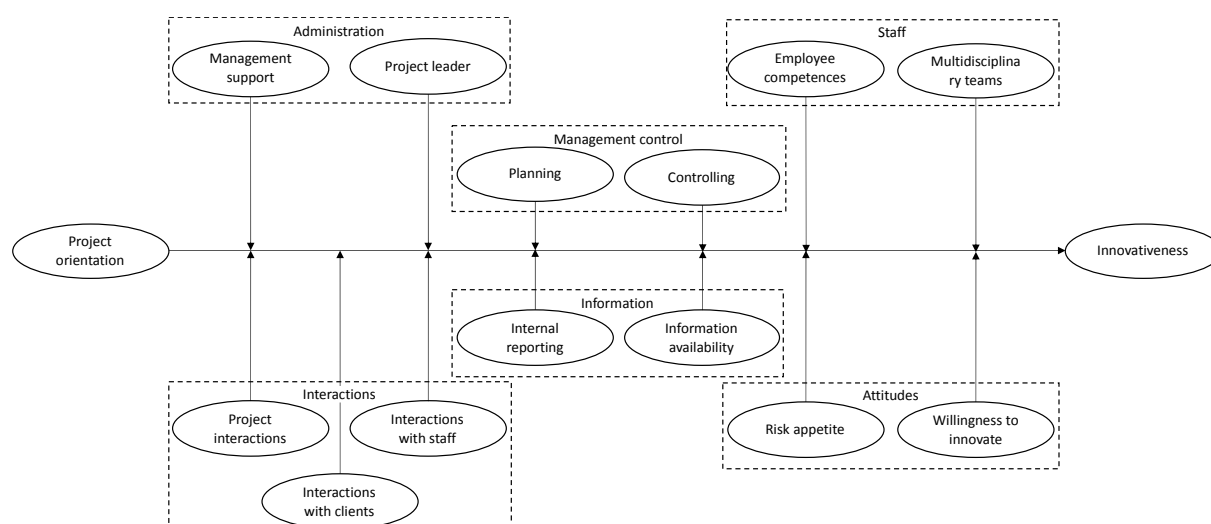


Figure 1. Model presenting the moderators of the link between project orientation and innovativeness in project-oriented KIBS in Central and Eastern Europe.

Source: own work.

This model representation constitutes a graphical summary of the study. It presents project orientation and innovativeness in line with the potential moderators of their relationship. The mere number of themes (moderators) indicates the complexity of the issue. In the case of complex phenomena, developing a theoretical explanation of any dependencies found is crucial, as it allows one to schematise the relationships. In relation to the research question, the results show that project orientation in T-KIBS enterprises may indeed lead to higher levels of innovativeness. However, the relationship is not straightforward, as all respondents suggested that a number of necessary conditions need to be met in order for project orientation to stimulate innovativeness.

The analytical framework developed based on the data is summarised in Table 2, followed by a descriptive component. The presentation is based on the recommendations of Boyatzis (1998) cited above. The moderators are grouped into 6 categories – administration, management control, staff, interactions, information, and attitudes.

Table 2.

Key elements of project orientation in stimulating innovativeness

Code	Definition	Description	Exclusion
Administration			
Management support	Supporting innovation projects by managers in terms of tangible and intangible resources	Most KIBS operating in CEE do not have a permanent department/function devoted to innovation. In this case, managerial support in each business/innovation project is the only way to assure the development of innovation	Support provided by other team members within a project or support provided between projects
	E.g. “The manager should create a whole climate that stimulates creativity. It is not only about the money, but also about meetings, conversations and listening to people” (respondent 22)		

Cont. table 2.

Project leader	Managing innovation by competent project leaders who understand both team dynamics and technical issues	In KIBS operating in CEE, the role of a project leader in innovation development is greater than in other sectors. He/she needs to possess two separate competences: (1) managerial skills and (2) advanced and often technical knowledge.	Competences of the other team members
	E.g. “It is our staff that produces innovation, but it is the role of the project leader to pick the valuable ideas, develop them and convince us of their worth, and that also is an important skill” (respondent 19)		
Management control			
Planning	Stimulating innovativeness by assuring flexible management of innovation projects and imposing budgetary constraints on business projects	In KIBS operating in CEE, rigorous planning is essential for the effective execution of business projects, but it fails to provide the flexibility that is much needed in innovation projects. To stimulate process innovation, budgetary constraints within business projects are important.	Controlling activities and tools
	E.g. “When confronted with limited resources, some people lose motivation, while the others look for new ways to cost-efficiently solve a problem. These are the ones responsible for process innovation in our company” (respondent 13)		
Controlling	Inspiring innovation by controlling deviations from plan	The optimum managerial involvement in innovation projects realised in KIBS companies operating in CEE includes the collaborative establishment of performance indicators and their verification. No involvement in decision-making at the project level is advised, as the teams are already composed of highly qualified specialists in the field.	Other aspects of project management and planning
	E.g. “The formulation of a plan is just a half way through, you need to constantly update it, remind people of the strategic goals and control for deviations” (respondent 13)		
Staff			
Employee competences	Focus on the competent staff at the disposal of KIBS adds to company innovativeness	The mix of highly competent workers within KIBS operating in CEE creates a favourable environment for innovation. High individual competences may be acquired through education and work experience.	Combined knowledge of the team, as opposed to individual competences
	E.g. “The best innovation comes from the most competent staff. That’s why we pay special attention to the competence of our people” (respondent 16)		
Multidisciplinary team	Fostering innovativeness by combining different areas of expertise and limiting the interpretative barriers	A multidisciplinary composition of the team is a strong innovation success factor in KIBS operating in CEE. Employees assigned to projects change from one project to another, which diminishes the interpretative barriers over time.	Issues referring to management and senior management
	E.g. “We are all specialists in our domains. Sometimes it’s ineffective to look for a solution on your own. You colleague may already have the solution you require” (respondent 12)		
Interactions			
Project interactions	Spreading product and process innovation with the use of interactions between different projects	If KIBS operating in CEE offer their solutions to companies operating on a homogeneous market, product innovation is likely to spread across projects. If this is not the case, process innovation is most likely to move from one project to another.	Interactions other than the ones between projects
	E.g. “On the one hand, we offer strictly tailored services for our clients. On the other hand, sometimes they do not recognize their own needs properly. The more projects we realize, the more solutions we have at our disposal, and the more we can offer them” (respondent 6)		

Cont. table 2.

Interactions with clients	Producing new services based on the clients' requests	In KIBS operating in CEE, the client-supplier cooperation is essential for innovation.	Own invention of new services
	E.g. "Your clients require you to be innovative. Often, they are looking for solutions that no one on the market provides" (respondent 5)		
Interaction with staff	Drawing innovation from the front-end staff	Such characteristics of KIBS operating in CEE as employing highly qualified specialists in the field and the lack of an R&D department mean that the "inventing by doing" approach is effective in innovation development.	The role of employees other than the front-end staff
	E.g. "Our greatest asset is our staff. It is them who are at the customer interface, who actually develop the solutions we offer on the market" (respondent 15)		
Information			
Internal reporting	Formalising internal reporting to stimulate the reproducibility of innovation projects	There are numerous advantages of internal reporting. The one that is key in KIBS operating in CEE is that of reproducibility. Internal reporting is one of the few tools that may be used to reproduce successful innovation projects in this particular setting.	Forms of coordination other than internal reporting
	E.g. "Reports are in fact an effective tool of communication. You cannot speak to everyone, but you may follow a brief report" (respondent 21)		
Information availability	Stimulating the reproducibility of innovation projects by encouraging the exchange of information	the availability of information on the effective solutions developed is an important innovation success factor in KIBS operating in CEE. It supports the reproducibility of such solutions.	Formal ways of sharing information
	E.g. "When we develop an efficient solution, we are encouraged to share. It is important, because other teams do not have to redo our work. Of course, we also benefit from the solutions developed by others" (respondent 16)		
Attitudes			
Willingness to innovate	Establishing the willingness to innovate based on the promotion of numerous minor improvements	In KIBS operating in CEE, successful innovation management requires for the staff to be constantly reminded of the importance of innovation. One effective reminding tool is the promotion of numerous, minor improvements that allow innovation to remain on the surface.	Promotion of breakthrough innovation
	E.g. "Of course, the formal systems are important, but at the end of the day these are people who innovate" (respondent 5)		
Risk appetite	Encouraging radical innovation through the support of risky projects	In KIBS operating in CEE, high appetite for risk is likely to support the development of radical innovation.	Supporting minor improvements
	E.g. "In order for radical innovation to appear, you need to be willing to take risks. Otherwise there is a real chance for you to miss the opportunity" (respondent 13)		

Source: own work.

The first category within the analytical framework is administration. It groups two specific potential moderators that emerged during the interviews: management support and the role of a project leader in increasing a company's innovativeness. Most respondents ($n = 19$) pointed out the extreme difficulty of innovation development without managerial support. The respondents stated that: "no matter how good the idea is, you will not be able to develop it without right people backing you" (respondent 2), and that "we usually proceed with several complex projects at once, we all need to be attentive to see when the innovation opportunity

comes" (respondent 9). This observation complements previous evidence, signalling that senior management support is a critical factor for the success of innovation projects (Bonner, Ruekert, Walker, 2003; Davila, 2003; Van der Panne, 2003). It is at the managerial level that the ideas to pursue are selected and the necessary financial and human resources are provided. The importance of managerial support was especially emphasized with regard to the specificity of KIBS: "some companies are well known for their R&D activity, they have R&D departments, special funds, labs etc. It is not the case here; we do not have such tools. That's why your manager is the only one you can go to, and if he rejects the idea, there is not much you can do" (respondent 11). It seems that the project-oriented KIBS are usually concentrated around business projects, and for the majority of employees, involvement in innovation projects is part-time at most. If there is no specific department devoted to R&D, managerial support is essential not only in (1) gaining resources, but also in (2) keeping the attention of the assigned staff on the innovation projects (even though the business ones are typically more urgent).

The second potential moderator related to administration is the direct role of the project leader. More than a half of the respondents ($n = 14$) indicated that a devoted project leader may have a decisive role in the development of both business and innovation projects. This was emphasized as specific to KIBS, where a twofold competence of the project leader is necessary. First of all, he/she needs to possess the necessary managerial skills. Second of all, he/she must possess specific, advanced, and often technical knowledge required at the frontline of innovation. "Our project leaders need to be experts in their domains. Otherwise they struggle to contribute, evaluate progress, control staff, innovate etc.", respondent 15 stated. Moreover, respondent 20 suggested that "most projects fail because the leader fails. It is a difficult task to lead a project in such business as ours, it requires a whole set of skills like understanding technical aspects, solving managerial and marketing issues, addressing communication problems within the team and outside of it, solving conflicts etc.". Respondent 8 added that an "active leader is part of the team. You may effectively communicate with people only if you are accepted as one of them", and, in relation to innovation, "you need to stay alert for all the emerging ideas, but then again, we also have superiors. Sometimes you want to act but your hands are tied". Previous evidence suggested that in project-oriented companies, the role of a project manager is simpler than in non-project-oriented ones (Hobday, 2000). The present study contradicts such a conclusion, and the difference is clearly explained by the specificity of KIBS. It seems that in project-oriented KIBS, the role of a project leader needs to be stressed, from day-to-day management to the active, spontaneous support and development of innovation. Functions such as coordination, translation and integration of the demands of different departments are insufficient, as the lack of an R&D department forces project leaders to take over responsibility for innovation.

The second category concerned the implementation and utilisation of a management control system or its specific tools. It emphasized the role of planning and controlling in increasing the innovativeness of project-oriented KIBS operating in CEE. 16 respondents stressed the importance of planning for the effective execution of projects in KIBS. Most respondents perceived planning as an essential component of project management, because there are few permanent organisational structures. Firstly, it “helps maintain focus on the issue of interest” (respondent 5) and makes it “clear what should be done, by whom and when” (respondent 19). Secondly, in relation to innovation, respondent 7 pointed that “budgetary constraints are reluctantly accepted, but stimulate people to search for the most effective solutions”. This observation further supports the previous considerations (Ernst, 2002; Henard and Szymanski, 2001; Van der Panne, 2003). On a different note, respondent 22 stated that “each project is different. We are not really able to plan much. Conditions tend to change quickly and we need to respond, irrespectively of what we have planned in advance”. Such contradictory statements demonstrate that the role of planning differs depending on the type of project managed by KIBS. While rigorous planning is suited to the needs of business projects, it fails to provide the flexibility that is much needed in innovation projects. Again, such an observation supports previous evidence (Blindenbach-Driessen & Van den Ende, 2006; Lewis, Dehler, and Green, 2002). The present study adds to previous knowledge by formulating an additional conclusion: as far as business projects are concerned, one aspect of planning in particular may foster innovativeness, and this is well-specified resource allocation, including budgets. Limited resources push the staff to look for ways to reduce resource usage through process innovation. Moreover, respondent 5 indicated that precise organization and controlling lead to waste minimization, which leaves greater funds for “ad hoc” innovation if needed. Lastly, the more complex the business project, the less benefit there is from precise planning. As far as innovation projects are concerned, the benefits of both planning and establishing a tight budget are distinctively smaller than in the case of business projects.

The potential moderator concerning planning was distinct from that of controlling, which was discussed by 8 respondents. It seems that controlling the projects throughout their execution by KIBS increases the chances for innovation to emerge. One purpose of a management control system is to point out any deviations from the initial plan. Thus, a controlling system clearly indicates the areas in which the goals are not met, and ones in which change is needed. “Even though maintaining formal control in an operation such as ours is challenging, it is worth making the effort. On the one hand, you can control the expenditures, on the other, it serves a clearly motivational purpose, as falling behind the plan pushes people to look for better solutions”, respondent 9 stated. Furthermore, respondent 9 added: “you should not impose the controls on the team members, you should work them out with the team before the project starts. Also, once the controls are set, you should not intervene in decision-making at the project level, they will know best what to do”. It seems, therefore, that extensive involvement is likely to hinder creativity and innovation. These conclusions are consistent with previous evidence,

indicating that early and interactive decision-making regarding control mechanisms is important for effective projects (Bonner, Ruekert Walker, 2003). The above considerations complement previous evidence by indicating rather clearly the optimum level of managerial involvement in innovation projects realised in KIBS companies – collaboratively developing a controlling mechanism (including performance indicators) and then controlling for deviations, while leaving the execution of the project entirely to the project team.

The third category clusters all the potential moderators concerning staff involved in the execution of projects, especially staff competences and the composition of project teams. Twelve interviewees underlined the importance of high competences in employees' respective fields of expertise. It turns out that the involvement of highly competent staff in projects contributes to higher company innovativeness. This is especially important in the case of KIBS, which rely heavily on engineers, scientists, and other experts. In such companies, human resources constitute a stronger basis for innovation than in other service companies. The mix of highly competent workers within KIBS creates a favourable environment for innovation. In this vein, respondent 11 stated: "the projects that we pursue are complex, and thus we need the best qualified staff. We are lucky to gather some great specialists and they clearly contribute to our advantage". Thus, it seems that what drives innovativeness in KIBS is the right coordination of highly competent staff. As explained in previous studies, KIBS perform complex operations of an intellectual nature, in which strong competences are the dominant success factor (Carmona-Lavado, Cuevas-Rodríguez, Cabello-Medina, 2013). In this context, the present study adds the conclusion that in their innovation activities, KIBS in CEE may rely to a large extent on what is already at their disposal, before chasing novel ideas from outside of the company. It is a clearly distinctive characteristic of KIBS, which works very much to their advantage compared to the general population of service providers.

Furthermore, project-oriented KIBS rely on project teams that vary in composition from one project to another. 17 respondents referred to the right composition of teams as a critical innovation success factor. "We all need to speak the same language; otherwise numerous conflicts arise. Technical aspects that are obvious for our engineers seem like secret knowledge to some of our staff, it's not easy to explain everything to everyone" (respondent 18). It appears, however, that there is also a bright side to multidisciplinary: "sometimes you look for a solution, and you don't even know that the problem is long solved and all you need to do is ask your colleague" (respondent 22). There was general agreement that joining different areas of expertise within a project creates favourable conditions for innovation to emerge. In this context, most evidence to date indicated that effectively collaborating multidisciplinary teams are the very basis of effective project execution (Cooper, 2001; Lovelace, Shapiro, Weingart, 2001). The present study adds to the previous conclusions by indicating that the specific nature of KIBS strongly impacts the composition of project teams and the mutual understanding among team members. Such entities usually employ representatives of different

specialties (both technical and non-technical). In subsequent projects, the staff tend to mix as they are assigned to different teams. From one project to another, the specialisation gap between workers diminishes, communication issues vanish, and the benefits of multidisciplinary, including innovation development, emerge. In non-project-based organisations, intra-company staff rotation tends to be smaller, and interpretative barriers between functional departments may prevail. Thus, the participation of staff representing different specialties serves innovation only in those companies that successfully diminish the interpretative barriers, one of which are project-based KIBS.

The fourth category included different types of interactions, with special regard to project integrations, interactions with clients, and interactions with staff. One important feature of project-based KIBS is that projects interact with one another. Almost a half of the respondents ($n = 10$) referred to the formal and informal interactions between project teams as an important success factor for innovation. As respondent 1 claimed: “we often pursue projects in related market segments. In such cases, it is important to exploit synergies. Once a project advances, the other projects should also benefit”. Such a conclusion may also be found in the existing scientific evidence. Especially Girotra, Terwiesch and Ulrich (2007) claim that the success of a project may be determined to a large extent by project interactions. The issue of project interactions was elaborated by Eilat, Golany and Shtub (2006), who concluded that interactions take place on three levels: that of resources (projects share the same resources), benefits (complementary and competitive projects), and outcomes (probability of a given project’s success depends on whether another project is undertaken). Importantly, in the case of KIBS, the benefits of interactions seemed to differ from one company to another. A possible explanation is that some of the firms concentrated on a particular market, while others offered their services to a wider range of clients. This is important for the way product and process innovation spreads across the KIBS. In the former case, project interactions allow for product innovations to penetrate from one project to another. It is the product innovation that, once it has been offered to a client, becomes a standard offering of the company and thus passes to other projects. In the latter case, the services offered tend to be highly diversified and therefore, the product innovation flow is unlikely. However, process innovation may still be effectively transmitted between projects. Thus, the present study complements previous research by indicating that the way innovation spreads across the company depended on the market(s) to which a KIBS company offered its services. Also, focus on a particular market supported continuity and the emergence of outcome interactions. Concerning resource interactions in project-oriented KIBS, the dominance of business projects over innovation projects hinders the development of the latter, as in most cases it is especially challenging for them to successfully compete for resources.

The second potential moderator that emerged within the “interactions” category involved communication with clients. According to the respondents, it constituted one of the most important links between project orientation and innovativeness ($n = 16$). Respondent 3 indicated

that: “sometimes you don’t have to look for innovation or spend any funds on ‘inventing’”. The innovation is right before you, you just have to listen carefully to your clients (...). It may turn out that just by following your client’s request you provide something new, that has never been provided before”. It appears that the specificity of KIBS was indirectly captured in the above statement. Providing individually tailored solutions, each of which is to some extent different from the others, entails a certain degree of novelty each time the service is provided. Thus, simply responding to the market needs may already make a company innovative. Moreover, “if a client needs a solution, it is likely that his competitors will need a similar one. So once a new service is developed, the solution might ultimately spread into wider use”, respondent 17 said. To some extent, this observation corresponds to previous evidence, which indicated that the client and the service provider may engage in an interaction within which new knowledge is created and shared. The process is effective when the customers possess high competences in their domain (Kemppilä & Mettänen, 2004). In this vein, the present study delivers further support for the previous conclusions, this time in the context of KIBS, where client-supplier cooperation is inscribed in the very essence of business activity.

The third potential moderator in the “interactions” category included interactions with staff. Though the study was conducted mainly among managers and project leaders, the role of staff in innovation activities pursued by KIBS was widely recognized ($n = 18$). Respondent 14 elaborated on the idea as follows: “I am of the opinion that the real innovation comes from our staff, from the ones that actually do stuff on the daily basis. Most of the valuable ideas were worked out in the actual process of service provision, not during the meetings, brainstorming, workshops etc.” Project orientation and the lack of a dedicated R&D department forces KIBS to look for other ways to develop innovation. The present study supplements previous evidence by emphasizing the importance of the “inventing by doing” approach in the KIBS setting. Consequently, it is the staff that are the most predisposed to come up with new ideas. This conclusion complements the previous scientific evidence on generativity (e.g. Kleysen, Street 2001). It indicates that the characteristics of KIBS – such as employing highly qualified specialists in the field and the lack of an R&D department – mean that the “inventing by doing” tactics are a much more effective way of innovation development than in other sectors.

The fifth category encompasses the broadly understood role of information in innovation development activities. Within this category, the respondents indirectly addressed the issue of reproducibility, which is especially challenging for project-oriented KIBS. Seven respondents were of the opinion that formalised projects, which satisfy the internal reporting principles, tend to contribute more to the company’s innovativeness in terms of reproducibility. It appears that when the progress of a project is well documented, the new solutions that have been developed are more easily reused and extended to other markets. The lack of such documentation bonds the know-how with particular staff, and hinders its spread across the company. Respondent 9 explained it as follows: “no one likes documentation, but at the end of the day, it has its merits. You may look at what has been done and see what you don’t have to

do any more. Also, you may find and implement in your project a whole bunch of clever solutions which are reported there. Otherwise some good solution may have gone unnoticed". The conclusion complements the previous evidence on the benefits of documentation by introducing the reproducibility-based advantage, which seemed neglected in scientific investigation to date. The existing evidence enumerated only such benefits as the use of non-financial reports as an opportunity to check corporate strategic positioning, redefine mission and values, evaluate progress, reorient corporate action, manage relationships with stakeholders, redefine responsibilities and tasks, enhance collaboration, identify synergies among divisions and corporate functions (Perrini, 2006).

Next, the respondents addressed the issue of information availability. In sectors like KIBS, the importance of information and knowledge is great by definition. The implementation of project orientation may hinder the free flow of information, as new knowledge developed within a project may remain within a single team. More than a half of the respondents ($n = 12$) referred to the issue of structural tools and informal actions enabling information-sharing and, ultimately, innovation. "We would like for all the staff to share their experiences; it would have saved us a whole lot of time and effort. In order to do so, we encourage our staff to share during the week-opening meeting. Until now, it works just fine", respondent 3 stated. Previous evidence showed that information availability is one of the crucial success factors at the project level, comparable to transparency (Martinsuo, Lehtonen, 2007). High availability of information improves decision-making quality and supports innovation development efforts. Again, what is important in the context of KIBS is that informal tools designed for information exchange can support reproducibility (complementing internal reporting), which constitutes a considerable challenge in project-based organizations.

The sixth category, widely discussed by the respondents, may be jointly described as "attitudes". Almost all respondents referred to it at some point ($n = 19$). It seems that two potential moderators emerged with particular clarity: willingness to innovate, and risk appetite. Willingness to innovate, both among the staff involved in the project and the managers in charge, contributes positively to KIBS' innovativeness. While such a statement may be considered a truism, what actually attracts attention is the issue of how to actively stimulate a willingness to innovate in KIBS that are strongly dominated by business activity. Respondent 11 brought attention to an important characteristic of KIBS in this context: "when we compare ourselves to other sectors, our offering is heterogenous and ephemeral. The effect of the project execution is not something you can touch and preserve". Thus, a similar sense of vanishing may exist in the case of innovation, which is there for a while and then gets lost somewhere amid the daily business activity. In this vein, respondent 7 continued: "what we need in order to stay innovative are the continuous minor improvements that remind us of the importance of innovation. We do not have our big R&D department that serves this purpose, and these little things make innovation activities noticeable, remind us that there is something more than the quarterly profit". The conclusion that in KIBS, where results are ephemeral,

successful innovation management requires for the staff to be constantly reminded of the importance of innovation, and one effective reminding tool is the promotion of numerous minor improvements, which allows for innovation to remain on the surface, seems to be a novelty. It complements the already well-developed set of tools and behaviours that leaders use to influence employees' innovative behaviours (De Jong, Den Hartog, 2007).

Respondents indicated that the appetite for risk increases the chances for radical innovation in KIBS. In contrast to minor improvements that sustain willingness to innovate, it may constitute an efficient tool for differentiation on the market and help establish a strong competitive advantage. As respondent 1 explained: "Risk appetite, if you want to call it this way, is a very important factor. The best idea will vanish if there is no one to pursue it. Sadly, some people tend to defend the current status quo and act against all changes". It appears that the fundamental distinction should be made here between risk associated with the feasibility of the project and risk associated with market success. While the former should be addressed by the project team, the latter is the domain of senior management. The importance of risk appetite with regard to innovativeness complements previous scientific evidence, which indicated that risk aversion had a significant positive impact on the likelihood of KIBS firms developing innovation capabilities involving external and internal R&D (Amara, Landry, Halilem, Traoré, 2010). Here, the difference in findings may be due to the different spatial scope (the study performed in Canada) and subject scope (engineering services, computer system designs services and management consulting services) of the previous research.

5. Conclusion

The present study contributed to literature on the relationship between project orientation and innovativeness in T-KIBS. Its theoretical contribution consisted in determining the categories and potential moderators that are key in increasing company innovativeness in project-oriented KIBS. In the study, the project-oriented organisation perspective was adopted and the role of administration, management control, staff, interactions, information and attitudes – as elements improving strategic management, organisational behaviour, and organisational design, and ultimately resulting in improved innovativeness – was emphasised. Therefore, the following research question was addressed: how and why project orientation contributes to higher innovativeness? In the study, a specific context was proposed for examining the relationship between project orientation and innovativeness – namely, the research scope was narrowed to the T-KIBS sector in order to account for its specificity. Such a setting corresponds to practical and theoretical gaps in knowledge on project management.

The data was gathered from 22 semi-structured interviews performed in the third and fourth quarters of 2018, in 12 technology-based companies offering knowledge-intensive business services, operating in Central and Eastern Europe. It targeted respondents best informed on the impact of introducing project-based organisation on innovativeness, i.e. senior management, project leaders, and innovation managers.

The study corroborated previous evidence indicating a positive relationship between project-based organisation and company innovativeness (Wald et al., 2015b). However, it demonstrated that the mechanism behind increasing innovativeness through the implementation of project-based organisation is not straightforward. Based on the data gathered, an analytical framework representing the relationship between project orientation and innovativeness was proposed, consisting of six categories within which 13 potential moderators are clustered. The framework is as follows: administration (management support and project leader), management control (planning and controlling), staff (employee competences and multidisciplinary teams), interactions (with staff, with clients, and between projects), information (internal reporting and information availability), and attitudes (risk appetite and willingness to innovate).

Given the re-confirmatory character of the study focused on the specificity of T-KIBS, its managerial implications are limited. However, managers may take advantage of the patterns described, as these provide valuable insights into some aspects of project orientation and innovativeness within KIBS in CEE. In order to provide greater clarity and practical applicability, the most important moderators based on the frequency and emphasis they received in the interviews were provided. In particular, managerial support, the right composition of teams and planning emerged as the most frequently mentioned (referred to by 19, 17 and 16 respondents, respectively). Other moderators received relatively fewer explicit references, they nonetheless underpin many of the processes needed for effective knowledge sharing and reproducibility. Indicating these three moderators offers a practical starting point for managers to prioritize resource allocation and policy interventions according to the areas deemed most critical for enhancing innovativeness in project-oriented T-KIBS. Following further confirmation in a large-scale study allowing for the generalisation of results, the proposed framework may ultimately become a managerial tool.

Future research could examine how the application of project orientation translates into long-term success of T-KIBS companies. Moreover, quantitative research on the impact of project-based organisation on company innovativeness in the context of T-KIBS seems of vital theoretical and practical importance. Further investigation including cross-country comparisons would clarify if the dynamics observed in Central and Eastern Europe hold true in other geographic regions. Additional longitudinal studies would help clarify the causal relationships between project orientation, staff autonomy, and organizational innovativeness over time. Moreover, there seems to be scientific potential in exploring the role of digital technologies and artificial intelligence in enhancing co-production and documentation processes in T-KIBS.

Findings from the study clearly appear to have answered the research question. However, the investigation was not free of limitations. First of all, though the study investigated the opinions of individuals that are best informed on the subject matter, this means that it solely presents the managerial perspective. Thus, one must be aware that the opinion of front-end employees may have been different. Second of all, due to the specific context of the study, its results are only applicable to T-KIBS companies. Third of all, while the snowballing procedure enabled obtaining a more comprehensive view of project-based organisation, it may have potentially increased the desirability bias (whereby interviewees say what they think their peers want them to say). As the interviewees knew that their associates suggested them as potential subjects, they may have tended to respond in a conservative manner.

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INNOVATIONS IN THE PUBLIC SECTOR IN RESPONSE TO THE CHALLENGES OF NEURODIVERSITY – FINDINGS FROM KRAKOW

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Purpose: The article analyzes innovations in public services in the context of the specific needs of neurodivergent individuals. The aim of the study is to identify key challenges associated with the implementation of these solutions and to evaluate their effectiveness based on an analysis of selected public services in Krakow.

Design/methodology/approach: The article employs a mixed-method approach, combining a literature review on innovations in the public sector and neurodiversity issues with empirical research. The study involved a survey conducted among students of Krakow's universities (N = 624) and a focus group interview with experts. The survey assessed the perception of the need for public service adaptations, while the expert interview provided in-depth insights into the challenges associated with implementing innovations in this area.

Findings: The majority of respondents recognize the need for improvements in the sensory accessibility of public services. The study indicates that this issue is systemic and requires a comprehensive approach. The findings also highlight a low level of public awareness regarding the needs of individuals on the autism spectrum and emphasize the necessity of actively involving them in the process of designing and evaluating implemented solutions.

Research limitations/implications: Given that the study was conducted among students, its results cannot be directly generalized to the entire population. It is recommended to extend the analysis to other user groups and a broader range of public services.

Practical implications: The research findings indicate the need to view adaptations for neurodivergent individuals not only as a legal requirement but as an integral part of a modern approach to public service management. The implementation of innovations in this area should incorporate evaluation mechanisms and active user participation, which will enhance the effectiveness of the adopted solutions.

Social implications: The analysis highlights the importance of raising public awareness about the needs of neurodivergent individuals and the necessity of conducting educational initiatives. Improving the accessibility of public services can contribute to greater social inclusion and an enhanced quality of life for individuals on the autism spectrum.

Originality/value: The article introduces a new perspective to research on public sector innovations, presenting adaptations for neurodivergent individuals as an integral part of public service management strategies. The findings may be useful for policymakers, researchers,

and public organizations seeking effective methods to adapt services to the needs of neurodivergent individuals.

Keywords: public services, public sector innovations, neurodiversity.

Category of the paper: Research paper.

1. Introduction

The issue of neurodiversity is a contemporary and still insufficiently explored area in management and quality sciences (Richards, Sang, 2016; Mellifont, 2020; Priscott, Allen, 2021; Spoor et al., 2022). The term neurodiversity is currently used in the literature in a rather broad sense, referring to various neurodevelopmental differences observed within the population. The resulting cognitive differences are often perceived positively as "naturally occurring types of cognitive mechanisms characterized by specific advantages that have contributed to technological and cultural development" (Silberman, 2017, p. 23). However, it is worth noting that the original understanding of the term was narrower and specifically associated with the autism spectrum (Singer, 1999, as cited in Jaarsma, Welin, 2012, p. 20). Given the specificity of different neurodevelopmental variations, in this article, the term neurodiversity will be used in this narrower sense – referring to the cognitive differences characteristic of individuals on the autism spectrum.

The relevance of research on neurodiversity is increasing due to the rising number of autism diagnoses and, consequently, the necessity of incorporating the perspectives of neurodivergent individuals in organizational activities. This is particularly significant for entities operating within the public sector, whose role is to achieve social goals and ensure equal access to services. Concern for this issue is also reflected in legal regulations, such as the Convention on the Rights of Persons with Disabilities (2006), ratified in Poland in 2012. According to Article 9 of the convention, individuals on the autism spectrum have the right to full participation in social life, including access to transportation and publicly available services and facilities.

The aim of this article is to discuss the necessary adaptations of public services to meet the needs of neurodivergent individuals and to assess how innovative solutions can contribute to increasing their accessibility. Two key research questions are formulated in this study: (1) What specific adaptations in transportation and entertainment services are considered essential from the perspective of individuals on the autism spectrum? (2) What are the opinions of users of selected public services in Krakow regarding the implemented accommodations for individuals on the autism spectrum? To address these questions, a literature review was conducted on the difficulties experienced by neurodivergent individuals and the mechanisms for implementing innovations in the public sector. Additionally, empirical research was carried out, including a survey among public service users in Krakow and a focus group interview with

experts. The analysis of the collected data allowed for the formulation of recommendations for public sector entities seeking to introduce innovative solutions that enhance accessibility and improve the quality of life for individuals on the autism spectrum.

2. Innovations in public services and the needs of neurodivergent individuals – theoretical background

The concept of autism as a diagnostic category within pervasive developmental disorders was introduced in the third edition of the *Diagnostic and Statistical Manual of Mental Disorders – DSM* by the American Psychiatric Association in 1980 (Grandin, Panek, 2021). However, research on autism had begun earlier, initiated by Leo Kanner's article "Autistic Disturbances of Affective Contact", published in *Nervous Child* in 1943. Today, the term pervasive developmental disorders has been replaced with autism spectrum disorder (ASD), and symptom descriptions, which account for severity and their impact on daily functioning, are classified using a three-level grading system (American Psychiatric Association, 2013).

In Poland, autism spectrum disorder (code 6A02) is diagnosed based on the International Classification of Diseases (ICD-11), which has been in effect since January 1, 2022, as developed by the World Health Organization. The diagnostic criteria in both classifications include persistent deficits in the ability to initiate and sustain reciprocal social interactions and communication, as well as a range of restricted, repetitive, and inflexible patterns of behavior, interests, or activities that are markedly atypical or excessive relative to age and sociocultural context (ICD-11 for Mortality and Morbidity Statistics).

In Poland, autism spectrum disorder (ASD) was incorporated into the disability certification system only in 2010, which may contribute to an underestimation of its actual prevalence (Supreme Audit Office, 2020). Undoubtedly, both in Poland and worldwide, there has been a dynamic increase in autism diagnoses – while in the 1980s, autism was diagnosed in 1 in 2000 children (0.05%), today it is identified in 1 in 100 children in Europe (Ferenc, 2020) and 1 in 54 children in the United States (Wright, 2020). In the European Union, approximately 5 million people (0.6%) are estimated to be on the autism spectrum, whereas in Poland, the number is estimated at around 45,000 individuals. The growing proportion of neurodivergent individuals in society necessitates a discussion on incorporating the perspective of neurodiversity into organizational activities, particularly within public service entities. Given their social mission, these organizations should be capable of flexibly responding to the diverse needs of their users to ensure accessibility and inclusion.

Among the challenges faced by individuals on the autism spectrum, sensory issues deserve particular attention, as they significantly limit the ability to fully utilize public services. A review of the literature indicates that over 90% of neurodivergent individuals experience

sensory integration disorders or exhibit an unusual sensitivity to sensory aspects of their environment (Chang et al., 2014). Sensory integration is the process in which information received by the brain through the senses is registered, sorted, and processed, then combined with previous experiences to enable an appropriate response to stimuli (Ayres, 1986). Disruptions in this process manifest as abnormal sensory reactivity, either hypersensitivity or hyposensitivity to light, colors, specific sounds, smells, or tastes (Grzywniak, 2016). Additionally, individuals with such dysfunctions are more prone to experiencing sensory overload, often with greater intensity (Karthikeyan, 2017). It is also important to emphasize that excessive stimulation of one or multiple senses may lead to their temporary "shutdown" or trigger a "fight or flight" response, thereby impairing the proper processing of sensory stimuli (Priporas et al., 2024).

Adapting public services to accommodate sensory integration disorders presents a significant challenge for service providers. The fact that these difficulties are common among individuals on the autism spectrum does not imply that a single, universal solution can address their needs. Public services encompass a wide range of sectors, including transportation, administration, healthcare, education, and culture, each varying in both the nature and intensity of sensory stimuli that may be distressing to sensory-sensitive individuals. Additionally, the feasibility of implementing modifications differs across sectors, necessitating tailored solutions adapted to the specific characteristics of each service. One example of such adaptations includes quiet hours in libraries and museums, during which noise levels and bright lighting are reduced to create a more accommodating environment for individuals sensitive to sensory stimuli. Another effective measure is the creation of designated quiet zones in public spaces, allowing individuals with sensory hypersensitivity to retreat from excessive stimuli. Mobile applications also hold significant potential in various aspects of neurodivergent individuals' daily activities, such as task planning and navigation in urban spaces. These initiatives not only enhance the accessibility of public services but also promote inclusivity and a greater understanding of diverse community needs (Sitarz et al., 2024; Bolak et al., 2024).

It is important to emphasize that efforts to improve the accessibility and comfort of public services for neurodivergent individuals are not optional but rather a legal obligation. In this context, general regulations concerning people with disabilities can be referenced. In Poland, the right of individuals with disabilities to fully participate in all aspects of life, including access to transportation, services, and public facilities, is guaranteed under Article 9 of the Convention on the Rights of Persons with Disabilities, which was ratified in 2012 (Convention on the Rights of Persons with Disabilities, 2006). Access to public services is crucial for fostering the independence of these individuals and enabling their full participation in society. Additionally, specific regulations apply directly to individuals on the autism spectrum. According to the Charter of Rights for Persons with Autism (2013), adopted by the Polish Parliament, these individuals are entitled to, among other things, support in using

transportation adapted to their needs and abilities, participation in cultural and entertainment activities, recreation, and sports, as well as equal access to public services and opportunities for social engagement.

The activities of public sector entities aimed at operationalizing these requirements generate numerous management challenges. The complexity of this process means that its explanation can be sought in various theoretical frameworks, such as change management, project management, and stakeholder relationship management (Joyce, 2015; Flynn, Asquer, 2016). Particularly useful in this context are diagnoses formulated within the field of public sector innovation management, which help explain the mechanisms, factors, and barriers associated with the implementation of such solutions (Dameri, Ricciardi, 2015; Bertot et al., 2016; Cinar et al., 2018).

For many years after the emergence of innovation as a concept in economic and management literature, it was primarily associated with private enterprises, where it played a key role in building competitive advantage and creating market value. However, since the 1990s, the significance of innovation in the public sector has been increasingly recognized. In this domain, innovation is seen as a tool for improving administrative efficiency, enhancing the quality and accessibility of public services, and responding to emerging societal challenges (Moore, 1995; Osborne, 1998; Gallouj, Savona, 2009). The way innovation is defined in the public sector is similar to its interpretation in business. It is typically understood as the practical implementation of new or significantly improved processes, technologies, organizational models, and service delivery methods, ultimately leading to positive outcomes (Hartley, 2005; Windrum, Koch, 2008; Jabłoński, Firszt, 2024). In the public sector, the primary benefits of innovation should be social in nature, aimed at improving stakeholders' quality of life – for example, by reducing waiting times for administrative decisions, ensuring equal access to services, strengthening social cohesion, or streamlining communication between citizens and government institutions. Economic benefits, such as reducing institutional operating costs, are also desirable in the public sphere, but they do not necessarily take priority (Mulgan, Albury, 2003).

Solutions introduced in public services to address the needs of individuals on the autism spectrum can be considered innovations, as they involve the implementation of new or significantly improved methods of service organization and delivery. The process of designing and implementing such accommodations is often more complex than in the case of solutions for individuals with physical disabilities, as difficulties related to sensory perception are less intuitive and less recognized in public service management practices (Gaines et al., 2016; Płatos, Pisula, 2019). This necessitates an innovative and unconventional approach. The innovativeness of these initiatives is evident not only in technological advancements but also in procedural and social solutions. The establishment of quiet zones in public spaces or flexible service hours are examples of improvements that address the needs of neurodivergent individuals while also aligning with the broader concept of social innovation (Bason, 2017).

Given the scale of unmet needs among this group of public service users, it is clear that there is significant potential for implementing original and pioneering solutions in this area. At the same time, conducting benchmarking analyses is recommended to identify ideas that have already been implemented – even in pilot form – in other cities, countries, or institutions.

The specific operating conditions and objectives of public sector entities significantly influence the innovation processes they undertake. One of the fundamental differences between public sector innovations and those in the private sector is the critical importance of actively identifying citizen needs and expectations, as well as the subsequent evaluation of implemented solutions. While in the private sector, market research is conducted to understand consumer expectations and opinions, it is primarily market mechanisms that serve as the key informational and motivational forces. Innovators introduce new solutions with the aim of gaining a competitive advantage and improving profitability, with high demand and revenue generation serving as confirmation of their success. In the public sector, however, demand-driven innovation mechanisms are either nonexistent (e.g., in government administration) or weakened (e.g., in municipal enterprises operating as local monopolies). Properly directing innovation efforts is particularly crucial in this context, as the public sector operates within the framework of the principle of legality. This means that new solutions must be precisely designed to align with the mission and scope of responsibilities of a given institution while simultaneously providing a genuine response to the needs of service users (Osborne, Brown, 2011; De Vries et al., 2016). Clear differences also exist in the communication of implemented innovations. In the public sector, communication cannot be exclusively targeted at potential beneficiaries, as is common in the promotion of new products in the private sector. Instead, it is particularly important to reach the entire community, especially in the case of changes dedicated to individuals on the autism spectrum, whose specific needs may not be well understood by those outside this group.

The social impact of innovations in the public sector, which is often a top priority, may sometimes conflict with efforts to reduce costs and maximize economic efficiency. One example of such a conflict is the implementation of certain improvements for individuals on the autism spectrum, which may require more time-consuming procedures or specialized tools, such as quiet zones. The introduction of these measures can potentially reduce the efficiency of service delivery for other stakeholders or increase the operational costs of a given institution. However, this is the price of achieving greater social cohesion and enhancing the quality of life and opportunities for previously marginalized groups. It is important to note that these negative economic effects are often short-term and primarily related to the initial implementation phase. In the long run, as public sector employees gain experience, the efficiency of service delivery in its modified form may increase, and the services themselves may become more accessible and user-friendly for all (Hartley et al., 2013; Bason, 2017).

It is widely recognized that the effective implementation of innovation processes in the public sector requires the engagement of citizens at all stages of developing new solutions. This concept is referred to as citizen participation. This issue has been particularly well-diagnosed within discussions on the smart city framework, where the success of digital transformation in cities is closely linked to the active involvement of local communities in identifying needs, co-creating innovations, evaluating them, and continuously improving them (Granier, Kudo, 2016). In this context, particular emphasis is placed on the importance of open innovation, in which citizens are not merely recipients of services but also active participants in innovation processes – acting as reviewers and even co-creators of new solutions (Gassmann et al., 2010). When designing accommodations for individuals on the autism spectrum, the focus should not be limited to collaborating with organizations familiar with their specific needs. Instead, the innovation development process itself should be inclusive, meaning that neurodivergent individuals actively participate in design efforts as initiators, consultants, or testers. This approach aligns with the living labs concept – real-world environments for testing innovations, where collaboration between the public sector, private entities, and citizens leads to solutions that are better suited to social needs (Nguyen et al., 2022). Moreover, involving neurodivergent individuals in the design and implementation of innovations enables the utilization of their unique cognitive abilities. Research shows that autistic individuals often demonstrate strong analytical thinking skills, attention to detail, and the ability to identify patterns, which can be valuable assets in innovation development (Chown et al., 2017). Thus, neurodiversity emerges not only as a challenge in adapting public services but also as a creative resource that can contribute to the development of innovative solutions in the public sector.

3. Research methodology

To achieve the research objectives of this article, two research methods were employed. The first method was a focused group interview, a moderated discussion conducted with a small group of participants, aimed at gathering in-depth insights into opinions, experiences, and attitudes toward a specific issue. The discussion follows a predefined script, while allowing room for free exchange of views among participants (Kvale, 2023).

The interview was conducted during the expert panel discussion titled “Neurodiverse Organization – Characteristics, Benefits, Challenges”, held as part of the 16th International Scientific Conference “Knowledge – Economy – Society” (CMQ2024) on May 21, 2024, at the Cracow University of Economics. The discussion involved three experts, who were selected purposefully based on their experience in implementing neurodiversity perspectives in Polish organizations.

The survey research was conducted in the first half of 2023 among students from eight major universities in Krakow. The selection of this group as respondents for the analysis of the adaptation of selected public services (transport and entertainment) to the needs of individuals on the autism spectrum was based on the fact that students are among the most active users of urban infrastructure. They frequently use public transportation and participate in cultural, sports, and entertainment events, allowing them to provide an informed assessment of the quality and accessibility of the analyzed solutions. Pragmatic considerations also played an important role in this decision – the survey was part of a broader research project on the study conditions in Kraków, which facilitated the seamless integration of issues related to sensory accessibility into an already ongoing study. This approach enabled the use of well-established respondent recruitment procedures and ensured access to a large and relatively homogeneous group. Moreover, other studies indicate significant sensory barriers in academic environments (Pisula et al., 2024), suggesting that students – including neurodivergent individuals – may have a heightened awareness of the challenges associated with functioning in public spaces.

According to the 2023 Municipality Report (UMK, 2024), at the time of the study, 129,360 students were enrolled in higher education institutions in Krakow. Assuming a confidence level of 95%, a margin of error of 5%, and a population proportion of 50%, the minimum required sample size for this population was approximately 383 respondents. It was assumed that, in the context of the research problem, students form a relatively homogeneous population. Ultimately, 624 students participated in the study, with 618 fully completed questionnaires. This means that the minimum sample size requirement was met, and the results can be considered representative of the entire student population in Krakow.

The diagnostic tool used in the study was an online survey questionnaire, which students completed during their academic classes, after prior coordination of the survey schedule and distribution of the survey link to academic instructors conducting the classes.

4. Identification of the needs of neurodivergent individuals in public spaces – expert opinions

The experts participating in the focus group interview shared their opinions and insights on three key aspects of introducing accommodations for neurodivergent individuals: sensory accessibility in public services, customer service for neurodivergent individuals in public institutions, and the inclusion of both inclusivity and rationality criteria in the design of adaptations.

The panel participants unanimously emphasized that sensory factors play a crucial role in adapting public spaces to the needs of neurodivergent individuals. The discussion revealed a shared conclusion that public spaces in Poland are currently designed primarily with the standard user in mind, leading to the marginalization of individuals with different sensory needs. The experts highlighted that various neurodivergent groups have distinct requirements, making it essential to provide diverse solutions, such as the option to choose areas with different levels of sensory stimuli. As one expert noted: "Let's start by thinking about it, exploring, researching, and asking questions – and based on that, we can design or redesign public spaces."

The discussion also highlighted that the modern pace of life and technological advancements have significantly contributed to the increase in sensory overload issues, particularly among younger generations. As one expert noted: "Blue light, fast-paced living, the simple fact that we no longer ride animals but instead travel in machines that reach speeds of 100–200 km/h – these factors stimulate our brains in completely different ways. (...) These are the effects of civilization." The experts emphasized the need for implementing solutions such as quiet hours in government offices, service facilities, and cultural institutions, allowing individuals to access these spaces under conditions that minimize sensory stress. According to the participants, such initiatives have already yielded positive results in commercial spaces, such as shopping malls, and should be more widely adopted in public services.

The second area discussed during the interview was customer service in public institutions. Experts pointed out that the current system of interaction with service users does not always meet the needs of neurodivergent individuals, and the introduction of simple infrastructural changes could significantly improve their comfort and experience. One example given was the designation of individual service rooms, which are already successfully implemented in the banking sector. Such solutions help reduce stress levels and enable personalized communication with individuals who are sensory-sensitive. Another key issue is the need to simplify documentation used in offices and public institutions. Experts referred to the simplified forms and procedures introduced after the outbreak of the war in Ukraine, which significantly facilitated administrative support for citizens affected by the migration crisis. A similar approach could be applied to neurodivergent individuals, for whom complex instructions and lengthy procedures may represent a significant barrier.

The literature emphasizes that adaptations should be carefully designed to avoid unintended segmentation and isolation of neurodivergent individuals (Kenna, 2022), while also meeting rationality criteria, including financial feasibility, practical applicability, and maintaining service quality for other users (Brown, Coomes, 2015; Ortiz, 2020; Sheykhmaleki et al., 2021; Waisman-Nitzan, Gal, Schreuer, 2021; Petty et al., 2022). The experts unanimously confirmed the validity of these recommendations. Another important issue raised in the discussion was the involvement of neurodivergent individuals in the design process. Experts pointed out that initiatives undertaken without the active participation of this group may fail to reflect their actual needs. As one participant noted: "Let's not do this alone, because what matters to us

might be something entirely different." Collaboration with neurodivergent individuals could contribute to the development of more effective and practical solutions, ensuring that they are not merely a formal compliance with accessibility requirements, but a genuine form of support for users.

The experts also agreed that adaptations should not be viewed as privileges, but rather as a means of ensuring equal opportunities, similar to accommodations for individuals with disabilities. As one participant emphasized: "These are not privileges; they are as objectively necessary as accommodations for people with disabilities."

5. Expectations regarding innovations and accommodations for individuals on the autism spectrum in selected public services in Krakow – survey results

The survey study collected opinions on two main topics: a general perspective on public sector innovation and a more specific focus on the adaptation of selected public services in Krakow. The analyzed services included public transportation, provided by Miejskie Przedsiębiorstwo Komunikacyjne S.A. (MPK Kraków), and entertainment services available at Tauron Arena Kraków, managed by Arena Kraków S.A. Both institutions are municipal companies owned by the City of Krakow, meaning that their operations fall within the public sector. The respondents expressed clear expectations regarding public sector innovation. The vast majority (nearly 80%) stated that the public sector should implement innovative solutions, with almost two-thirds of respondents viewing this as a fundamental obligation of public institutions. Only 1% of respondents believed that innovations in the public sphere are unnecessary (see Figure 1).

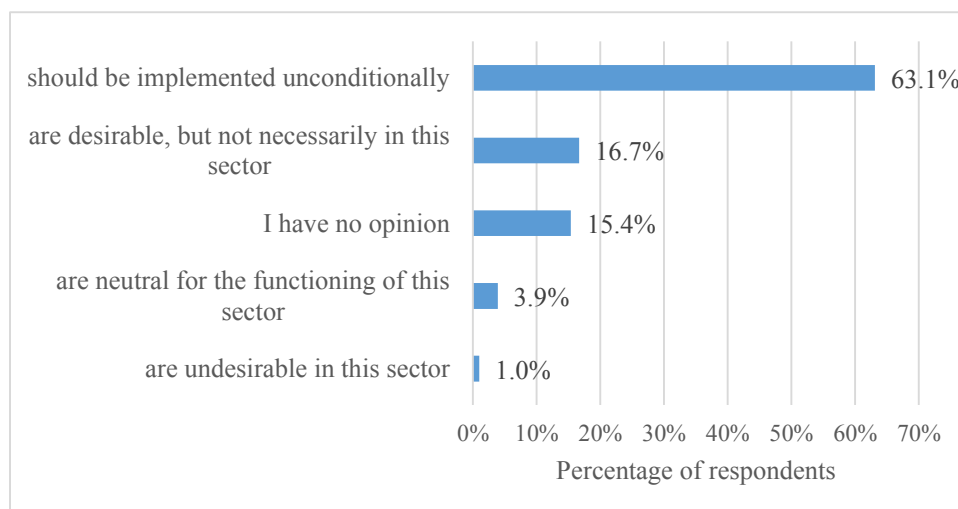


Figure 1. Respondents' perceptions of innovation in the public sector (N = 618).

Source: Own elaboration based on survey research.

When interpreting these results, it is important to note that the respondents were students, a group of young individuals who are typically more interested in new solutions across various areas of life. However, such clear and strong declarations suggest that, along with the evolving approach to public sector innovation in academic literature, public perception of this phenomenon is also shifting. It is also worth noting that the authors conducted a similar study a few years earlier (in 2019) on a comparable group of respondents. At that time, the percentage of individuals supporting innovation in the public sector was significantly lower – by approximately 25 percentage points (Jabłoński, Firszt, 2024).

In the next question, students were asked to identify specific issues that public sector innovations should focus on addressing. The responses obtained are illustrated in Figure 2.

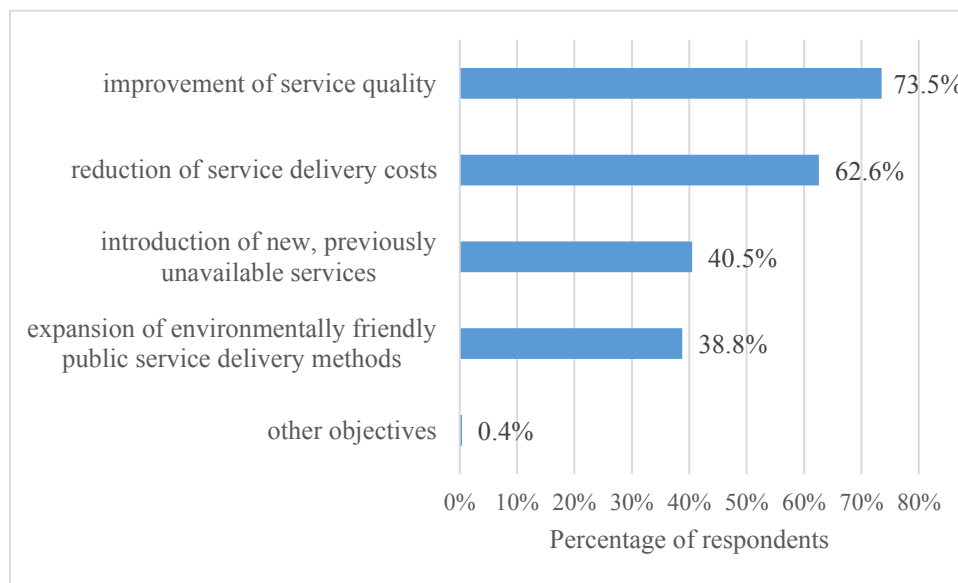


Figure 2. Respondents' opinions on desired directions of innovation in the public sector (N = 618).

Source: Own elaboration based on survey research.

Among the respondents, the prevailing view was that the primary goal of innovation in the public sector should be improving the quality of services provided. Nearly three-quarters of respondents expressed this expectation. Although the concept of quality is broad, it can be assumed that it also includes changes and accommodations that enhance service accessibility for individuals with specific needs. Respondents also recognized the potential economic benefits of an innovative approach to public services – nearly two-thirds of participants identified cost reduction as one of the expected outcomes of new solutions. In contrast, the scope for introducing entirely new services, which would be the equivalent of product innovation in the private sector, appears more limited – fewer than 40% of respondents expected that new, previously unavailable services would be introduced. A similar proportion of respondents believed that public sector innovations should focus on achieving positive environmental effects. It is important to note that this question allowed for multiple responses, meaning that the results do not sum to 100%.

When analyzing general issues related to innovation activity in the public sector, responses from all respondents were considered. However, for specific issues regarding adaptations aimed at the needs of neurodivergent individuals, it was deemed necessary to assess the respondents' level of knowledge on this subject. Taking into account the principle "Nothing about us without us", which is associated with the Convention on the Rights of Persons with Disabilities and was adopted as the theme of the United Nations' International Day of Persons with Disabilities in 2004, a question measuring familiarity with autism spectrum characteristics was included in the survey (Figure 3). Based on the responses, a decision was made to exclude from the analysis those respondents who declared a lack of knowledge on this issue.

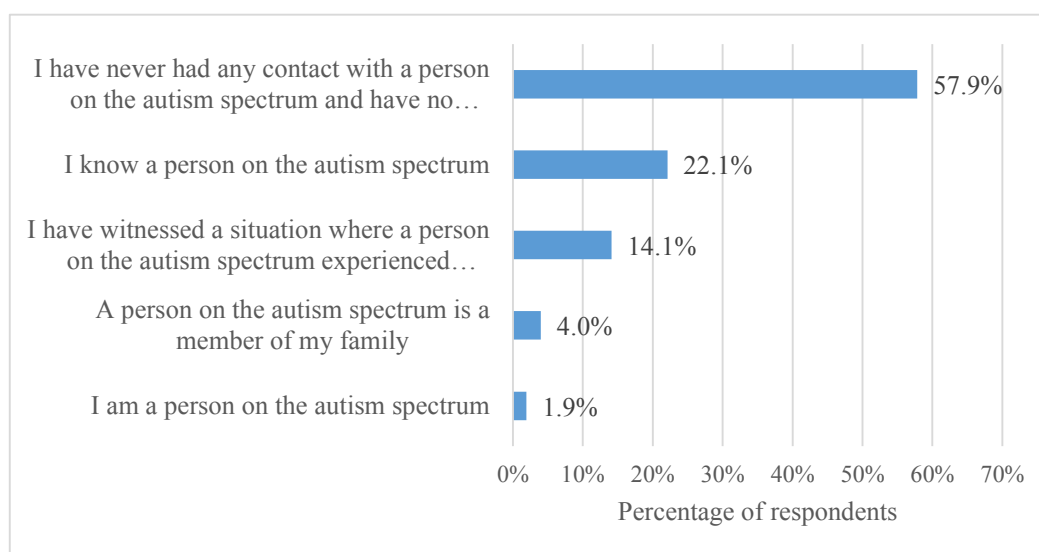


Figure 3. Respondents' declarations regarding their knowledge of autism and sources of information on the topic (N = 618).

Source: Own elaboration based on survey research.

The study results indicate that the specific challenges faced by individuals on the autism spectrum are not widely recognized among students in Krakow. Nearly 58% of respondents stated that they had never had any contact with individuals on the autism spectrum and had no knowledge on the subject. Among those who reported some level of experience, the largest group consisted of students who know someone with autism – this response was indicated by over 22% of participants. An interesting observation is that a significant portion of respondents (14%) had witnessed a situation where a neurodivergent individual encountered difficulties while using public services. This suggests that such barriers are noticeable not only to those directly affected but also to bystanders, which may imply that the lack of accommodations is not an isolated issue but a systemic challenge that requires attention. Additionally, 4% of respondents reported having a family member on the autism spectrum, while just under 2% identified themselves as autistic.

Analyzing these data, it can be observed that the prevalence of autism within the surveyed student population is comparable to U.S. statistics, which, as previously mentioned, indicate that 1 in 54 children is diagnosed with autism. If we extrapolate these findings to the entire

student population in Poland, estimated at approximately 1.25 million individuals (GUS, 2024), the number of autistic students in this group could be estimated at around 24,000. This estimate aligns with previous assumptions that official statistics, which report 45,000 autism cases in Poland across all age groups, may be significantly underestimated. However, these results should not be interpreted as definitive conclusions, due to interpretational limitations stemming from the sample – the findings are representative of students in Krakow, but not necessarily of students nationwide or the general population. It is also worth noting that the number of individuals identifying as autistic may be underreported due to lack of diagnosis, as many individuals receive a formal autism diagnosis only in adulthood.

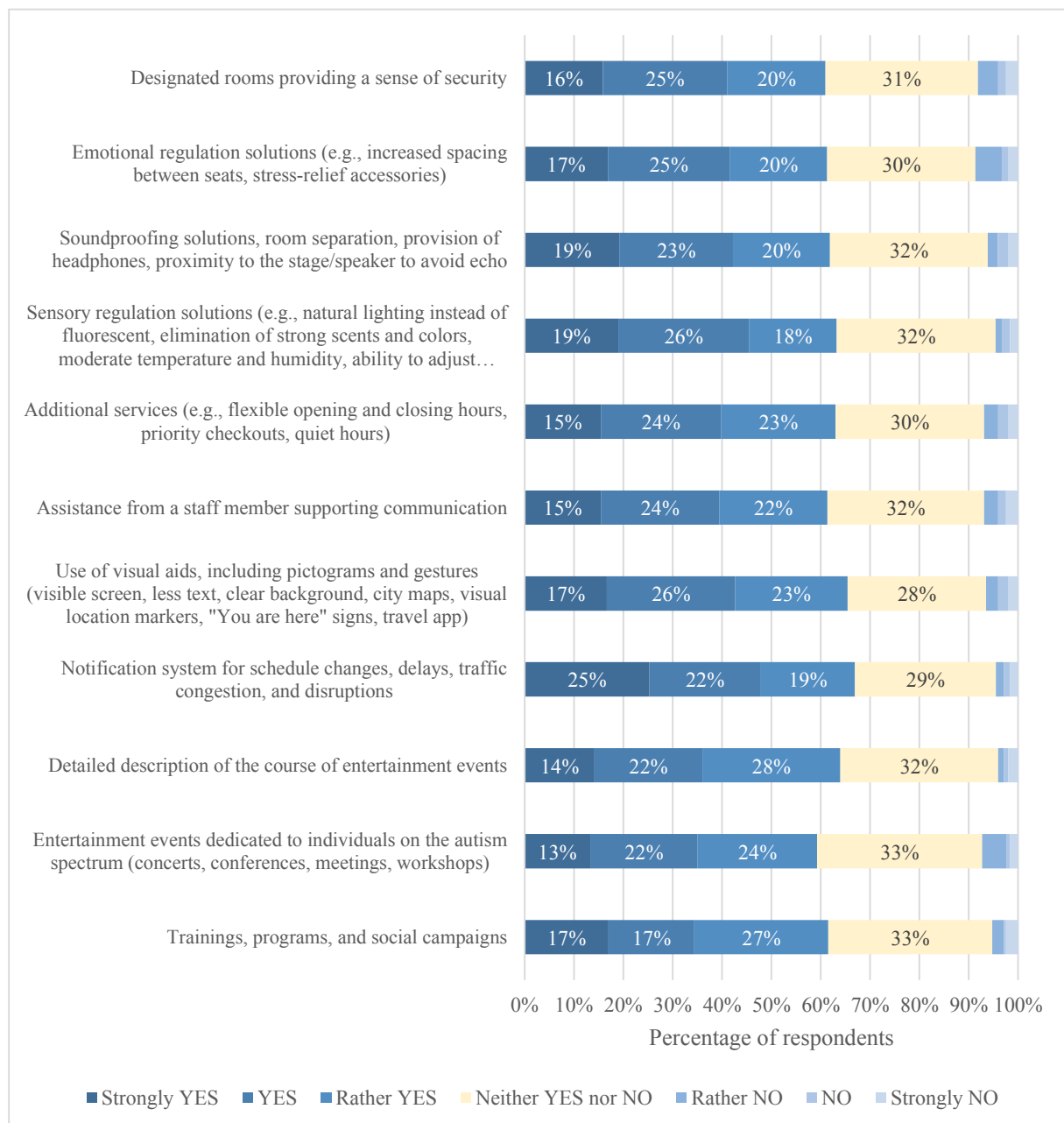


Figure 4. Responses to the question: Which actions implemented by MPK Kraków and Tauron Arena Kraków for individuals on the autism spectrum require improvement? (N = 260).

Source: Own elaboration based on survey research.

In the assessment of accommodations implemented in Krakow's transport and entertainment services, only the opinions of students who had encountered autism-related issues and had some knowledge on the topic were considered. There were 260 such individuals in the surveyed group. Students were asked to identify which measures implemented in Krakow's public transport services (MPK Kraków) and entertainment services (Tauron Arena) require improvements. Respondents could choose from 11 different measures, ranging from awareness campaigns and additional visual aids to architectural solutions, such as designating special spaces. The responses to this question are illustrated in Figure 4.

The survey results indicate that the majority of respondents recognize the need for improvements in all the measures for neurodivergent individuals included in the questionnaire. Notably, opinions on individual solutions are very similar – the percentage of respondents who selected "strongly yes", "yes", or "rather yes" ranges from 59% to 67%. The number of respondents who see no need for changes in any of the analyzed aspects is relatively low, never exceeding 10%. Meanwhile, around 30% of respondents remain undecided, regardless of which solution is being assessed. The only area that stands out from the rest (though not significantly) is the notification system for schedule changes and urban traffic management. In this case, 25% of respondents stated that improvements are definitely needed, while more than 75% expressed support for their implementation (combining responses "strongly yes", "yes", and "rather yes"). These findings, particularly the similar assessments of different measures, suggest that ensuring effective accommodations for neurodivergent individuals is a systemic challenge. Therefore, a comprehensive approach is required, one that encompasses both the standards for implementing accommodations and mechanisms for their ongoing evaluation and adaptation to the actual needs of users.

6. Conclusions and recommendations

In recent years, the needs of neurodivergent individuals have been gaining increasing attention in public policy, which is reflected in both legal regulations and nationwide accessibility initiatives. The development of the "Accessibility Plus" program and the introduction of the Act on Digital Accessibility of Public Entities are examples that highlight the growing awareness among policymakers regarding the need to eliminate barriers and create inclusive spaces for all citizens. This is undoubtedly a positive shift that paves the way for further improvements.

An analysis of the literature and expert opinions presented in this article leads to the conclusion that accommodations for neurodivergent individuals in public services should be viewed not only as a legal obligation but primarily as innovations in the public sector. Treating them solely as a top-down regulatory requirement carries the risk of implementing superficial

solutions that meet formal criteria but fail to address the actual needs of users. Achieving genuine improvements requires an innovative approach, encompassing technological and architectural solutions as well as procedural and organizational changes.

Both the design and evaluation of implemented accommodations should actively involve neurodivergent individuals. Including this group in these processes – as consultants, testers, or co-designers – will ensure that adaptations are genuinely useful and tailored to their needs. It is worth drawing on the experiences of cities implementing the smart city concept, where social participation is a key element of innovation policy. One of the most evident aspects of such participation is the effort to employ neurodivergent individuals in public administration and companies providing public services. Therefore, it is advisable to review recruitment procedures in these institutions to identify and eliminate barriers that may limit the employment opportunities for neurodivergent individuals. Enhancing the competencies of those responsible for recruitment is also of crucial importance. Training programs for managerial staff should not only focus on ensuring appropriate working conditions but also on effectively leveraging the unique cognitive and creative potential of neurodivergent individuals within organizational structures.

In the analyzed public services in Krakow (MPK Kraków and Tauron Arena Kraków), certain accommodations for neurodivergent individuals have been implemented. However, the research findings indicate that these measures are insufficient. Less than 10% of respondents considered the current solutions to be fully satisfactory, which clearly suggests a need for further improvements. Key areas requiring enhancement include, among others, the notification system for schedule changes and urban traffic management, which received particularly negative evaluations – 75% of respondents indicated the need for improvements in this aspect.

The low ratings of accommodations in public transport services can largely be explained by objective circumstances. The nature of public transportation (e.g., noise, crowding, and traffic disruptions due to construction work) makes it challenging to implement solutions that fully meet the needs of both hypersensitive and hyposensitive individuals. One possible approach is a more flexible system of visual and auditory notifications that would allow users to select their preferred level of communication intensity. Enhancements such as more intuitive maps and pictograms would serve as universal improvements, benefiting not only neurodivergent individuals but also other passenger groups, such as tourists and older adults. In some modes of transport, it may be worth considering the introduction of quiet zones or spaces designed to provide greater comfort for individuals with specific sensory needs. In the case of entertainment venues, such solutions appear easier to implement and could take the form of zones with varying levels of sensory stimulation, such as quiet rooms for hypersensitive individuals and sensory activation areas for hyposensitive individuals who function better in environments with increased sensory input.

One of the key challenges is the low level of public awareness regarding the needs of neurodivergent individuals. More than 58% of respondents reported having no knowledge on this topic. The implementation of innovations in public services should go hand in hand with educational initiatives and awareness campaigns aimed at increasing social understanding and acceptance of proposed solutions. In this context, municipal companies can utilize their informational displays at bus stops and within public transport vehicles, drawing inspiration from successful campaigns such as the promotion of tap water consumption led by Kraków Waterworks.

The research findings suggest that autism may be significantly more prevalent than indicated by official statistics. However, due to the specific characteristics of the surveyed population (students), these results cannot be regarded as definitive evidence. It is advisable to improve data collection methodologies to provide a more precise estimate of the scale of neurodiversity in Poland and its impact on public service usage.

The studies cited in this article were preliminary and conducted among students of Kraków's universities. Although this group frequently uses transport and entertainment services, it does not constitute a representative sample of the entire population. It is important to emphasize that the needs of neurodivergent individuals may vary depending on their age, lifestyle, and professional activity. While difficulties related to public transportation can be considered largely universal for this group of users, priorities may differ significantly in other areas – working adults may face the greatest challenges in accessing administrative services, whereas children and adolescents may encounter the most difficulties within the education system. Including representatives of these groups in future studies and expanding the analysis to cover additional areas of public services would provide a more comprehensive picture of sensory barriers and the effectiveness of existing solutions. Consequently, recommendations for innovations in the public sector could be better tailored to the diverse needs of service users.

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